Journal of Clinical and Translational Science

www.cambridge.org/cts

Barriers and solutions to developing and maintaining research networks during a pandemic: An example from the iELEVATE perinatal network

Donna A. Santillan[1], Debra S. Brandt[1], Rachel Sinkey[2], Sheila Scheib[3], Susan Peterson[4], Rachel LeDuke[5], Lisa Dimperio[5], Cindy Cherek[6], Angela Varsho[7], Melissa Granza[7], Kim Logan[3], Stephen K. Hunter[1], Boyd M. Knosp[8], Heather A. Davis[8], Joseph C. Spring[8], Debra Piehl[3], Rani Makkapati[4], Thomas Doering[6], Stacy Harris[5], Lyndsey Day[9], Milton Eder[10], Patricia Winokur[8] and Mark K. Santillan[1]

[1]Department of Obstetrics & Gynecology, The University of Iowa Hospitals & Clinics, Iowa City, IA, USA; [2]Department of Obstetrics & Gynecology, The University of Alabama at Birmingham School of Medicine, Birmingham, AL, USA; [3]OB-Gyn Associates, PC., Cedar Rapids, IA, USA; [4]West Des Moines OB/GYN Associates, West Des Moines, IA, USA; [5]Department of Obstetrics & Gynecology, UAB Medicine, Birmingham, AL, USA; [6]Marshfield Clinic Health System, Marshfield, WI, USA; [7]Marshfield Clinic Research Institute, Marshfield, WI, USA; [8]Institute for Clinical and Translational Science, The University of Iowa, Iowa City, IA, USA; [9]The Group, Obstetrics and Gynecology Specialists, Davenport, IA, USA and [10]Department of Family Medicine and Community Health, University of Minnesota, Minneapolis, MN, USA

Research Methods and Technology Research Article

Cite this article: Santillan DA, Brandt DS, Sinkey R, Scheib S, Peterson S, LeDuke R, Dimperio L, Cherek C, Varsho A, Granza M, Logan K, Hunter SK, Knosp BM, Davis HA, Spring JC, Piehl D, Makkapati R, Doering T, Harris S, Day L, Eder M, Winokur P, and Santillan MK. Barriers and solutions to developing and maintaining research networks during a pandemic: An example from the iELEVATE perinatal network. *Journal of Clinical and Translational Science* **6**: e56, 1–8. doi: 10.1017/cts.2022.5

Received: 19 November 2021
Revised: 7 January 2022
Accepted: 10 January 2022

Keywords:
Clinical research; pandemic; sample collection; COVID-19; research network

Address for correspondence:
D. A. Santillan, PhD, Department of Obstetrics & Gynecology, University of Iowa Hospitals & Clinics, 200 Hawkins Drive, MRF 464, Iowa City, IA 52242, USA.
Email: donna-santillan@uiowa.edu

Abstract

Introduction: To improve maternal health outcomes, increased diversity is needed among pregnant people in research studies and community surveillance. To expand the pool, we sought to develop a network encompassing academic and community obstetrics clinics. Typical challenges in developing a network include site identification, contracting, onboarding sites, staff engagement, participant recruitment, funding, and institutional review board approvals. While not insurmountable, these challenges became magnified as we built a research network during a global pandemic. Our objective is to describe the framework utilized to resolve pandemic-related issues. *Methods:* We developed a framework for site-specific adaptation of the generalized study protocol. Twice monthly video meetings were held between the lead academic sites to identify local challenges and to generate ideas for solutions. We identified site and participant recruitment challenges and then implemented solutions tailored to the local workflow. These solutions included the use of an electronic consent and videoconferences with local clinic leadership and staff. The processes for network development and maintenance changed to address issues related to the COVID-19 pandemic. However, aspects of the sample processing/storage and data collection elements were held constant between sites. *Results:* Adapting our consenting approach enabled maintaining study enrollment during the pandemic. The pandemic amplified issues related to contracting, onboarding, and IRB approval. Maintaining continuity in sample management and clinical data collection allowed for pooling of information between sites. *Conclusions:* Adaptability is key to maintaining network sites. Rapidly changing guidelines for beginning and continuing research during the pandemic required frequent intra- and inter-institutional communication to navigate.

Introduction

The ongoing COVID-19 pandemic has demonstrated the need for scientific teams to work effectively together. However, assembling and maintaining scientific teams can be challenging [1]. Successful scientific teams require trust, a shared vision, strategic choice of team members, and clear roles and expectations [2]. Involvement of community physicians in research teams has traditionally been low; only 3% of all clinicians were engaged in research in 2004. A lack of formal research infrastructure, reductions in clinic efficiency, and increasing demands on clinicians' time have been cited as main impediments for the participation of community health practices in research [3]. The NIH addressed the need to reverse this trend in the 2003 roadmap [4].

