



Published in final edited form as:

Sex Transm Dis. 2021 December 01; 48(12): S174–S179. doi:10.1097/OLQ.0000000000001536.

Enhancing U.S. Local, State, and Federal Preparedness Through Simulated Interactive Tabletop Exercises of a Mock Antibiotic-Resistant Gonorrhea Outbreak, 2018–2019

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Abstract

Background: Responding effectively to outbreaks of antibiotic-resistant gonorrhea (ARGC) in the future will likely prove challenging. Tabletop exercises (TTXs) may assist local, state, and federal public health officials evaluate existing ARGC outbreak response plans, strengthen preparedness and response effectiveness, and identify critical gaps to address before an outbreak.

Methods: In 2018 to 2019, Centers for Disease Control and Prevention (CDC) collaborated with state partners to develop and implement TTXs to simulate a public health emergency involving an ARGC outbreak. Before the TTXs, 2 state-local health department pairs developed ARGC outbreak response plans. During each 1-day exercise (in Indiana and Illinois), participants discussed roles, clinical management, public health response, and communication based on predeveloped response plans. Observers identified outbreak response strengths and gaps, and participants completed feedback forms.

Results: Forty-one (Illinois) and 48 people (Indiana) participated in each TTX, including sexually transmitted disease clinical staff, laboratorians, public health infectious disease program staff, and CDC observers. Strengths and gaps varied by jurisdiction, but identified gaps included: (1) local access to gonorrhea culture and timely antimicrobial susceptibility testing, (2) protocols for clinical management of suspected treatment failures, (3) communication plans, and (4) clarity regarding state and local responsibilities. The CDC observers identified opportunities to provide national-level technical assistance, foster local antimicrobial susceptibility testing, and develop

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Conflict of Interest and Sources of Funding: None declared.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

further response guidance. Tabletop exercises summary reports were used to guide modifications to local response plans to address gaps.

Conclusions: The TTXs allowed participants to practice responding to a simulated public health emergency and may have enhanced local response capacity. Centers for Disease Control and Prevention made TTX implementation materials publicly available.

With the uncertainty that accompanies a new global pandemic, public health agencies have had first-hand experience developing response efforts around evolving situations. To prepare for such response efforts, agencies often proactively develop response plans in advance of an outbreak. To further solidify emergency preparedness, public health officials may design and conduct tabletop exercises (TTXs) to test the robustness of and identify gaps in outbreak response plans in a learning environment; gaps can then be addressed by the participating agencies.¹⁻¹¹ Although TTXs are often conducted to address bioterrorism, nuclear or chemical threats, or infectious diseases, such as pandemic influenza, the authors are not aware of any TTXs that have addressed outbreaks of sexually transmitted diseases (STDs).⁸

Antibiotic-resistant gonorrhea (ARGC) is an emerging threat; emergence of gonococcal infections that are resistant to recommended therapy can undermine treatment success and control efforts.¹² Yet responding to an ARGC outbreak can be challenging. *Neisseria gonorrhoeae* may quickly spread through sexual networks, particularly if detection and treatment of patients are delayed and partners are not promptly notified, tested, and treated. Partner notification, testing, and treatment are hampered when patients have multiple or anonymous partners. Factors compounding the challenges and complexity of responding to an ARGC outbreak are anticipated to include uncertainty about optimal therapy, limited access to antimicrobial susceptibility testing (AST) by health care providers, and limited public health resources. The anticipated complexity of responding to such outbreaks suggests public health preparedness through development of outbreak response plans and TTXs would be beneficial. This article describes the design, implementation of, and key findings from TTXs that simulated a response to ARGC outbreaks conducted in 2 states.

METHODS

Planning for and Implementing the TTXs

Beginning in 2018, the Centers for Disease Control and Prevention (CDC)'s Division of STD Prevention (DSTDP) collaborated with CDC's Center for Preparedness and Response (CPR) and 2 state health departments (HDs) (Indiana Department of Health [IDOH] and Illinois Department of Public Health [IDPH]) to design, conduct, and evaluate an ARGC TTX. Indiana Department of Health, in partnership with the Marion County Public Health Department, participates in the CDC-supported *Strengthening the US Response to Resistant Gonorrhea (SURRG)* project; SURRG provides resources to build local and state capacity to rapidly detect (such as through expanded culture and AST) and respond to emerging gonococcal resistance.¹³ The IDPH does not participate in SURRG but was keenly interested in improving local and state ARGC preparedness; IDPH partnered with the Champaign-Urbana Public Health District (CUPHD) for the TTX.

