Development, Implementation, and Outcomes of a Global Infectious Disease Training Course

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ABSTRACT

BACKGROUND: Skilled healthcare professionals are critical for providing quality healthcare for children with cancer globally. Training curricula addressing the knowledge needs in infection care and prevention (ICP) in cancer are scarce.

PROGRAM DESCRIPTION: We implemented a 10-week blended course in ICP. The distance learning had four 2-week modules: Infectious Complications, Quality in Infection Care, Quality in Infection Prevention, and Sustainability, Research, and Dissemination. Each module had pre- and post-tests and weekly webinars. The 2-week in-person learning had lectures, group exercises, clinical observations, hospital and laboratory tours, and ended in an annual conference. An individual project developed during the distance learning was presented in the in-person workshop. Course attendance criteria were English language proficiency and participants' role in ICP at their institutions.

PROGRAM EVALUATION AND RESULTS: Twenty-two students from 17 hospitals in 10 countries completed the course, developed a project, and answered surveys covering knowledge assessments and satisfaction, and 6-month course and 1-year project follow-ups. Pretest and post-test scores revealed knowledge improvement ($P < .001$). Participants rated the distance learning as outstanding (63%) or good (28%); and the in-person as outstanding (87%). In the follow-up survey, graduates felt more comfortable at managing infections and participated more in quality improvement and academics at their institutions. Seventeen participants (77%) took steps to implement their study projects, and 9 were successful. Collaboration and networking of trainees were notable outcomes.

DISCUSSION: The ICP course is a resource to improve knowledge, engage graduates in network collaborations, and a reliable model to develop other thematic healthcare global training programs.

KEYWORDS: Infectious diseases, infection prevention, pediatric cancer, training course, low- and middle-income country

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Background

Survival for children with cancer in high-income countries (HICs) has surpassed 80%, but outcomes of children with cancer in low- and middle-income countries (LMICs) remain poor.[1] This disparity includes advanced disease at diagnosis, treatment abandonment, and high treatment-related mortality, which is largely due to infections.[2] Therefore, outcomes of these children can be improved by implementing measures to prevent or control infections.

In many LMICs, shortage of skilled healthcare professionals hinders quality care, and post-graduate education and training are often constrained.[3] To optimize the use of limited resources and ensure the success of healthcare interventions, healthcare providers (HCPs) in pediatric cancer centers (PCCs) in LMICs need to be master clinicians, and know about best practices in infection care and prevention (ICP) and resources available for ICP. Thus, improving the HCP knowledge in ICP is the first step for building an effective institutional workforce and sustaining the quality of healthcare for pediatric cancer patients.

Program Description

For more than 10 years, St. Jude Children's Research Hospital (St. Jude) has worked with clinicians worldwide to improve care capacity and prevent infections in children with cancer.[4,5] These efforts focused on strengthening suboptimal ICP programs in hospitals with PCCs, conducting specific subject training, and hosting clinical observerships of selected healthcare professionals.[4,6] A well-trained healthcare workforce is an essential component of programs seeking to increase access to care. The St. Jude

Box 1. Distance learning modules and lessons.

MODULES	LESSONS
Module 1: Infections in pediatric cancer (2 weeks)	• Febrile neutropenia • Typhlitis • Oral mucositis • Multidrug resistant organism infections • Central line-associated blood stream infection • Fungal infections • Respiratory infections • Bacteremia
Module 2: Quality in infection care (2 weeks)	• Diagnostics in infections • Imaging in infections • Clinical decision tools and guidelines • Antibiogram • Anti-infective pharmacology • Quality improvement in infection care • Antimicrobial stewardship program
Module 3: Quality in infection prevention (2 weeks)	• Infection prevention and control program—components • Surveillance • Outbreak investigation • Prioritizing infection prevention and control interventions • Developing policies and procedures (manual) • Education program • Implementation (behavioral theories)
Module 4: Research, dissemination, implementation (2 weeks)	• Capacity building • Sustaining improvement • Research essentials • Research protocol • Biomedical research ethics oversight (IRB) • Data management (including Epi Info™) • Scientific writing and publication • Grant writing

Abbreviation: IRB, institutional review board.

Global Infectious Disease course was launched in January 2017 as a training program for HCPs worldwide on ICP practices.