In addition to a lack of community providers in research, the NIH identified a lack of rural representation in research populations. Inclusive research is better equipped to identify root causes of health differences. For example, health disparities in the rural population are

well-noted. Rural populations are experiencing increasingly poor access to quality health care due to drastic changes in the rural economy, exacerbated by reduced spending power [5]. The health care deserts in rural areas contribute to poorer outcomes; in the years 2004–2014, 45% (n = 898) of rural counties had no hospital-based obstetric services in the USA [6]. Women who live in rural counties without obstetric services are more likely to deliver preterm (<37 weeks gestation), deliver at a hospital more than 30 minutes from their residence, and deliver in a hospital without obstetric services or deliver outside of a hospital. Maternal morbidity rates are also higher in rural women [7–10]. Rural women may experience different risk factors than their urban counterparts such as obesity, smoking, or environmental exposures [11–13]. Unfortunately, these factors likely contribute to the rising maternal mortality ratio among rural US women. In 2018, the National Center for Advancing Translational Sciences issued an opportunity for building research networks to increase rural populations in health studies. The University of Iowa, the University of Minnesota, and the University of Alabama were awarded funding to build such a research network – iELEVATE (Improving women's and children's health via biobanking and electronic registry). The objective of iELEVATE was to expand and diversify a current network to accelerate long-term translational mechanistic and outcomes research and community surveillance in the pregnant population. To attain this objective, we sought to establish a widely available biorepository with a clinical data warehouse and a research registry to support long-term prospective cohort collections through partnerships with academic sites and community clinics for recruitment (Fig. 1).

The development of iELEVATE has faced the combined challenges of building a network including both rural academic and community medical clinics and doing so during a global pandemic. The ongoing COVID-19 pandemic provides a clear example of the need for science to be able to act swiftly to identify biological mechanisms, exposures, and effective treatments. The speed of science required to rapidly respond to COVID-19 has meant that networks must work together to share data and resources. However, clinical research networks during the COVID-19 pandemic have been severely hampered by the reductions of in-person clinic visits and the temporary shuttering of research activities at universities and medical centers. In this study, we detail the opportunities and challenges associated with building a perinatal research network during the global COVID-19 pandemic as well as the flexible and pragmatic framework used to successfully overcome multiple barriers.

Materials and Methods

Institutional Review Board Approval

The University of Iowa is the IRB of oversight (UI IRB#201901749). SmartIRB is being used as the reliance platform for the University of Minnesota (STUDY00006621, SITE 00000546) and the University of Alabama at Birmingham (IRB# 3000003641). Community practice sites have an investigator agreement with the University of Iowa. No changes have been made to the requirements for IRB approval based on the pandemic.

Establishing a Network

To build a network, each university site solicited the help of regional clinical practice sites. Clinical practices that provided obstetrical care were approached to consider participation in the iELEVATE study in one of two ways: 1) the Principal Investigator (PI) asking colleagues in current practice or who were participating in other studies or 2) by cold-calling clinical practices to ask them to consider participating in the study. Additional sites approached the PI to be part of the study as word of the study spread. Site recruitment visits (SRVs) were conducted in person or online to familiarize each site with the study aims and general protocol and to learn about the workflows of each individual site. Questions and concerns were addressed. Follow-up meetings have been held with each local team to develop site-specific workflows for participant recruitment, consenting, and sample collection, processing, and shipping.

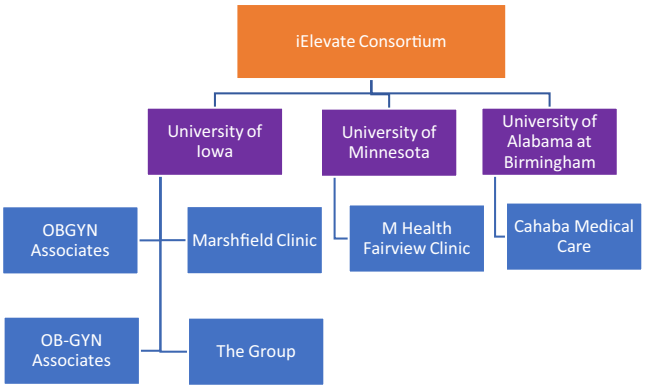

Fig. 1. Academic and community practices comprise the iELEVATE perinatal research network. The University of Iowa, University of Minnesota, and the University of Alabama at Birmingham (purple) originated the network and recruited area community practice sites (blue) to join the network to provide greater diversity and inclusion of pregnant patients.

Site Training

After community practice sites verbally agreed to participate, local members of the research team completed Human Subjects training online through the University of Iowa using the Collaborative Institutional Training Initiative Program. Human Subjects training has not been changed due to the pandemic. After IRB approval was obtained to include the new site, site initiation visits (SIVs) were conducted in person (pre-pandemic) or online (intra-pandemic) to train team members and lab personnel with the site-specific study protocol.

Inter-site Agreements

Contractual agreements were signed between community practice sites and their coordinating academic site. These agreements included the community practice site tasks (i.e., only members of the research team would recruit and conduct the study procedures, including collecting biospecimens and data in their first trimester of pregnancy and follow-up data at delivery and provisions for site monitoring) and the academic site tasks (i.e., assistance and coordination of IRB approval and maintenance, providing training and continued protocol support, compensation, and provision of supplies).

