Multihospital Infection Prevention Collaborative: Informatics Challenges and Strategies to Prevent MRSA

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Abstract

We formed a collaborative to spread effective MRSA *prevention strategies. We conducted a two-phase, multisite, quasi-experimental study of seven hospital systems (11 hospitals) in IN, MT, ME and Ontario, Canada over six years. Patients with prior MRSA were identified at admission using regional health information exchange data. We developed a system to return an alert message indicating a prior history of MRSA, directed to infection preventionists and admissions. Alerts indicated the prior anatomic site, and the originating institution. The combined approach of training and coaching, implementation of MRSA registries, notifying hospitals on admission of previously infected or colonized patients, and change strategies was effective in reducing MRSA infections over 80%. Further research and development of electronic surveillance tools is needed to better integrate the varied data source and support preventing MRSA infections. Our study supports the importance of hospitals collaborating to share data and implement effective strategies to prevent MRSA.*

Introduction

Methicillin-resistant *S. aureus* (MRSA) is an important cause of healthcare-associated infections, both in hospitals and in the community.[1] Furthermore, effective strategies to prevent MRSA have been implemented and shown to be effective.[2]

To support efforts to reduce MRSA infections, we organized a MRSA Prevention Collaborative to identify barriers, develop common definitions and procedures, and share successful strategies among participating hospitals. We also implemented a social-change staff training program consisting of evidence-based infection prevention precautions in hospitals. Using Lean and Positive Deviance (PD) training, we supported the implementation of MRSA prevention practices by hospital staff teams, with professional coaches from the Plexus Institute, which helps people apply concepts from complexity science. [3]

Intervention

An overall goal of the project was to foster spread of the MRSA Intervention Bundle to other hospital units and additional hospitals. The MRSA Intervention Bundle, based on published literature, experience with other MRSA reduction collaboratives, and our previous work of MRSA reduction, consisted of (1) active surveillance cultures for all patients admitted to study units, (2) pre-emptive barrier isolation of those identified as either infected or colonized with MRSA, and (3) institution of strict hand-hygiene before and after each patient contact.[2,4] The implementation of these MRSA prevention practices by hospital staff teams was supported by Lean and PD training, professional coaching, and participation in a MRSA Reduction Collaborative. The aims of this collaborative were setting goals, identifying barriers to using infection control practices, and sharing successful strategies for increasing successful infection control practices.[5-10]

A second overall goal was to evaluate the effectiveness of the implementation strategies, foster learning among the participants by applying technology and multi-method approaches to enable automated collection, sharing, analysis and reporting of data, and identify institutional factors predicting success. We conducted a quasi-experimental study in a sample of hospitals to assess changes in MRSA infection rates over time and to relate differences in rates to implementation processes, adherence to MRSA bundle components, context, use of social networks, and technology use. Implementation included developing local goals and making changes to infection control practices. The implementation was evaluated through the application of information technology to enable consistent collection, sharing, and reporting of data related to MRSA intervention implementation, such as baseline and follow-up MRSA rates of colonization and clinical incidence.[9-15] The data collected included both quantitative and qualitative data.

A third overall goal was to build a growing network of people and organizations devoted to MRSA prevention as a means to foster learning, disseminate findings, and stimulate new action. Our Dissemination and Outreach Plan sought to disseminate findings and provide recommendations for other individuals, systems, organizations and programs interested in implementing MRSA reduction programs. Through our work, we developed a mechanism for key organizations with an interest in MRSA prevention, and other regional safety and quality collaboratives, to learn from the work of this initiative. We worked closely with our AHRQ project officer and CDC liaisons, the Plexus Institute, the RWJ Foundation, the Indianapolis Patient Safety Coalition, IN Patient Safety Center, and other MRSA collaboratives to foster dialogue, active teamwork and partnership in the active transfer of "common knowledge" in what works.

Hospital Selection

In 2009, a committee of individuals (operations, coaches and investigators) organized a competitive request for proposal process, to invite potentially interested hospitals to submit applications to participate in this study. The committee reviewed and discussed each application, selecting seven hospital systems that were committed to reducing MRSA in their organizations. Our on-site facilitators (one each in Lean and in PD) were assigned to work with interested staff teams at each facility to engage leadership, conduct discovery and action dialogues, select target units and team members, and drive implementation-and-spread activities. These activities included training hospital staff in facilitation, developing implementation plans, creating and implementing strategies to broaden staff engagement, planning rapid process change cycles, implementing solutions for locally identified barriers to using MRSA bundle practices, and assessing impact using feedback tools.