Indiana Department of Health, IDPH, and CUPHD developed jurisdictional outbreak response plans informed by guidance and technical assistance from DSTDP.^{14,15} Topics the plans addressed were as follows: (1) defining the case definition for ARGC, (2) deciding the number of cases that would necessitate an outbreak response, and (3) establishing roles and responsibilities by state and local staff for outbreak response efforts.

The TTX planning committees were established in each state included staff members from the federal (CDC DSTDP and CPR staff), state, and local levels. For each TTX, CDC staff led the planning phase following CPR's Training & Exercise Program model, with 6 structured planning meetings over 6 months addressing TTX participation, structure, key roles (facilitator, evaluator, note taker), and other meeting logistics. The planning committees also provided feedback to CDC on the TTX scenario and developed educational resources and reference guides for participants. The CDC staff developed participant and facilitator manuals, facilitator slides, and a participant feedback form. Before the TTX, participants were invited to a webinar developed and hosted by CDC that provided an overview of ARGC.¹⁶

TTX Scenario

The scenario focused on an ARGC outbreak within the participants' jurisdiction. The scenario was structured in 3 modules: 1) preparedness, 2) response, and 3) recovery. In the first module, the state HD STD program director was contacted within a 2-week period by clinicians at 3 community clinics within the same local jurisdiction about patients with gonorrhea who experienced persistent symptoms despite having received CDC-recommended treatment, currently a 500-mg injection of ceftriaxone.¹⁷ A fourth such patient had just recently been identified at the HD STD clinic within that same jurisdiction. Discussion questions centered on steps to determine if these cases would be considered an outbreak, what clinical guidance would be provided to the health care providers of the patients, and at this point, public health actions the local and/or state HD STD programs would take (eg, case investigations, facilitating AST, and communications) and the envisioned structure of an outbreak response.

In the second module, *N. gonorrhoeae* isolates from the patients were found to be non-susceptible to ceftriaxone by in vitro AST (ie, indicating the infections may not respond to the recommended ceftriaxone treatment). Despite retreatment with a higher dose of ceftriaxone, one of the patients remained infected. Intravenous antibiotic therapy was attempted on this patient. Six new patients with suspected gonorrhea treatment failures were identified. Discussion questions centered on what additional actions and communications the local and/or state HDs would take, whether the envisioned structure of the response would change, identification of additional needed resources, any proposed changes to clinical guidance for local health care providers and HD surveillance systems, how to expand provider access to culture and AST, and the logistics of administering intravenous therapy.

In the third module scenario, multiple additional patients were identified who were unsuccessfully treated with recommended therapy; these patients were eventually cured either using an increased dose of ceftriaxone or intravenous antibiotic therapy. Cases were investigated and sexual partners to cases were contacted, tested, and treated. Over

the ensuing month, no further treatment failure cases were detected. Discussion questions focused on whether any response activities would continue at this stage of recovery, which activities to scale back, evaluation of the response, and any planned changes to the response plan based on the TTX.

Implementation

The TTX was a 6-hour, single-day, discussion-based exercise (in-person with some remote participation) conducted in Indianapolis, Indiana and Champaign, Illinois in April and May 2019. Two authors (K.S. and H.H.) served as the exercise director and exercise coordinator, respectively; a member of the IDOH Emergency Preparedness Division and IDPH Infectious Diseases Division moderated the exercise in their respective states. Participants (48 in Indiana and 41 in Illinois) included leaders and representatives from the state and county STD programs (including disease investigation field staff and clinicians), emergency response and preparedness programs, agency leadership, laboratory services, communications experts, and local health systems. The CDC staff from DSTDP and CPR served as observers. Participants were given a manual that included the scenario, outbreak response plan(s), and additional resource materials; the phased discussion questions were projected on a screen. Table assignments were developed before the event; IDOH used 3 tables with cross-discipline and cross-agency participation and IDPH had separate tables for each agency (IDPH, CUPHD, CDC). Participants were encouraged to interact with those seated at other tables. Between 60 and 70 minutes were allotted for each module. At the end of each module, participants seated at each table reported on their decisions and discussed with the larger group. At the end of the day, the facilitator led a debriefing discussion of the TTX and outbreak response plan strengths and areas for improvement. Dedicated evaluators and scribes took notes throughout the TTX.