Site Initiation Visit

After IRB approval and contracts were executed between institutions, a SIV was completed in person or virtually. The goal of the SIV was to revisit and expand upon the information covered

in the SRV and review the process and procedures of the research study. Each step of the study procedures, from identifying potential participants to obtaining biospecimens and data, was discussed in detail with the community practice site research team. When SIVs could not be held in person due to COVID-19-related travel restrictions, we conducted a virtual SIV and shipped the study materials.

Whether we conducted the site visit in person or online, the content of the visit was the same. The protocol, study procedures, review of the Manual of Operations, Reportable Events, Investigator, and research team member responsibilities, and biospecimen disposition were reviewed in detail. Role play was used to demonstrate recruitment and the informed consent process so the local research team members could experience what it is like to approach and conduct the informed consent process with a potential study participant. Various scenarios were created that might arise during the informed consent process, such as how to avoid coercion in an unsure participant. The open lines of communication for any questions or concerns from any member of the study team to the PI or study coordinator were emphasized.

Participant Recruitment

Recruitment of eligible participants is targeted to occur at the initial prenatal visit. Inclusion criteria include being in the first trimester of pregnancy, ≥18 years old, and able to provide informed consent. Exclusion criteria include being a prisoner, known to be HIV positive and/or hepatitis C positive, and having a known non-viable pregnancy at the time of consent. Inclusion/exclusion criteria are consistent between all sites and have not changed. Prior to the pandemic, recruitment was performed in person in the clinic. When COVID-19-related restrictions were implemented, phone and video recruitment approaches were implemented. During a first trimester obstetrical visit, a clinical staff member who is also a member of the research team reads an IRB-approved script that briefly describes the study to the woman as a potential participant. If the woman indicates an interest in learning more or participating in this research study, she provides an email and is sent a link to an electronic consent form.

Electronic Consent

Research Electronic Data Capture (REDCap) was chosen as the platform for electronic consenting (e-consent) and data capture [14,15]. The REDCap platform is managed by the Biomedical Informatics Core in the Institute for Clinical and Translational Science at the University of Iowa. The informed consent document was divided into sections (e.g., purpose, study procedures, risks, etc.) that presented individually on the screen for ease of reading. The potential participant had the option to agree to each section. Agreement resulted in continuing to the next consent section whereas declining ended the consent process. There were opportunities to stop the consent process and notify a research team member to contact the potential participant to answer questions. For persons who provided informed consent electronically, a copy of the signed consent was emailed to the participant over a secure network. The e-consent was designed in order to confirm participant understanding of the study with minimal research staff interaction [15].

Biological Sample Collection and Processing

At a first trimester visit (less than 14 weeks gestation), a blood sample in an ACD-A tube (Becton Dickinson) and a urine sample are collected, preferably at the same time as clinically indicated samples. Both blood and urine are commonly obtained at the initial obstetrical visit for standard-of-care clinical labs. The overall method of processing and storage did not vary due to the pandemic; however, the extent to which sites process and store samples until transfer to the University of Iowa depended on local lab and staff capacity. All samples ship to the University of Iowa for long-term storage. Standardized biosampling and storage protocols have been published [16].

Data Collection

Clinical data are collected in one of two ways. First, data can be entered manually after extraction by local research team members into a common REDCap (each site only has access to their identified data). Monitoring visits are performed periodically by research team members to validate local data entry. Remote access to the medical records of consented patients has also been provided by one community practice site to allow research team member to perform remote data extraction. Utilizing remote data extraction also eliminates the need for research team members to visit clinics in person as clinics are trying to reduce the number of people physically present to allow for better social distancing.

As an alternative, at one site data are automatically entered into the Iowa Intergenerational Health Knowledgebase (IIHK). The IIHK is a clinical research data warehouse at the University of Iowa. Automated data extraction of validated variables reduced the possibility of errors in data entry.

From all sites, demographic data and pregnancy and delivery-related data were collected. Additionally, COVID-19-related health data were also collected. Any questions about the local medical records are adjudicated by a clinician on the research team (MKS).

Results

A perinatal research network consisting of seven sites was built and maintained during the COVID-19 pandemic. Each site was provided with a SIV and continued support for implementation and adaptation of protocols. Because most of the community clinics involved in this network do not have significant, if any, research infrastructure we utilized the training for human subjects research through the University of Iowa. Per travel and visitor restrictions at each location, the site startup trainings were sometimes limited to virtual meetings. However, whenever possible, these meetings were held in person and very thorough trainings were conducted in the processes of informed consent, data entry, and sample collection and shipping were held. We met with all of the different staff involved at each site including from medical assistants, phlebotomists, nurses, and clinic managers. For each group, we reviewed the importance of the work, the critical need for community clinic and rural patients, and the details of their specific aspect of the protocol. When in-person visits were not possible, we tried to have at least one representative from each of the involved teams be present on the virtual meeting. We provided cell phone numbers for team members at the University of Iowa in order for local sites to be able to have questions answered quickly while they were recruiting a participant or handling specimens. The rapid changing and evolution of local site protocols resulted in identifying critical processes that could not be altered. Additionally, the sites worked together to develop pragmatic solutions that worked within the pandemic-related protocols, but also maintained the critical aspects of the original protocol.