The seven hospital systems selected to participate in this project were: Clarian Health (now IU Health), Indianapolis, IN; Community Health Network, Community North, Indianapolis, IN; Maine Health, Maine Medical Center, Portland, ME; St. Patrick Hospital, Missoula, MT; St. Francis Hospital and Health, Indianapolis, IN; St. Vincent Health, St. Vincent Hospital, Indianapolis, IN; University Health Network, Toronto, Ontario; Dialysis Units, Maine.

Informatics Infrastructure

The Indianapolis health care systems utilize, and are connected by, the Indiana Network Patient for Patient Care (INPC) interface called Careweb, which was developed by the Regenstrief Institute. Careweb is a secure web-based application built upon the INPC's extensive network of real-time electronic interfaces to the hospital information systems.

For the purposes of this project, we developed electronic alerts of positive MRSA cases between hospitals and hospital systems. Our RHIO generates an Admission-Discharge Transfer (ADT) message indicating that a patient is being admitted to any of the Indianapolis hospitals. We developed a program which examines that patient's health information exchange (HIE) record to check if there is evidence of prior MRSA infection (e.g. a diagnosis or culture result in the HIE record from every microbiology lab in Indiana). If evidence of prior MRSA is found, then asecure email message is sent back to the registrar and infection preventionists at the admitting institution indicating the patient's prior history of MRSA and site of infection and including a link to login to Careweb for additional details.

As part of this study, we designed and implemented a database system to take advantage of existing electronic data sharing with Regenstrief Institute, Inc., to facilitate collection, measurement, and reporting of MRSA clinical incidence. We validated this approach and linked measurement of clinical incidence with near real time process measures relevant to the prevention of MRSA infections.

Data Measures

Standard measures for MRSA colonization and infection rates were collected at the participating hospitals over time. The primary measure was the rate of the number of nosocomial blood stream infections caused by MRSA per 1,000 patient days collected over time before (pre-implementation period of 2 years before implementation) and after (post-implementation period of 1 year after implementation) the intervention program. Secondary measures included central line associated bloodstream infections (CLABSI - laboratory confirmed bloodstream infection in patient with a central line at the time of [or within 48-hours prior to] the onset of symptoms, and infection is not related to an infection from another site) and hospital-acquired infections (HAI – laboratory confirmed infection occurring greater than 48 hours after hospital admission) with MRSA, although data on these infections was not uniformly available at all hospitals.

Data Strategies

Adherence to bundle components was collected on a monthly basis by project staff, in order to support the implementation process. These measures included an observation estimating the percent appropriate hand hygiene practice by health care workers, percent of indicated cases placed in contact precautions at admission, and screening at admission for MRSA colonization per 1,000 admissions. These measures were collected over time before and after the intervention program.

Microbiologic and infection control data from 14 hospitals around the Indianapolis metro area are collected and stored in the INPC (Indianapolis Network for Patient Care) system an extensive network of real-time electronic interfaces with hospital information systems, and are reflected in Careweb, a secure web-based application. We integrated local data from the Indianapolis hospitals on patients previously colonized or infected with MRSA into a MRSA Case Registry. We developed an electronic data collection tool for use at individual hospitals to track compliance rates with the intervention implementation and to share data on MRSA cases with our MRSA registry.

In certain hospital systems, this initiative depended upon implementation of the CDC's WHO-NET software to capture the clinical incidence measure from each hospital's data stream. Dr. John Stelling adapted the automated download of MRSA clinical incidence data and the CDC MRSA Prevention Initiative to use the lab database to build a clinical incidence measure of new MRSA at the participating hospitals. WHO-NET software, a flexible, user-friendly tool for the management and analysis of microbiology test results, was offered to participating hospitals.