After the TTX, participants completed a written feedback form. Federal and state preparedness staff produced a TTX summary document and After-Action Report, respectively, which both summarized the TTX and identified gaps in the outbreak response plans. State participants updated their outbreak response plans and made other preparedness enhancements based on gaps identified during the TTX.

RESULTS

Evaluation Findings

Among 43 participants who responded to the postexercise evaluation form (response rate was 46% in Indiana and 51% in Illinois), participants found the TTX to be well-structured and beneficial (Fig. 1). Ninety-eight percent found the TTX to be well-structured and organized, and all agreed (scores of 4–5 of 5) that the scenario was plausible and realistic (Fig. 1). Over 97% agreed that the TTX allowed their section to discuss and improve priority capabilities, and that participation in the TTX better prepared them to successfully respond to the exercised scenario.

Key Themes and Lessons Learned

Case Definitions and Response Structures—The case definitions for suspected and probable ceftriaxone-resistant infections were clearly outlined in the response plans ahead of the TTX and built upon the framework in CDC’s Ceftriaxone-Resistant Gonorrhea Outbreak Response Plan Guide (see Table 1).^{14,15} Ceftriaxone minimum inhibitory concentration thresholds differed across plans, reflecting the lack of established resistance breakpoints in the United States. In Indiana, TTX participants articulated that a single ceftriaxone-resistant infection was considered an outbreak and sufficient to activate the ARGC outbreak response plan. With local and/or state response plans as the resource, participants were able to describe a detailed plan for notification of leadership and development of an incident command response structure. In Illinois, participants used the state response plan to describe tiered outbreak definitions (sporadic, local, regional, and widespread), defined specific actions to be taken at each tier, and a well-defined incident command response structure. However, operationalization of the plans was limited by challenges defining and detecting resistant cases because of a lack of ready access to AST (see below under: N. gonorrhoeae Culture and AST Access). On a national level, revisiting of CDC case definitions and development of guidance on timing and thresholds for activating state and local response plans may advance preparedness.

Clinical and Laboratory Detection and Reporting—The TTX scenario began with state HDs notified of multiple recent cases of suspected treatment failures from providers. However, participants from both TTXs indicated such timely notification may not be likely given current systems. Illinois Department of Public Health investigates multiple gonorrhea case reports for the same individual within 60 days as a way of identifying possible treatment failures, but only on a quarterly basis, and Indiana had no treatment failure reporting protocols in place apart from those designated at clinics participating in SURRG. Tabletop exercise participants acknowledged a need to enhance protocols and systems for reporting of suspected treatment failure cases and how HD staff would respond to such reports (eg, case details to collect; how to assess for likely reinfection versus treatment failure). On a national level, DSTDP recognized timely detection and response capacity may benefit from CDC developing treatment failure surveillance guidance for local jurisdictions and a national treatment failure reporting form.

After multiple treatment failure cases were identified in the scenario, participants discussed the potential need to expand gonorrhea testing opportunities in the community to look for other circulating resistant cases, the importance for such testing to include testing for pharyngeal and rectal gonorrhea (often asymptomatic) in addition to urogenital gonorrhea, and considerations regarding when and if the local HD would recommend a test of cure (TOC). Through their participation in SURRG, Indiana was well poised to offer expanded gonorrhea testing, culturing, and AST for sexual partners to cases and other populations at risk through participating SURRG clinics, and already had a TOC protocol in place that could be modified for outbreak response. In Illinois, local HDs were well positioned to expand gonorrhea testing and implement TOC protocols; however, neither local nor state public health laboratories had the capability to perform gonorrhea culture or AST.

Clinical Management—Planned clinical management of patients with suspected treatment failures, as outlined in the response plans, aligned with the 2015 CDC STD Treatment Guidelines (current at the time of the TTX).¹⁸ Patients with suspected treatment failures were to have specimens collected for culture and AST, be retreated with recommended therapy, and return for TOC with culture and AST. With well-established procedures and ready access to culture and AST, Indiana participants moved quickly through this section of the exercise. This section posed substantial challenges to the Illinois, as procedures and capacities for culture and AST had not yet been established. During the Illinois TTX, partnerships with a local health system for culture specimen collection (but not AST) were able to be established.

For added difficulty, the second TTX module included intravenous administration of an antibiotic after some patients experienced repeated treatment failures with ceftriaxone. During the TTX, the HD representatives were able to coordinate with local hospital systems for intravenous therapy, but also highlighted the need to establish memoranda of understanding (MOU), streamlined procedures, and considerations of payment for uninsured patients in advance of an outbreak.