Course content

Overview. The course was directed at physicians involved in ICP of immunocompromised patients in Latin America, including pediatricians, pediatric oncologists, and pediatric infectious disease specialists. To accommodate the time constraints of working professionals, this course was of a short duration (10 weeks; January 3-March 6, 2017). The goals of the course were as follows:

1. Improve knowledge of common infection syndromes seen during cancer care
2. Define best practices for ICP that can be implemented in PCCs in LMICs
3. Increase knowledge in the principles of quality improvement, including implementation, dissemination, and sustainability of improvements
4. Increase knowledge in the methodology of clinical research
5. Establish a framework for students to identify areas of future research collaboration

The curriculum was developed by team members of the departments of Global Pediatric Medicine (n = 3), Infectious Diseases (n = 1), and Quality Management (n = 1) at St. Jude who had experience in ICP and education.[4,5] The content (Boxes 1 and 2) was based on standard ICP themes and prior general needs assessments elicited during multiple interactions with HCPs and sought to impart knowledge globally applicable for ICP. Course and workshop facilitators and mentors included 43 clinicians, scientists, and quality improvement experts from St. Jude, Le Bonheur Children's Hospital, the University of Tennessee Health Science Center, and the University of Memphis, and the Centers for Disease Control and Prevention (CDC).

Course components

Distance learning. The 8-week distance learning segment included 4 learning modules: (1) Infectious Complications; (2) Quality in Infection Care; (3) Quality in Infection Prevention; and (4) Sustainability, Research, and Dissemination (Box 1). Each of the four 2-week modules included knowledge pretests

Box 2. In-person learning themes and lessons: seminars (S), workshops (W), and tours (T).

THEMES	LESSONS (SEMINARS, WORKSHOPS, AND TOURS)*
Pediatric education	• Pediatric residency (S) • Pediatric infectious diseases fellowship (S)
Infections in cancer	• Fever and neutropenia (S) • Central line-associated bloodstream infections (S) • Fungal infections (S) • Influenza in immunocompromised children (S)
Infection care and prevention	• Microbiology laboratory role in infection care and prevention (S) • Antibiotic stewardship program (clinical and pharmacy perspectives) (S) • Infection control at St. Jude and Le Bonheur (S) • St. Jude infection control, pharmacy, BMT, and patient care areas (T) • Le Bonheur patient care areas, infection control, and laboratories (T)
Quality improvement	• Quality improvement techniques (S) • Finding a quality improvement project (S) • Epi Info 7 for the mobile device (W) • Application of the PDSA cycle to improve infection care (W) • CDC definitions for HAI surveillance: 2017 updates (W) • SWOT analysis of the antimicrobial stewardship program (W)
Research elements	• Research protocols: IRB perspective (S) • Biostatistical considerations in research (S) • Community-engaged research (S)
Writing	• Ethical basis when writing and reviewing a clinical protocol (W) • Writing a scientific manuscript (W)
Research, discovery, and therapeutic development in infectious diseases	• Research on *Streptococcus pneumoniae* (S) • Development of an RSV vaccine (S) • Development of the annual influenza vaccine (S) • Virology of the gastrointestinal tract (S) • Anti-infective drug development (S) • St. Jude research laboratories (T)

Abbreviations: BMT, bone marrow transplant; CDC, Centers for Disease Control and Prevention; HAI, healthcare-associated infection; IRB, institutional review board; PDSA, Plan, Do, Study, Act; RSV, respiratory syncytial virus; SWOT, strength, weakness, opportunities, threats.
*The duration of the educational sessions varied based on the type: the seminars (S) were 30 to 45 minutes, the workshops (W) were 60 to 90 minutes and tours (T) were up to 120 minutes.

and posttests, lectures, reading materials, videos, and research project assignments (Figure 1). Distance-learning modules provided the flexibility of self-paced (asynchronous) learning; participants needed to meet predetermined deadlines to move from 1 module to the next, but they could review the learning material within each 2-week period at their own pace. Moreover, during distance learning, students attended structured, interactive, online, and live (synchronous) 1-hour weekly sessions.