We coordinated with hospitals to develop a common data infrastructure that allow data sharing, including common process based and outcomes measures as required. This infrastructure development necessitated refining current data collection tools and developing common strategies for application of the tools within the intervention. These efforts were leveraged by the existing INPC machinery, including the Master Patient Index function, to ensure unique linkage of records across disparate sites. By uniquely identifying patients across institutions, we created a longitudinal history of a patient's record of infection and prevented redundant entry of cases. Where possible, we integrated with existing hospital data sources (e.g. ADT, microbiology) to minimize administrative burden. During phase I, data from all Indianapolis hospitals was manually entered into a database when the data was available from the hospitals. As much as possible, we automated this process by working with the IT staff at each of these hospitals to determine which data could be provided in a predetermined format to import the data into the database and reduce/eliminate data transcription errors.

Implementation Activities

Qualitative data was collected to 1) understand the implementation activities associated with the spread of MRSA prevention and control practices and 2) assess lessons learned during the implementation. Qualitative data was collected using a two-tiered series of semi-structured interviews (the implementation plan interview with the project leader at each system, and later, key informant interviews with other project members and leadership to discover lessons learned). We collected information about implementation activities and lessons learned from a total of 33 key informants (team leaders, implementation team members, coaches, and project leadership). These key informants were identified by the project team leads at each of the participating hospital system and included a diverse group representing infection control providers, nurses, physicians, ward clerks, transportation personnel, respiratory therapy, lab directors, unit leaders, VPs of nursing, chief medical officers, dietary personnel, environmental services, and administration assistants. The majority of the study units were intensive care units.

For the first round of interviews aimed at understanding the implementation activities, team leaders from each hospital or hospital system participated. Implementation Activities interviews were conducted between June, 2011 and August, 2011. The implementation plan interview guide was developed based on the goals of identifying successes, challenges and key lessons learned in implementing MRSA reduction efforts. This interview guide included questions to assess characteristics of the participating hospitals, the degree of involvement of frontline staff and physicians in MRSA reduction efforts, descriptions of the specific MRSA reduction efforts implemented (i.e., activities and timelines), characteristics of the teams implementing these interventions (i.e., personnel involved), assessments of the projects (methods, outcomes), challenges encountered, solutions for the challenges, and lessons learned. The interview followed a semi-structured format with the option for the interviewer to ask follow-up questions as appropriate to understand the implementation activities associated with the MRSA reduction effort. Based on these interviews, our measures of implementation activities included assessments of the resources available to the team, team meeting frequency, types of educational sessions held and their target audience, and data

feedback mechanisms to support process adherence measurement. Our approach to evaluating the implementation was also shaped by the interviews.

For the second round of interviews, questions included: “What were the 2 or 3 most important activities or tasks that were implemented as part of the MRSA project?”; “What are your 3 key learnings?”

Barriers to Fostering Change:

Using the qualitative data from the interviews to assess lessons learned, we identified barriers to and strategies for implementing MRSA reduction practices. The primary barriers to fostering change were time constraints, resistance to change, poor communication, and resident turnover. Respondents consistently mentioned that finding time to participate in the MRSA project was a barrier. Logistically, attendance at meetings can be difficult for employees whose primary responsibility is direct patient care. Moreover, finding coverage for units so that a large number of employees can attend the same meeting is complicated. Resistance to change and how to overcome that resistance was a focus of the interview. Many different occupational groups were mentioned as non-compliant with the MRSA reduction practices. The most commonly mentioned group was physicians (which includes both resident and staff physicians). Poor communication took many different forms for this project. Communication about MRSA status across units was one example. In other cases, communication between project personnel and leadership was poor. The communication with the leadership required more structured time that was face-to-face (compared with e-mail updates about the MRSA project).

Strategies for Implementing MRSA Reduction Practices:

Strategies participants consistently identified that worked to overcome barriers to change included the following: accountability, awareness, engagement, reinforcement, tailored intervention, teamwork, support, and resources.

Accountability. Accountability refers to the instances in which healthcare workers were held responsible for complying with the MRSA reduction practices. Two types of accountability were used to enforce compliance. One type relied on managers or other superiors talking one-on-one with staff, residents, or other physicians who were not following isolation procedures or hand hygiene protocols. For example, a key informant said that "I took names and I would send it on to Infection Control and they took care of it." Another type of accountability involved co-workers speaking to one another or to other providers who were not following isolation and hand hygiene protocols.

Awareness. Awareness of MRSA reduction practices and of the rate, severity, and impact on patients and staff of MRSA infections was raised in various ways as part of the implementation activities. Some of the activities reported as raising awareness were hand hygiene campaigns, kickoff meetings, individual stories, and active surveillance.