***N. gonorrhoeae* Culture and AST Access**—Owing to existing infrastructure and procedures in Indiana developed during participation in CDC's *Gonococcal Isolate Surveillance Project* (since 2013) and SURRG (since 2016) and as outlined in their response plan, Indiana participants were able to readily identify clinical locations where patients could be directed for collection of specimens for *N. gonorrhoeae* culture, the procedures for specimen transport, and the laboratory where culture and AST by Etest could be performed. Illinois participants had not previously established such infrastructure; *N. gonorrhoeae* culture was not routinely performed at IDPH laboratories, and infrastructure for transport of culture specimens had not been established. Thus, the use of culture and AST to confirm resistance and conduct TOC proved more challenging. Illinois participants determined that 2 local health systems would be able to collect and process specimens for culture but did not perform *N. gonorrhoeae* AST. After the TTX, IDPH began considering several options to address this gap, including establishing an MOU with local health systems to address payment and physician ordering of culture testing, establishing training on specimen collection and transport, and establishing culture and AST capacity in the state public health laboratory. IDPH also piloted transport of specimens to CDC for culture and AST as a strategy to use while establishing their own culture and AST capacity. In part because of their observations at the TTX, CDC DSTDP participants recognized a need on a national level to facilitate increased local access to culture and AST and shortly after the TTX, developed a pilot project where providers can submit specimens from patients with suspected treatment failures for culture and AST to a designated regional laboratory.

Case Investigations and Partner Services—Conducting STD case investigations and partner services (which includes eliciting recent sexual partners for exposure notification, testing and treatment) is a core function of STD programs; these activities were well described in response plans and were readily available during the TTX as a key component of response efforts. Due to their participation in SURRG, Indiana participants referred to

their SURRG-specific disease investigation protocols during the TTX that included ARGC-specific patient messaging and asking patients questions about risk factors specifically associated with resistant gonorrhea acquisition (eg, recent sex during any international travel or sex with someone who recently traveled internationally). For Illinois participants, the TTX identified additional ARGC-specific disease investigation preparedness needs, such as considerations for modifying investigation protocols to address ARGC-specific concerns and additional training needs for disease intervention staff (DIS) staff. Participants in both states discussed the potential benefit of quickly developing a database that would be easily accessible to DIS and other outbreak response staff to facilitate tracking of patient information, AST results, treatments, TOC results, case investigations, and the value of incorporating details of the database into their response plans.

Communication—The participating HDs demonstrated excellent communication between state and local entities during the TTXs; clear and consistent communication between state and local staff was highlighted as essential for rapid and effective response efforts. Response plans, however, had not addressed planned communication approaches for the media, health care providers, or affected communities; these proved more challenging during the TTXs. Participants decided that once antibiotic resistance was laboratory-confirmed, an involved HD would issue a press release describing the investigation and providing educational material for the general population, update its website, and develop social media messaging. Indiana participants decided to utilize the HD public relations department to review and approve material to provide cohesive messaging. Participants in both states discussed the importance of directing specific messaging to affected populations as the outbreak expanded. State HDs considered using Health Alert Network (HAN) notifications to communicate with health care providers and possibly Epidemic Information Exchange (Epi-X) alerts to notify other states. Health care providers and other county HDs would be invited to educational webinars; education about current testing and treatment recommendations was seen as a priority. Participants in both states considered a centralized hotline to address questions from the public and health care providers. Identified gaps included a lack of clarity about organization of and responsibility for communication strategies and cohesive messaging, and which communication channels were available to rapidly communicate with all local health care providers. After the TTX, IDOH participants created a communications plan with scripted and approved messaging that can be shared across agencies and used during an outbreak. They also created a just-in-time training slide set template that is ready to present to local health systems to facilitate expansion of culture collection locations in the event of a large outbreak.

Resource Utilization and Preparedness—Participants in both states identified the need to outline response funding and emergency funding mobilization if needed. Participants also suggested defining the available human resource inventory as part of preparedness, including identifying all internal staff with DIS skills and ways to request additional support staff from neighboring counties, the state HD, and/or CDC if needed.

DISCUSSION

Tabletop exercises can be an effective way to strengthen outbreak preparedness and identify gaps in response plans and unanticipated challenges that may arise during outbreaks. By conducting ARGC-focused TTXs, local, state, and federal partners identified existing strengths and gaps that can be addressed. The TTXs also provided an opportunity for participants to establish new relationships among local, state, and federal stakeholders, such as between STD and emergency preparedness staff.