In-person learning. Distance learning was followed by a 2-week in-person learning designed to consolidate, review, and apply the learning conducted online (Box 2). Lectures, small-group learning, individual assignments, workshops, and tours were used to maximize learning opportunities. During lectures, instructors presented topics linked to module lessons delivered during distance learning and shared their experiences about building on theoretical knowledge in practice and had face-to-face question and answer sessions. In the course of workshops, team-based exercises introduced CDC definitions of healthcare-associated infections, quality improvement techniques (eg, Plan-Do-Study-Act cycle), and analysis techniques of infection prevention programs (eg, Strengths, Weaknesses, Opportunities, and Threats [SWOT] analysis). Participants toured clinical/research facilities at St. Jude and Le Bonheur. Guided tours demonstrated institutional organization and performance. For example, St. Jude provides highly specialized cancer care, and Le Bonheur, a collaborating hospital of St. Jude, provides general pediatric care. Course participants had the opportunity to see leading-edge clinical and research operations during these tours. Twenty-two merit-based scholarships were provided for in-person learning. Participants had to complete at least 80% of assignments during the distance learning. Lectures and workshops for in-person learning were conducted at the St. Jude Graduate School of Biomedical Sciences.

Individual research project development. Students designed a research or quality improvement project proposal during the distance learning segment according to the scientific methods described in the course instructions. Assignments were submitted at 4 and 8 weeks and scored. During in-person learning, students gave an oral presentation of their project proposals to fellow students and course faculty at a workshop (Figure 1) and received feedback from St. Jude researchers and personnel.

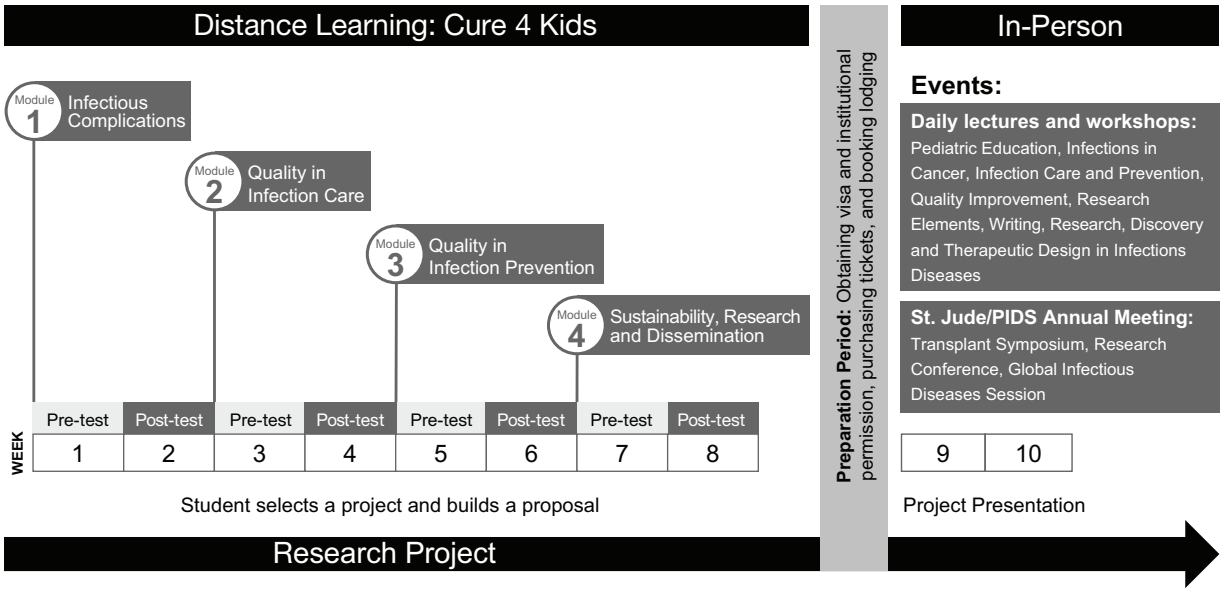

Figure 1. St. Jude Global Academy—infectious disease training: timeline and components of distance and in-person learning.

Annual St. Jude/Pediatric Infectious Disease Society (PIDS) Research Conference.

The course's in-person learning component merges with that of the Annual St. Jude/PIDS Pediatric Infectious Diseases Research Conference. Leading investigators in the field discuss themes on infectious pathogens, especially those affecting children with depressed immunity. Additional sessions on global health research integrated course attendees and other participants and provided a forum for participants (n = 9) to present their posters. Students engaged with conference attendees and established new contacts for future collaborations.