Engagement. The members of the local MRSA project team fostered engagement. Respondents indicated that having frontline staff as part of the project team was critical. Another project member characterized it as “it works better and things are adopted better if it’s their idea; then they don’t just come you know with an edict down from infection control.” Also, credible clinicians were important because they gained attention for the MRSA reduction project. The inclusion of a physician champion was noted as important for engaging other physicians in the MRSA reduction effort.

Reinforcement. One reportedly effective strategy was providing feedback to frontline staff. Seeing decreases in MRSA rates provided tangible evidence that the new practices were effective. A resilient attitude and sense of empowerment by team and staff were also identified as reinforcing change and keeping the project moving forward. Examples of a resilient attitude include "when it was frustrating" "and I felt like throwing in the towel" another project member "encouraged me to stay on and told me I couldn't leave the project;" and "failure wasn't an option."

Tailoring the intervention. Tailoring the intervention to local systems, whether it be a unit, floor, or hospital system, proved to be important for successful implementation. While the MRSA Bundle was identical in each participating system and the implementation plans similar, the flexibility and willingness to let front line staff help design and adapt the local implementation was viewed as highly beneficial.

Teamwork. Many respondents mentioned teamwork and team members as a key predictor of success. The involvement of different levels of staff, leadership, and especially multiple departments was often cited as key. A team that included frontline nursing staff, environmental services, unit leaders, dietary personnel, physicians, transport staff, and leadership was a common model used. This approach is consistent with the increasing literature regarding multi-team systems.

Support and Resources. Support and resources included adding staff, providing financial support to the project, participating in an inter-hospital collaborative, having adequate IT support, and leadership support.

Dissemination Strategies

Our dissemination strategy included the incorporation of effective facilitated dissemination, spread, and marketing using a conceptual framework incorporating principles of social and network marketing, diffusion of innovations, positive deviance drawn from complexity science, and knowledge management.

To foster learning and disseminate findings we used several concurrent approaches, including:

A. An electronic environment for communication and sharing for all interested parties at our partner institution. We instituted an online communication and sharing system using BASECAMP with over 150 registered users from multiple different national hospital systems, four different research systems, and our AHRQ and CDC representatives. This provided a regular and open means of communication of ideas, documents, schedules, and results.

B. In months 6, 12, and 18, hospital leaders, infection control practitioners, and the research team attended a one-day MRSA summit to discuss grant progress, issues, and next steps. We had three (two hosted by the Indianapolis research team and one hosted by our University Health Network partner in Toronto, Ontario, Canada) 1-1.5 day MRSA summits at these time points. Each meeting provided our network with the opportunity to review progress, identify barriers, and share stories of success. Notes from these well-attended meetings were shared with the entire group electronically in BASECAMP. At two of our meetings we facilitated tours of participating study units open to attendees. This allowed our network members to see "first hand" how implementation and change happen in the field.

C. We created and disseminated case studies for this project. Our case studies illustrated how hospital systems were able to implement the intervention bundle, as well as how they were able to overcome common pitfalls/barriers. Here we provided an overall summary of the case studies of all participating hospital systems, in which specific hospital results will not be identified. In addition, we have developed and shared a more detailed version for each of the participating systems summarizing and sharing their specific results.

D. We sent outcomes of the research results and subsequent intervention assessments to interested stakeholders, relevant professional organizations, research centers, and regional and national meetings. Members of our research team and hospital partners gave presentations at multiple national meetings.

E. We employed information technology and media communications solutions to foster ongoing dialogue and conversation about collaboration and dissemination. These included videoconferencing to conduct interviews, training, and gather feedback on the various interventions being deployed. We also used collaborative and project management software to improve communications and outcomes dissemination. This allowed for capabilities such as real-time document sharing, editing, presentations, scheduled meetings, invitations, etc.

F. We also used standards-based products and technologies to deliver information and improve communications with the appropriate audiences. These included list managers, threaded discussion groups, web-based topical forums, web & podcasts, CBT delivery and archives, document sharing, delivery, and archival software. We developed a FIGHT MRSA Blog with posting and editing capabilities taught and given to our network members to share news from their respective health systems. Additionally, our Plexus partners developed a similar blog that is used to communicate with their network of interested partners.