Key themes highlighted the value of preparedness and planning before an outbreak. Establishment of procedures for culture specimen collection, transport, and access to AST were identified as linchpins for preparedness. While establishing laboratory capacity to conduct culture and AST, HDs should clearly communicate best practices for collection, handling, and transport of specimens to the appropriate laboratory. Establishing clear procedures for providers to report suspected treatment failure cases and subsequent HD investigation of such cases, including provider interpretation of AST results, were also identified as key gaps. Sexually transmitted disease programs are encouraged to develop such systems and protocols before an outbreak.

Well-crafted outbreak response plans proved valuable during the TTXs; participants were able to refer to the response plans and smoothly advance response efforts. Elements of the response plans that proved particularly valuable included clear definitions of ceftriaxone-resistant infections and outbreaks, clear thresholds for activating plans, delineation of roles and responsibilities, public health laboratory testing capacity, and clinical management of patients with resistant infections. Response plans should be realistic and reflect local capacities. For example, case definitions of resistance that rely on culture and AST are of limited use if culture and AST is not locally available. Tabletop exercise participants identified that crafting a communications plan for the outbreak response would enhance preparedness. Antibiotic-resistant gonorrhea messaging can be nuanced and will likely differ by target population; development of prescribed messaging and considerations for outreach to different populations would likely prove beneficial during an outbreak. Timely, clear, and consistent communication between state and local public health was seen as paramount for effective response efforts. Discussions about response funding and the need for MOUs with hospitals were unanticipated and shed light on the value of such exercises.

The TTX also highlighted opportunities for research to address areas of uncertainty. Research into optimal transport media for different clinical settings and patient-centered specimen collection approaches could inform improvements in culture access. Important programmatic questions to consider during an ARGC outbreak are thresholds for changing local gonorrhea treatment guidelines and when and how to expand screening or TOC guidance, if appropriate. With advances in molecular assays for resistance and whole genome sequencing, research could also focus on how molecular assays for resistance markers may contribute to detection of outbreak strains, and how molecular assays could be rolled out rapidly enough to be impactful.^{19,20} Research into optimal messaging about ARGC and eliciting partners from patients during outbreak investigations may prove fruitful.

On a national level, beyond potentially moving the proposed research agenda forward, DSTDP identified opportunities to develop additional guidance and expand technical assistance and other support related to developing local outbreak response plans (eg, case definitions, thresholds for activating response plans), enhancing treatment failure surveillance, increasing culture and AST access, and guidance for outbreak investigations.

We described findings from TTXs conducted in only 2 state-county pairs, and the findings may not be generalizable to other jurisdictions. However, we anticipate that at least some findings may be relevant to other locales. Other jurisdictions are encouraged to conduct TTXs to identify local outbreak response strengths and gaps; DSTDP-developed ARGC TTX materials based on this TTX can be found here: <https://www.cdc.gov/std/program/outbreakresources/default.htm>.

New antibiotics and prevention approaches, such as vaccination, are urgently needed to address the emerging threat of ARGC. However, such interventions are unlikely to be available in the near future. Meanwhile, *N. gonorrhoeae* continues to mutate at an alarming rate. Preparedness efforts, such as TTXs, and optimal public health responses now may provide the best opportunities in the short-term to slow the spread of ARGC, maintain treatment efficacy, and prevent unnecessary reproductive health sequelae.

Acknowledgments:

The authors thank the following people for their support implementing the tabletop exercises in Indiana and Illinois: Janet Arno, Kathy Borgmann, Caitlin Conrad, Rob Davies, Livia Navon (CDC/CPR), Janet Nuss, and Andrew Wilson.

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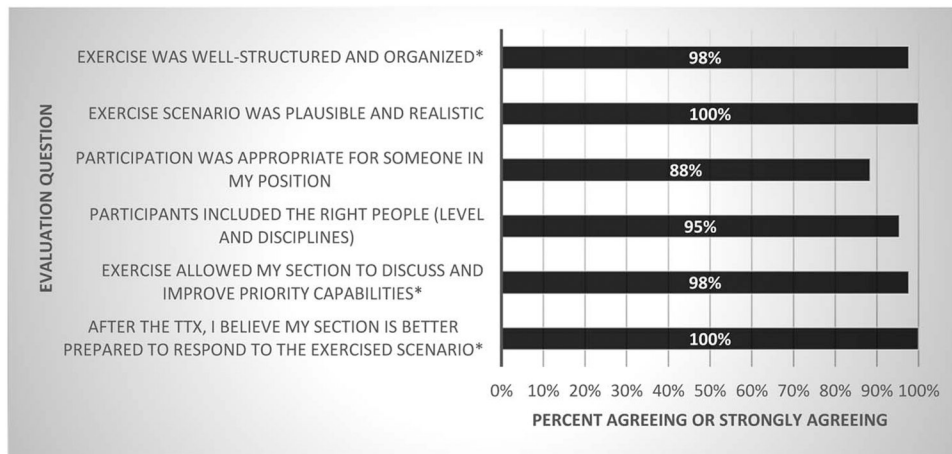