Evaluation. Participants completed knowledge assessments and 3 types of surveys electronically: satisfaction, 6-month course follow-up, and 1-year outcome of the project of interest. These multipronged assessments include domains of Kirkpatrick's evaluation model of the effect of the training, namely reaction, learning, behavior, and results.[7] Knowledge was assessed during distance learning by 20 multiple-choice, true/false, matching, and vignette questions given before and after each module to measure participants' knowledge. Posttests comprised 75%, project assignments 15%, and class participation activities (live meeting attendance and discussion posts) 10% of the overall course grade of participants. The satisfaction survey for each online module had 11 questions and for in-person learning varied (10-14 questions) by daily programming and included Likert-scale surveys and open-ended questions for students to comment on each module's quality and relevance to daily practice. The 6-month follow-up survey evaluated the program's impact on job performance of students 6 months after returning to their countries (Tables 1 and 2). An electronic survey (10 questions) 1 year after course completion was administered to assess their research proposal presented during the in-person session (Supplemental Digital Content—Survey).

Statistical analysis. Wilcoxon signed-rank test was used to compare performances of students on the knowledge assessment before and after each 2-week module. Median and range with correlating *P* values are reported. A 2-sided $P < .05$ was considered significant. Survey results are reported descriptively. All analyses were performed in SPSS, Version 25.0. (Armonk, NY: IBM Corp).

Outcomes

Demographics

In this first course, 22 physicians from 17 hospitals in 10 countries were trained. Participants were from Mexico (n = 8), Honduras (n = 3), Nicaragua (n = 2), Guatemala (n = 2), Argentina (n = 2), Spain (n = 1), El Salvador (n = 1), Bolivia (n = 1), Peru (n = 1), and Ecuador (n = 1). Most participants were 31 to 40 years old (n = 14, 64%) and female (n = 13, 59%). Eleven participants had been practicing for over 3 years. One participant specialized in adult medicine and infectious diseases, and 21 were pediatricians. All course participants were working full time when enrolled in this course.

Scores

Median tests scores in distance-learning modules revealed a significant increase ($P < .001$) between participants' pretest and posttest in all 4 learning modules (Table 3).

Surveys response

Satisfaction surveys were obtained after modules I, II, III, and IV, and they were answered by 22/22, 22/22, 20/22, and 19/22 participants respectively. The 6-month and 1-year course follow-up surveys were answered by all 22 participants.

Table 1. Performance evaluation 6 months after course completion in areas of instructions and training in infection care.

	TEACHING SESSIONS (N)	PARTICIPATION IN EVALUATING QUALITY (N)	PARTICIPATION IN EVALUATING ACCESSIBILITY (N)	RECOMMENDED SPECIFIC IMPROVEMENTS (N)
ID diagnostics	153	271	125	138
ID imaging	113	108	57	66
Clinical decision tools/guidelines	112	98	92	65
Antibiograms	57	90	97	86
Antibiotics	86	110	134	160
Antimicrobial stewardship programs	70	88	103	112

Abbreviations: ID, infectious diseases; n, total number of times the graduate participated in an institutional activity in the area of infection care.

Table 2. Performance evaluation 6 months after course completion in areas of instructions and training in infection prevention.

	PARTICIPATION IN MEETINGS (N)	PARTICIPATION IN EVALUATION (N)	RECOMMENDED SPECIFIC IMPROVEMENTS (N)	LED A MEETING (N)
Infection prevention programs	156	108	121	105
Surveillance	118	116	102	96
Outbreak investigation	51	51	45	33
Policies and procedures	75	68	63	46
Education and training	75	64	51	58

Abbreviation: n, total number of times the graduate participated in an institutional activity in the area of infection prevention.

Table 3. Pretest and posttest scores for the 4 modules of the distance-learning component.

MODULE	PRETEST SCORE (MEAN ± SD)	POSTTEST SCORE (MEAN ± SD)	*P* VALUE
Infectious complications	66.37 ± 15.47	93.41 ± 7.658	<.001
Quality in infection care	62.97 ± 9.707	88.68 ± 8.859	<.001
Quality in infection prevention	56.95 ± 9.397	90.34 ± 6.560	<.001
Sustainability, research, and dissemination	60.29 ± 13.921	89.88 ± 0.249	<.001
Overall	61.64 ± 12.12	90.57 ± 8.33	**<.001**

Abbreviation: SD, standard deviation.

Satisfaction

Participants were satisfied with content and delivery of the distance-learning segment: 63% rated the overall course as "outstanding," 28% as "good," and 10% as "satisfactory." Participants found the content of modules relevant to their daily practice of medicine. Approximately 87% of participants scored the in-person learning segment as "outstanding."