G. We disseminated information from the project in presentations at regional and national meetings, as well as through publications in peer-reviewed scientific journals. We are currently developing and further refining several other manuscripts for submission.

Impact of the Intervention

Handwashing compliance and admission and discharge screening increased during phase I and remained high in phase II for hospitals that participated in both phases. Analysis of MRSA rates (per 1000 bed days) by hospital system revealed a significant decrease in daily rate of CLABSI during post implementation compared to baseline period. For example, MRSA CLABSI decreased during the post-implementation period. Similarly, in phase II, MRSA BSI incident rate ratios decreased 85% in the implementation period, compared to baseline (p=0.012). Rates in the 1 year post-implementation period remained 32% lower. MRSA CLABSI reduced 84% during the post-implementation period (p=0.046). The details on the effectiveness of the intervention will be reported separately.

Informatics and Data Challenges

The data collection, integration, and analysis process was complex and multifaceted. One of the realities of this project was that each hospital system had its unique IT departmental structure, as well as unique data systems. Notably, some hospitals have robust IT structure/systems with dedicated data analysts, while other hospitals are manually tracking data using workbooks (e.g., Microsoft Excel™) and have a single data analyst for the entire hospital. Regardless of the size of the IT support team, essentially every hospital had an understaffed IT group, given current demand for operational priorities.

We examined the key informant interviews of team members to better understand the implementation efforts, looking specifically for reports of challenges with data, reporting or informatics (Table 1). Communication challenges were relatively common, in terms of scope and type of data required as well as data preparation requirements prior to data transfer.

Table 1. Identified data and informatics barriers or challenges and suggested solutions.

Data Challenges	Solutions
Communication challenges	Developing regular written updates of progress, action items, timelines and project management tools
Lack of sufficient IT support (insufficient IT staff, competing demands [e.g., switch in EHR vendors, or other hospital priorities]	Project team may need to discuss alternate strategies, such as negotiating more limited IT support from the hospital, suggesting alternate data capture strategies, or the collaborative providing data management support on-site
Limited data availability	Project team working with IT departments and team leaders, automating data entry, leveraging existing informatics structure, availability of data from other sources
Commercial entities (e.g., microbiologic labs, commercial surveillance tools, commercial dialysis units, etc,) may not consider data sharing a priority	Discussion with both hospital and commercial entities about expected return on investment
Incomplete/slow communication of MRSA infection status	Automated alerts of prior infection status, use of PCR tests for quicker results
Data silos (e.g., microbiology, infection surveillance, ADT) may not be integrated	Develop plans for integration of data with representatives of all units, focusing on value of a shared data architecture
Inability to see regular progress reports	Develop unit-level reporting at regular (weekly or monthly) intervals to support engagement of staff and sustain efforts.

We found multiple barriers to data sharing and management including: 1) hospitals with significantly reduced and backlogged IT staff; 2) “mid-stream” switch in IT vendor systems at two hospitals requiring full effort of key resources; 3) unanticipated competition for IT staff with both industry and stimulus-funded projects at participating hospitals; 4) loss of lead data analysts/ personnel who were directly supporting our project. We also found challenges in applying the WHOnet approach to data sharing, with multiple competing demands in the area of public health informatics within the health systems (or state initiatives), the Regenstrief Institute, and supporting CDC initiatives. Furthermore, externally-owned entities, such as laboratories that manage microbiology data may not

necessarily be on board with the need for data sharing with a "research organization". We also found differing experiences among and interpretations by key staff at several facilities with regard to Institutional Review Board (IRB) issues, data sharing, and HIPAA rules significantly impacted the ability of key staff at a participating hospital to share data.

Solutions

To address these challenges, we partnered with critical staff from information systems, infection prevention, administration and microbiology within each health system, in order to continue to work together to resolve problems. We also developed detailed documentation of the data architecture and data management plans, and dynamically re-adjusted approaches as needed to accommodate the multiple information systems and sources, as well as the shifting organizational priorities within hospitals. This process included developing a detailed data requirement document that had been thoroughly vetted by our data team and investigators for each of the hospitals. This document included the set of study measures, required data elements, date ranges, likely source systems, alternative approaches, standards/definitions and reporting methodology. We reviewed the standards with each hospital data team to ensure that future information was provided in a compatible format.