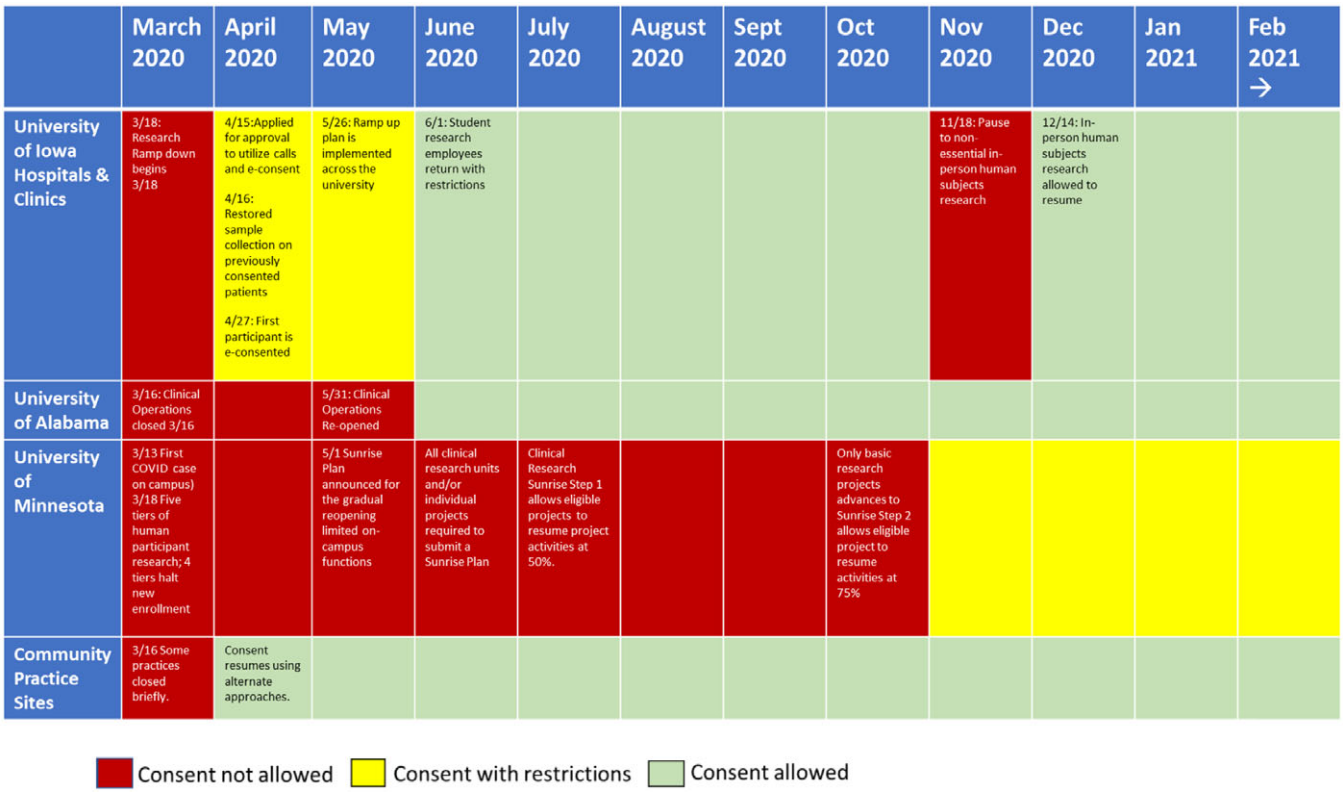

Fig. 2. Timeline of institution responses to pandemic. Academic and community practice sites had varying responses to the pandemic in regard to allowing research to proceed.

COVID-19-related restrictions were implemented at each location (Fig. 2). At several sites, clinical research projects that could be safely halted were paused, including recruitment. At other sites, we were able to modify our approach to contact potential participants. For example, approval was obtained from the University of Iowa IRB for a member of the research team to call potential participants who had completed a prenatal clinic appointment and to email them a link to complete the electronic consent. Other sites offered participation in the study at the time of a virtual obstetric intake visit. These sites read an IRB-approved script to the patient and, if the patient was interested, emailed her a link to the e-consent. Other sites continued to have in-patient visits and continued recruitment using an e-consent to reduce face-to-face contact. Between March 2020 and November 2021, we recruited 181 mother–child pairs at the iELEVATE sites outside of Iowa and 1635 at the University of Iowa. Success varied by method of recruitment. The most successful was face-to-face recruitment with the use of an e-consent, rates ranged between 50 and 83%. Offering a link to the e-consent was less successful but allowed continued enrollment. Twenty seven percent of the women who received an email link to the study opened the e-consent; however, of those that started the e-consent 67% successfully completed the document thus enrolling in the study.

Discussion

The objective for developing a network of obstetrics clinics to involve a broad, diverse cohort of pregnant women was unchanged by the COVID-19 pandemic. In fact, the ongoing pandemic only highlights the disparities in care and outcomes for cohorts of people, including rural populations. Thus, it is even more important to continue our work through the pandemic and to be able to collect biological samples and clinical data from this unique period.