Figure 1. Participant satisfaction with ARGC TTX (n = 43), Indiana and Illinois, 2019. *n = 43.

TABLE 1.

Key Lessons Learned From ARGCC TTX, Indiana and Illinois, 2019

Key Themes	Lessons Learned
<i>Case definitions & response structures</i>	<ul style="list-style-type: none"> • Include clear descriptions of the following in outbreak response plan: <ol style="list-style-type: none"> 1. Case definitions for ceftriaxone-resistant infections 2. How to notify leadership of emerging outbreaks (and who to notify) 3. Triggers for different response tiers 4. Incident command structure and key roles for ARGCC outbreak response 5. Considerations regarding when response efforts may move from being led by local jurisdiction versus state HD • On a national level, develop guidance for local jurisdictions on timing and thresholds for activating state and local response plans (eg, ceftriaxone resistance breakpoints)
<i>Clinical & laboratory detection and reporting</i>	<ul style="list-style-type: none"> • Enhance protocols and systems for identifying (eg, provider reporting) and responding to suspected treatment failure cases • Establish local capacity and protocols for gonorrhea culture and AST for cases of suspected treatment failure (ie, at public health clinic, hospital, and/or commercial laboratory) • Include details in response plan on community expansion of testing, including pharyngeal and rectal testing, and TOC protocols; build such capacity in advance of an outbreak • On a national level, develop treatment failure surveillance guidance for local jurisdictions and a national treatment failure reporting form
<i>Clinical management</i>	<ul style="list-style-type: none"> • Align clinical management protocols for patients with ARGCC with the most recent CDC treatment guidelines • Develop infrastructure to collect culture and perform AST from patients with suspected treatment failures • Identify local hospital or other health care system where intravenous treatment could be provided if needed for highly resistant cases. Consider establishing a MOU and potential sources of payment for care of uninsured patients
<i>N. gonorrhoeae culture & AST access</i>	<ul style="list-style-type: none"> • Establish capacity and protocols for gonorrhea culture and AST for cases of suspected treatment failure in advance of an outbreak. This work may involve: <ol style="list-style-type: none"> 1. Establishing culture and AST capacity at local public health clinics and laboratories 2. Establishing relationships with hospitals or commercial laboratories that could perform culture and/or AST 3. Building capacity to collect specimens and transport them to a designated laboratory in a timely manner 4. Piloting provider submission of samples directly to a regional laboratory for culture and AST • On a national level, provide additional support, resources, and guidance to local jurisdictions to increase access to culture and AST
<i>Case Investigations & Partner Services</i>	<ul style="list-style-type: none"> • Ensure outbreak response plan includes ARGCC-specific considerations for implementing investigations and partner services during an outbreak (eg, ARGCC-specific interview questions, patient or partner messaging, or training needs) • Consider documenting key functionality of a database for use during an outbreak to track key patient and investigation information on cases and their sexual partners

Lessons Learned

Key Themes

Communication

• Include the following in the outbreak response plan:

- 1. An outline of clear and consistent communication strategies between state and local entities
 - 2. Details on or considerations for, a communication plan that includes approaches to communicating with media, health care providers, and affected communities
 - 3. Considerations for creating a centralized hotline where providers and the general public can call with outbreak-related questions and concerns in the outbreak response plan
- Draft template press releases, health alert network advisories, and/or social media messages in advance of an outbreak that can be rapidly customized and distributed during an outbreak
 - Create ARGC informational and/or training slide set templates for health care providers and other public health staff that can be customized and rolled out rapidly during an outbreak

Resource utilization & preparedness

- Identify possible funding sources for response efforts in advance of an outbreak, including partnerships with emergency preparedness to facilitate access to federal emergency funds
- Define available human resource inventory that may be needed for expansive outbreaks, including staff with disease intervention skills within local HD, neighboring county HDs, or CDC