Hospital staff and leadership voiced a strong interest in being able to see data on the impact of interventions, provide rapid feedback on progress and support further implementation and spread of techniques to reduce MRSA. The measurement of these data was identified as a significant need to support the spread of adoption of evidence-based practices to reduce MRSA infection. As a result, we developed the ability to generate ad hoc reports to meet the needs of the MRSA teams. These tools were designed in concert with the users, reviewed and piloted by them, and then made available to participating hospitals for internal quality control and research purposes.

Data availability and ability to readily generate reports were both highly valued by participants, but very challenging to obtain in most hospital infection prevention programs.

To facilitate data collection, we reviewed the standards with each hospital data team to ensure that future data/information was provided in a compatible format. To meet the needs of each hospital system, we advanced in parallel tracks with each of the sites. For the Indianapolis hospitals, we were able to collect some required data elements from the Indiana Network for Patient Care (INPC) to validate the data provided from the hospitals where available. Notably, some INPC MRSA data is insufficiently structured and had to be supplemented with well-structured and coded data from the hospitals, their vendors, or WHOnet.

Because of the challenges in obtaining adequately structured microbiologic and infection prevention data in hospitals, CDC has been supporting the efforts of Harvard's WHO Collaborating Centre for Surveillance of Antimicrobial Resistance, and its WHONet. Commercial packages, such as MedMined ™ are available at a few larger, well-funded hospitals, but the costs are prohibitive for many hospitals. Further research and development is needed to create user-friendly tools, which can capture and make available for analysis such data to hospitals and other staff.

We witnessed many competing demands on the infection preventionists, quality improvement personnel and IT specialists. In light of the many competing demands for data management and IT support at certain hospitals, we feel it is important for funding agencies to consider the need for providing support to participating hospitals for the data management needs for participation.

It should also be noted that many of our intervention hospitals had already implemented the MRSA Bundle in our Phase 1 project, thus their rates of MRSA were already very low. To achieve a significant reduction from this baseline is even more remarkable.

Conclusions

The significance of this project lies in its innovative strategies to foster organizational change, data sharing, system redesign and sustainability. The size of the reduction in MRSA infections over time is considerable and sustained. Multiple organizations that have embraced these strategies have found them transformative in how they address quality and performance issues in general. A Chief Nursing Officer noted that this project has permanently transformed their organization for the better, through demonstrating how to implement and sustain change.

The data and informatics challenges in fostering multihospital intervention studies are considerable. Effective data sharing and registry development require partnering with multiple hospital data systems stewards, developing detailed documentation of the data architecture and data management plans, and dynamically re-adjusting

approaches as needed to accommodate multiple information systems and the shifting organizational priorities within hospitals. Regular review of data standards with each data team is important to ensure that future information is provided in a compatible format.

In any intervention study, it is critical to provide rapid feedback on progress in order to support further implementation and sustainability. The ability to generate ad hoc reports to meet the needs of the implementation teams is important for ongoing engagement of the hospital staff and for evaluation purposes. Further research and development are needed to create user-friendly tools, which can capture and make available such data for analysis.

We are currently applying these strategies to other hospital-acquired infections, and are using tools such as natural language processing, to develop better electronic surveillance systems. All hospitals with multidrug resistant infections such as MRSA should actively investigate strategies for effective prevention. In our experience, these are likely to include surveillance, staff training and engagement, and system redesign approaches. Further investments in research and development are needed to foster development of software and data standards to create user-friendly tools which can capture and make available for analysis infection prevention and quality improvement data to hospitals and other staff, in order to support organizational change efforts.

Acknowledgment of Agency Support:

This project was supported by the US Agency for Healthcare Research and Quality (AHRQ) (contract HHSA 2902006000131), and (HSA290200600013-3 Task Order 5). Our ongoing work is partially supported by a grant from the Department of Veterans Affairs: Healthcare Informatics Research Consortium; CHIR-Ontology Development and Text Processing for MRSA Surveillance (CHIR-MRSA), Project # HIR 09-004. We appreciate the many contributions of the hospital staff, physicians, nurses and information officers in the participating hospitals. We also appreciate Drs. Matt Burton and John Stelling who contributed to developing our data management plans, the advice of our expert panel, and our AHRQ Project Officers (Cynthia Palmer, Dr. Darryl Gray), and CDC Advisors (Drs. John Jernigan and Alex Kallen).

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