It is noteworthy that community practice sites continued with very limited downtime and allowed research under altered conditions to protect staff and patients. In contrast, academic sites initially shuttered research due to the pandemic and many research staff were working from home (Fig. 3). Academic sites used the "downtime" to recruit and onboard new community practices to our network. We learned that we had to build an adaptable framework that maintained fidelity to the protocol yet adjusted to the unique situation of each site. The frequency of changes to site-specific COVID-19 guidelines provided an additional adjustment as these changes often resulted in study adjustment. The COVID-19 pandemic taught us many crucial lessons about developing a research network (Table 1). Key lessons are described in more detail below.

A SRV Was Crucial to Community Practice Site Participation

In person or virtual SRVs were crucial to introduce the iELEVATE study to prospective participating community practice sites. The goal of the SRV was to inform the site personnel about how research can impact the morbidity and mortality of pregnancy including the rural populations that they served and how their participation in the research network would have an important role in that impact. The SRV detailed the background information, specific aims of the iELEVATE study, inclusion/exclusion criteria, and data and sample collection. A considerable amount of time was also spent discussing the clinical flow of each community site and how the recruitment and study procedures of the iELEVATE study might fit into the daily workflow of clinical practice without overwhelming already busy clinical staff. We made suggestions based on our own clinical and research experience but relied on

Table 1. *Challenges and solutions for developing a network during a pandemic*

Establishing a network	Network building challenges due to COVID	Related solutions
Site recruitment visit	Decreased PI team travel for site recruitment	• Global increased experience with videoconferencing allowed for site engagement
Regulatory work	Many key personnel working from home	• Planned for increased time for pre-research, regulatory requirements including the IRB approvals and contracting in anticipation of the lifting of COVID restrictions
Site initiation and training	Unable to visit site in person	• Use of teleconferencing for site initiation visit • Close communication with sites via cellular communication • Community sites had ability to directly contact PIs at any time (24 hours/7 days) via cell phone, text, and email
Participant recruitment and consenting	Reduced clinical and research effort available due to increased COVID-related assignments as well as patients visits conducted by telephone or video	• Innovative, clinical nurse/research team stepwise recruitment strategies in approaching patients based on local workflow • Validated e-consent • Streamlining the consent process and decreasing potential exposure time between participants and study team • Harmonized and electronic data collection processes to lessen the burden of data extraction
Study communication	Similar COVID-related clinical/research workflow problems	• Frequent team videoconference meetings to brainstorm and elucidate solutions

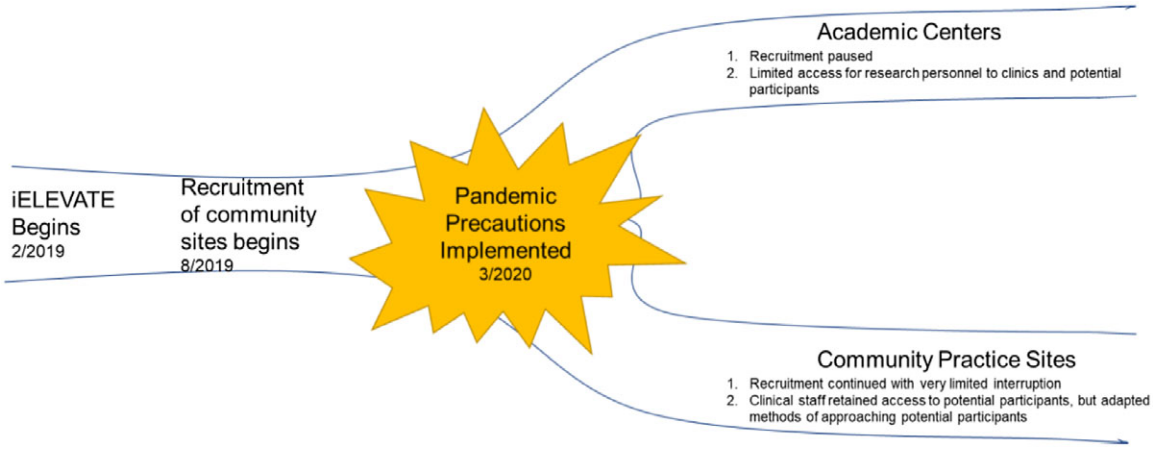

Fig. 3. Divergence in COVID response. The differences in COVID protocols between institutions resulted in changes to recruitment strategies in order for continued progress to be made.

the sites' individual knowledge to incorporate the research study into their own practice. Brainstorming sessions were conducted to address any potential barriers as well as potential solutions. This allowed the local sites to identify how the procedures were implemented within their local clinical workflow. Allowing the protocol to fit into their workflow was important for sites to consider participating as well as for future site success. However, in order to balance this flexibility with fidelity to the key elements of the protocol, SRVs brought together research coordinators, lab coordinators, and clinical directors of this study to ensure understanding and collaboration.