Knowledge implementation

Six months after course completion, graduates reported being more comfortable at managing common infectious syndromes. They could also evaluate and provide recommendations for current ICP elements at their institutions and share their learning with onsite teams.

Sharing and disseminating

For the St. Jude/PIDS Research Conference, all participants were encouraged to present abstracts, as required by the event. Nine participants (41%) presented their research in poster sessions at the conference. The conference focused on several course themes, including infections in the immunocompromised host, transplant medicine, and global health. The forum

allowed the students to share their work with other attendees. The 2017 conference was attended by about 300 participants, growing to over 1000 participants in 2021.

Collaboration

To continue communicating and collaborating in common areas of interest after course completion, under the guidance of St. Jude, course attendees formed a network focusing on care and prevention of infections in children with cancer in Latin America (**Pr**evencionistas e **In**fectologos de **C**ancer **P**ediátrico en **A**merica **L**atina, or the PRINCIPAL network). As per this year, 2021, 35 physicians, most of them graduates of the course, participate in PRINCIPAL network led activities. This group include several who graduated in the 2017 cohort. Additionally, another similar network emerged, the **L**inking **O**ncology **T**o **U**niversal **S**afety in ICP (LOTUS) for English speaking countries and regions.

Study project proposal follow up

All 22 participants responded to the 1-year follow-up survey sent electronically. Nine successfully implemented their proposals. At that time, participants had either presented their proposals for academic merit within their institution (n = 2), clinically implemented their projects (n = 6), or presented their work at a scientific conference (n = 1). Major reasons for postponing the further development and implementation of projects were the principal investigator's lack of protected time and lack of resources, especially human resources, at the institution.

Subsequent global infectious disease training course modification and delivery

After implementing the course in 2017, we conducted a further needs assessment[8] to confirm and improve content for future offerings. This assessment used a web-based survey that inquired about the specific needs of pediatric infectious disease training programs in Latin America including infections in hematopoietic stem cell transplantation, HIV, and research methodology. In the ensuing years, we conducted the program yearly using the 10-week blended learning design and expanded participation to all global regions. Also, our model guided the successful design and implementation of other thematic global training courses, including a neuro-oncology training[9] and a critical care course.

Discussion

The Global Infectious Disease training course clearly demonstrated its beneficial effect in several ways; improving ICP knowledge and assurance, motivating local leadership, and promoting the academic productivity of global participants. The characteristics of the training components and the blended methodology facilitated the delivery of the content in a highly organized and efficient manner and encouraged the graduates to engage in learning and network collaborations. The unique features of the training will serve as a reproducible model for building and implementing similar thematic healthcare training programs.

Attendees of the ICP course represented a large area of Spanish speaking countries. Medical education and competencies of pediatricians are not homogeneous in the Latin American region.[10] Although the participants came from different backgrounds, origins, and levels of education, they all found the course advantageous thereby reflecting its general utility. The ICP training course tested its efficacy and model consistency by continually assessing the graduates' performance and monitoring their satisfaction with the course content and experience. By focusing on healthcare professionals caring for children with cancer in LMICs, the organizers ensured that the content was sound and based on evidence. Also, the course length was designed to be short to accommodate the limited time availability of participants. Course methodology, a focused audience, post-course continuous engagement and a model for related disciplines were notable characteristics of the training and augmented the utility of the initial training input.

Blended learning[11] combines traditional in-person learning and distance-learning using asynchronous or synchronous e-learning. This training methodology has gained increasing acceptance in multiple and diverse educational settings and is becoming a required resource for educators.[12] Although e-learning offers significant advantages such as overcoming geographic and time barriers, the participants must have access to the required information technology services and have the necessary technical proficiency to participate in the course with the required rigor. This technological readiness is often called, e-readiness.[13] We found that the blended methodology model was ideally suited to the trainees and efficiently increased their knowledge and significantly improved ICP-related practices. We expanded access to the course in multiple regions of the world and offered the course as a yearly training event. Based on the feedback, we subsequently decreased online reading materials but incorporated additional training blocks (clinical cases discussions, quality improvement training, and leadership). Leadership and quality improvement training complemented the course themes (quality of care, research, dissemination of results, and sustainable interventions), and we expect them to facilitate practicing learned course themes, thus promoting the development of future healthcare leaders.[14] Therefore, we demonstrated that blended learning is ideal for teaching our ICP curriculum and allowed us to quickly expand to multiple regions of the world in successive years.