Prior to the pandemic, SRVs were performed in person. However, pandemic restrictions at universities and visitor restrictions at community sites meant that we had to hold site visits virtually using videoconferencing. Given the increased use of telemedicine and videoconferencing due to COVID-19-related restrictions, both community and academic practice sites had the equipment and familiarity with videoconferencing to feel comfortable with this format [17–20]. However, while they were willing to attend the SRV, three community practice sites were too overwhelmed with evolving COVID-19 protocols and procedures and subsequent staffing shortages to consider adding a research study to their workflow at that time. Consequently, these three community practice sites chose not to participate after the SRV. Additionally, most academic sites had restrictions on new research projects being implemented. Yet, during the time of COVID-19 restrictions, we were still able to 1) gain interest from clinical sites, 2) complete appropriate regulatory work such as contracts and Institutional Review Board approvals, and 3) start discussions of potential workflow once COVID-19 restrictions are lifted. Because of the length of time needed to get a site operational, it was key to move forward with these tasks even when we could not start enrolling participants.

Team Meetings

Videoconference meetings were held with all sites every other week. At these meetings, each site provided updates, included

any changes in local interruptions of research due to COVID-19, enrollment of participants, any new challenges faced; everyone in the conference brainstormed solutions to these challenges. Newly onboarded community sites benefited from the experience and advice provided by the other participating community clinical sites. This networking helped to provide solutions for the different challenges faced in community clinical practices versus academic clinical practices. These frequent meetings were also useful in keeping sites invested in recruitment.

Fitting Research into a Community-Based Practice Site

With input from each site, we developed procedures that could be incorporated into busy community practices with minimum burden. For example, pre-assembled packets are periodically distributed to the sites. These packets (one for each pregnant person recruited) are individualized based on each site. All packets contain a "cheat sheet" with a bullet point of instructions. Every sheet included a reminder of inclusion/exclusion criteria and sample disposition. Then the remainder of the cheat sheet was individualized for each site. For example, for the site that uses a courier to transport participant specimens to the lab, its packet contains instructions to contact the courier. For other sites that process and aliquot the specimens, their packets contain brief reminders on centrifuge speed, etc. The remainder of the items in the packet include prelabeled specimen collection tubes required for each site. Lastly, these sheets included contact information for the PIs and study coordinator for questions or issues. The PIs were readily available to answer questions by cell phone, text, and email. Community sites were encouraged to contact PIs in real time with any questions regarding procedures.

Recruitment and consent have required the most changes in protocol due to the pandemic. However, it was critical to make these changes in order not to lose study momentum at ongoing sites and to continue ramping up sites that had agreed to participate prior to the implementation of pandemic restrictions. Participant recruitment and consenting methods also had to be flexible based on the local sites' workflows. Enrollment methods had to adapt to COVID-19-related restrictions to limit the staff face-to-face contact with patients in the clinic. This flexibility required working with the IRBs involved to determine which approaches would be allowed. For example, several of the institutions and IRBs involved do not permit cold-calling of potential participants for recruitment. Without having a recruiter in clinic, which most sites would not allow due to COVID-19 contact restrictions, recruitment would have ceased. However, the IRBs rapidly reviewed and approved protocol modifications that enabled the study to accommodate limitations due to COVID-19 and continue to progress.

Several different solutions were devised and implemented to maintain enrollment during the pandemic. It was apparent early in the pandemic that COVID-19 placed a significant burden on clinical workflows which further blocked research endeavors. Given the increased COVID-19-related clinical burden at these sites, economy of resources and time was paramount in order to not burden the clinical sites. One solution implemented was having clinic nurses introduce the study during a scheduled telemedicine visit. Patients that indicated interest were then emailed a link to the electronic consent. Another solution to pandemic social distancing requirements was for a research team member to call patients who had a scheduled prenatal appointment and to ask if they were interested in learning more about a pregnancy-related research project. If a patient agreed, then the project was described in more detail and the person was either sent the link to the electronic consent or mailed consent packets. Additionally, to reduce staff face-to-face contact with patients to reduce potential exposure time, we also obtained permission to use electronic tablets in clinic to obtain informed consent from patients who indicated an interest in participating. In this approach, the potential study participant could autonomously complete the informed consent process via the tablet. The team member was there if questions or concerns arose, but overall face-to-face time was reduced. The efficacy and the development of this tool were demonstrated pre-pandemic [15]. Consequently, e-consent proved to be an important "COVID-19 proof" tool. Even as we can return to in-person consent, this period demonstrated the ongoing value of e-consent.

Thought was also given to the busy practices to streamline data collection. The format for the clinical data collection forms followed the format of American College of Obstetricians and Gynecologists (ACOG) Antepartum Record and Obstetric Medical History Form [21]. This was done purposefully as we thought it was highly likely the ACOG forms would have been used during the education and training of the providers and hence they may use the ACOG forms or develop similar forms. Therefore, it would be more efficient to enter data into the REDCap system if the forms aligned. As more knowledge was gained regarding COVID-19 and the vaccine became more broadly available, the questions addressing COVID-19 were changed, and data extraction was re-performed for participants enrolled prior to the change.