We built the professional network, PRINCIPAL to stimulate exchange of knowledge, promote cross-mentoring, and encourage collaboration among graduates after completing the course. The course catalyzed conversations among participants, and the high level of collaboration and interaction during the course cemented their professional camaraderie. A forum for continuous exchange of ICP topics and related patient care was an evident need that was addressed by the course. Cancer is a rare health condition in children, and the disease and the complex treatment protocols affect the immune system and predispose these children to a wide range of types and severity of infections.[15] Activities of a professional network, like the

PRINCIPAL network, for the care and prevention of infection in children with cancer is critical to stimulate the growth of the expertise among its members, which is scarce..[8] Therefore, a network that focuses on sharing clinical experiences, for example in case-based learning sessions, offers a valuable opportunity to collaborate, and to standardize and implement best care practices. By using the train-the-trainer model, participants were encouraged to teach others at their institutions the specific topics taught during the course (eg, use of healthcare-associated definitions, PDSA). According to the American Academy of Pediatrics,[16] collaborative networks can transform the practice of pediatrics, especially those networks that have focused outcomes, and build communities of practitioners such as the PRINCIPAL network. Since the completion of the course, members of this network have participated in multiple educational initiatives in the Latin American region, built a practice guideline[17] and more recently hosted a weekly case-based learning session of ICP in pediatric cancer that gets together graduates and guests to discuss difficult cases of infections. The network acts as a "repository" of trained individuals for continuing their engagement and to augment the training with a growing cohort of Spanish-speaking experts. Strengthening the network structure and operations, recruiting graduates, and retaining them in networks have emerged as essential tasks for the long-term objective of our course.

The relatively short duration of the course and the focused audience allowed the use of several strategies, including blended methodology, stand-alone modules of essential themes, and participation of teachers and experts from multiple institutions. To date, we have repeated the course 3 times and obtained consistent outcomes. The ICP training model has now been tested in other disciplines where similar global gaps are evident in the workforce. Thus, our training experience has served as a prototype to design, plan, and implement training efforts in other areas of global pediatric oncology. Two thematic courses, critical care and neuro-oncology, were built and implemented following our methodology.[9] Globalization and dynamic exchange of disease-related data, as well as expertise and knowledge, are teaching us that maximizing the use of virtual education and training platforms by using modern training delivery methodology and collaboration, as we have successfully done, is becoming the norm in education.

We identified 2 limitations in our study. One limitation was the small sample size of our cohort, which initially had a reduced number due to the constraints of the model and the financial considerations. However, as a trial group, our course provided important insights onto the curriculum and the delivery method, which we used to refine our course content for successive deliveries. Another limitation was that our cohort represented only physicians coming from Spanish speaking countries in Latin America, and their experience might not be completely applicable to other regions of the world. But, regardless of the possible cultural and language biases of our cohort, Latin America is a very diverse region, and our cohort included representatives of economically and socially diverse countries, paralleling the various economic and social situations of similar world regions.

Despite the rapid growth of the literature surrounding e-learning in the past 5 years, there are few reports using blended methodology similar to our study, and none of these addressed the content and methods we used in our training.[18-20] Training strengthens local human capacity and is a key step to bridge the disparity in survival rates of children with cancer in LMICs and HICs. Therefore, our unique training experience will be essential for building and sustaining knowledge and expertise related to ICP globally.

In conclusion, our training curriculum has improved knowledge, engaged graduates in network collaborations, and represents an ideal model for other thematic healthcare training programs in global child health. The COVID-19 pandemic has taught us that by using innovation and modernization in teaching, as we had done with the blended methodology, we will be able to respond with necessary precision and speed that is required to address major health events such as a pandemic. A rapid, broad, effective, agile, and evidence-based response is needed to face this time of high uncertainty, and it absolutely needs reliable information for building expertise in healthcare.

Author's Note

This study was used as a master's project for one of the authors (MAC), and presented on June 29, 2017 at the University of Memphis, Memphis, TN, USA.

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Author Contributions

MAC designed the study. MH, LT acquired and prepared the data. MAC, MH, LT, EA analyzed the data and prepared the manuscript. All authors reviewed and revised the manuscript critically and approved it.

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The authors have no financial relationships relevant to this article to disclose.

Ethical Approval

The St. Jude Children's Research Hospital Institutional Review Board granted an approval for this study on 5/31/2018 [Pro00008760].

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Supplemental Material

Supplemental material for this article is available online.

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