Laboratory Processing

To maintain overall study fidelity for sample processing, we did not change the blood collection tube or the protocol for its processing (such as speed and time of centrifugation and volume of aliquots). Each site is given sets of biological sample kits which include directions for sample collection and pre-labeled tubes for collection and for aliquots. For sample collection, this occurs either within the clinic or at an outpatient laboratory. For sites that do not perform their own phlebotomy, we contacted the local laboratory to participate. Similar to the clinic, we visited the local laboratory, either in person or through videoconference to review the study and the protocol.

As time is of the essence in regard to the integrity of biological specimens, for sites that could not process samples locally, they refrigerated samples after collection and then we arranged for a courier or overnight cold shipping of samples to the University of Iowa for processing according to our standard protocols [16]. Biological samples are delivered to the clinical lab at the University of Iowa where they are refrigerated until being retrieved by lab personnel for processing and storage. For sites outside the courier system, they were either asked to process, freeze, and batch ship samples or to overnight ship non-processed samples. Community practice sites are also provided shipping coolers, manifests, cooler packs, and required packaging labels. Flexibility to adapt to local site processes was always necessary to be able to include sites that have differing lab capabilities. Ultimately, the samples received the same processing regardless of which site performed the intermediate steps.

COVID-19 impacted shipping due to courier staffing issues and could not fulfill overnight shipping as requested. In one instance, blood and urine sample were not received at the University of Iowa in a timely manner and were subsequently destroyed. To address this challenge, we requested that the local site only consents patients Monday through Wednesday and ships samples on

Wednesday. If samples were delayed until Saturday, a member of the research team processes and stores the sample on Saturday to preserve its integrity.

Flexibility

The common features of our program framework are pragmatism and flexibility. Most clinical research protocols have very prescribed methods, but that would not result in a successful outcome during a global pandemic. A practical approach allowed us to accomplish our primary aim of building a high-quality biobank that included women who are often underrepresented in research by partnering with local community practice sites. Rather, we sought to provide these sites with a protocol that worked within the culture and practices of their particular location. By creating a partnership and listening to their needs, we sought to empower the sites to help identify and implement solutions and to feel valued as members of the research team. The most difficult aspects of building and maintaining the iELEVATE research network are the elements that could not be adapted. These elements included the contracting, required institutional trainings, and obtaining multiple layers of IRB approval, as well as the personnel adapting to working out of the office area and employee turnover attributed to COVID. Not only was it difficult to manage these aspects, but they also caused the greatest delays. With our timeline hampered by reduced access to clinic at the beginning of COVID, we had to maintain frequent contact with the human subjects offices to address concerns and to encourage expeditious review of our applications.

Importantly, not all adaptations were initially successful. For example, at the beginning of the pandemic, we introduced COVID-19-related questions in our clinical data collection. Questions were related to patient COVID-19 screening, symptoms, testing, and treatment. However, as clinical COVID-19 protocols evolved over the pandemic, our questions and multiple-choice answers became quickly outdated. Moreover, the data dictionary became difficult to maintain as the definition of terms such as "screening" also evolved over time and at each location. For example, screening could be interpreted to mean temperature checks at the door, the answering of questions about symptoms, or, when it became available, the results of a rapid antigen test. These rapid evolutions of terms and protocols made it difficult to retrospectively extract clinical data. Trying to predict what clinical information would be important later in evaluating responses and exposures during the pandemic has been a formidable challenge. An iterative process continues to be used for assessing COVID-19-related issues.

Conclusion

Establishing collaboration, frequent and open communication, adaptability, and flexibility have been the guiding principles in building and expanding the iELEVATE program during the pandemic. While these principles are generally deemed necessary for successful teamwork, they are indispensable during this unusual time. Because of the opportunity to collect unique samples and information related to COVID-19 and pregnancy, it has been imperative that we continued to move forward and overcome any local obstacles. It is noteworthy that while COVID-19 shuttered the academic sites from recruitment for varying amounts of time, the community clinics did not experience the same lengthy downtime or restrictions on research and were able to continue recruitment with modifications.

Additionally, as COVID-19 appears to be an ongoing situation, we will continue to face challenges implementing research and surveillance. Researchers will have to be flexible and creative to overcome new pandemic-related challenges and to be able to continue studies funded prior to the pandemic. Most importantly, we found that working closely with collaborators to develop novel, yet pragmatic solutions allow for the successful implementation and expansion of a multi-site study, even during a pandemic.

The lessons that we learned can be broadly applied to other research studies regardless of a public health crisis. For example, continuing use of the virtual site visits reduces travel burden and costs. Additionally, use of the e-consent reduces the requirement for face-to-face time. Studies that allow flexibility or adaptations of their protocols based on community site capabilities and local practices may increase site willingness to participate. As more variants of the COVID-19 virus arise, it seems unlikely that the pandemic will pass quickly; it remains vitally important to continue to utilize these strategies to maintain productive clinical research networks.

Acknowledgements. The authors would like to thank Rachel Jacobsen at the University of Minnesota for her assistance in developing the network.

Funding. This work was funded in part by the University of Rochester CLIC, under Grant U24TR002260. CLIC is the coordinating center for the CTSA Program, funded by the NCATS at the National Institutes of Health (NIH). This work was also supported by grants UL1TR001855, UL1TR001881, UL1TR002736, UL1TR001872, UL1TR001422, UL1TR000050, UL1TR002389, UL1TR002537 (to University of Iowa), UL1TR002494 (to University of Minnesota), UL1TR003096 (to UAB), R01HD089940 (to MS), Health Resources and Services Administration through a contract with the Iowa Department of Public Health to the University of Iowa; and the Iowa Health Data Resource, a University of Iowa Public Private Partnership (P3) project. The content is solely the responsibility of the authors and does not necessarily represent the official views of the funding agencies.

Disclosures. The authors have no conflicts of interest to report.

References

1. **Walsh JP, Maloney NG.** Collaboration structure, communication media, and problems in scientific work teams. *Journal of Computer-Mediated Communication* 2007; **12**(2): 712–732.
2. **Bennett LM, Gadlin H.** Collaboration and team science: from theory to practice. *Journal of Investigative Medicine* 2012; **60**(5): 768–775.
3. **Kahn K, Ryan G, Beckett M, *et al.*** Bridging the gap between basic science and clinical practice: a role for community clinicians. *Implementation Science* 2011; **6**(1): 34.
4. **Medicine ZE.** The NIH roadmap. *Science* 2003; **302**(5642): 63–72.
5. **Burton LM, Lichter DT, Baker RS, Eason JM.** Inequality, family processes, and health in the, new, rural america. *American Behavioral Scientist* 2013; **57**(8): 1128–1151.
6. **Hung P, Henning-Smith CE, Casey MM, Kozhimannil KB.** Access to obstetric services in rural counties still declining, with 9 percent losing services, 2004-14. *Health Affairs (Millwood)* 2017; **36**(9): 1663–1671.
7. **Kozhimannil KB, Hung P, Henning-Smith C, Casey MM, Prasad S.** Association between loss of hospital-based obstetric services and birth outcomes in rural counties in the United States. *JAMA* 2018; **319**(12): 1239–1247.
8. **Sullivan MH, Denslow S, Lorenz K, Dixon S, Kelly E, Foley KA.** Exploration of the effects of rural obstetric unit closures on birth outcomes in North Carolina. *The Journal of Rural Health* 2020; **37**: 373–384.

9. **Kozhimannil KB, Casey MM, Hung P, Prasad S, Moscovice IS.** Location of childbirth for rural women: implications for maternal levels of care. *American Journal of Obstetrics and Gynecology* 2016; **214**(5): 661.e1–661.e10.
10. **Lisonkova S, Haslam MD, Dahlgren L, Chen I, Synnes AR, Lim KI.** Maternal morbidity and perinatal outcomes among women in rural versus urban areas. *Canadian Medical Association Journal* 2016; **188**(17-18): E456–E465.
11. **Merkt PT, Kramer MR, Goodman DA, *et al.*** Urban-rural differences in pregnancy-related deaths, United States, 2011-2016. *American Journal of Obstetrics and Gynecology* 2021; **225**(2): 183.e1–183.e16.
12. **Nighbor TD, Doogan NJ, Roberts ME, *et al.*** Smoking prevalence and trends among a U.S. national sample of women of reproductive age in rural versus urban settings. *PloS One* 2018; **13**(11): e0207818.
13. **Hendryx M, Fedorko E, Halverson J.** Pollution sources and mortality rates across rural-urban areas in the United States. *The Journal of Rural Health* 2010; **26**(4): 383–391.
14. **Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG.** Research electronic data capture (REDCap)–a metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of Biomedical Informatics* 2009; **42**(2): 377–381.
15. **Weiss J, Santillan DA, Thomas K, Davis H, Santillan MK, Brandt DS.** Introducing e-consents in a clinical setting. *Proceedings in Obstetrics and Gynecology* 2018; **8**(3): 2.
16. **Santillan MK, Leslie KK, Hamilton WS, *et al.*** Collection of a lifetime: a practical approach to developing a longitudinal collection of women's healthcare biological samples. *European Journal of Obstetrics & Gynecology and Reproductive Biology* 2014; **179**(9): 94–99.
17. **Mann DM, Chen J, Chunara R, Testa PA, Nov O.** COVID-19 transforms health care through telemedicine: evidence from the field. *Journal of the American Medical Informatics Association* 2020; **27**(7): 1132–1135.
18. **Alexander GC, Tajanlangit M, Heyward J, Mansour O, Qato DM, Stafford RS.** Use and content of primary care office-based vs telemedicine care visits during the COVID-19 pandemic in the US. *JAMA Network Open* 2020; **3**(10): e2021476.
19. **Gomez T, Anaya YB, Shih KJ, Tarn DM.** A qualitative study of primary care physicians' experiences with telemedicine during COVID-19. *The Journal of the American Board of Family Medicine* 2021; **34**(Suppl): S61–S70.
20. **Sinha S, Kern LM, Gingras LF, *et al.*** Implementation of video visits during COVID-19: lessons learned from a primary care practice in New York City. *Frontiers in Public Health* 2020; **8**: 514.
21. **American College of Obstretricians and Gynecologists**.*Obstetric Patient Record Forms*, 2021. (https://www.acog.org/clinical-information/obstetric-patient-record-forms)