The Impact of Prospective Telemedicine Implementation in the Management of Childhood Acute Lymphoblastic Leukemia in Recife, Brazil

Francisco Pedrosa, MD,¹ Faisal Shaikh, MD,² Gaston Rivera, MD,³ Raul Ribeiro, MD,³ and Ibrahim Qaddoumi, MD, MS³

¹Department of Oncology, Instituto Materno-Infantil de Pernambuco, Recife, Brazil.

²Department of Internal Medicine, Weill Cornell University, New York, New York.

³Department of Global Pediatric Medicine, St. Jude Children's Research Hospital, Memphis, Tennessee.

Abstract

Background: A gap in childhood cancer outcomes remains between developed and developing countries. Persistence of this gap may be caused by financial, social, or educational disparities. Twinning and distance learning initiatives may improve such disparities. Integrating telemedicine into pediatric oncology twinning programs enhances education and facilitates patient-centered capacity building.

Materials and Methods: We performed an analysis of Web-based meetings held from August 2005 through July 2009 between the International Outreach Program at St. Jude Children's Research Hospital and the Instituto Materno Infantil de Pernambuco (IMIP) in Recife, Brazil. We determined the effect of these online conferences on the development and implementation of an innovative protocol for children with acute lymphoblastic leukemia (ALL) at IMIP.

Results: Meetings occurred in 45 months of the 48-month study period with an average of two meetings per month. A total of 163 new patients were discussed during the study period; we retrieved documentation of patient-related discussions for 147 of them, constituting 286 discussions. On average, each patient was discussed 1.9 times (range, 1–15 discussions/patient). Compared with that of the era predating the online meetings (1993–2005), overall mortality, early death, and relapse of patients with ALL decreased after the telemedicine program was instituted at IMIP.

Discussion: Personal dedication and institutional support are essential for successful telemedicine initiatives. Documentation and archival of meetings are important for accurately measuring outcomes and developing methods for improved care.

Conclusions: Integration of telemedicine into twinning programs facilitates communication about interventions, leading to improved outcomes of pediatric patients with cancer.

Keywords: Brazil, developing countries, education, leukemia, pediatric cancer, telemedicine

Introduction

Twinning programs, aimed at sharing knowledge and expertise between high- and low-/middle-income countries, effectively improve the outcomes of children with cancer.^{1–3} Integrating systematic, virtual, and real-time communication (i.e., telemedicine) into twinning initiatives improves patient care,⁴ promotes capacity building,⁵ enhances collaborative clinical research,⁶ implements quality assurance projects,^{7,8} and optimizes resource utilization⁹ and education.^{2–10} The Instituto Materno Infantil de Pernambuco (IMIP) in Recife, Brazil, is a partner site in the St. Jude Children's Research Hospital (St. Jude) International Outreach Program. Acute lymphoblastic leukemia (ALL) was the first disease addressed when the twinning program between St. Jude and IMIP was launched in 1993.

Within 9 years of the launch of the twinning program, the overall 5-year disease-free survival for patients with ALL at IMIP improved from 32% to 63%.³ Although disease relapse and treatment-abandonment rates were reduced, treatment toxicity became the leading cause of mortality, contributing to 14% of ALL-related deaths at IMIP. Retrospective analysis of these toxicity-associated deaths revealed that although patients were treated according to specific guidelines, death may have been avoided in some instances.³ Slight modifications of chemotherapy or prompt introduction of supportive care measures may have reduced or avoided treatment toxicity-associated death. We hypothesized that treatment of ALL could be further improved at IMIP by active participation in a telemedicine initiative to facilitate healthcare changes at a time when children are at the highest risk for complications and treatment toxicity.

In 2005, four modifications to the ALL treatment-specific guidelines at IMIP were implemented: first, a St. Jude-IMIP ALL working group was established. Second, a newly designed

childhood ALL protocol (RE-ALL-05) was initiated at IMIP to improve detection of minimal residual disease (MRD) with a flow cytometry-based assay. Patients identified as “good responders” to induction therapy with a low risk of relapse were treated with low-intensity therapy. Third, to minimize the risk of life-threatening toxicities, close evaluation of patients through web conferencing was performed, particularly during the treatment phases associated with high morbidity and mortality. This allowed modification of treatment or supportive care in real time. Fourth, frequent interim evaluations of treatment tolerance and short-term efficacy were performed to determine if therapy amendments were required.

In this study, we assessed the effect of the St. Jude–IMIP telemedicine program, which facilitated modification of pediatric oncology treatments in real time, by reviewing the outcomes of children with ALL treated at IMIP before and after program implementation.

Materials and Methods

WEB-CONFERENCING SESSIONS

In August 2005, the St. Jude–IMIP ALL working group began participating in weekly Web-conferencing sessions through an online healthcare collaborative platform (i.e., Cure4kids) developed by St. Jude.¹¹ Specific dates and times for the meetings were agreed upon by the two medical teams. An IMIP pediatric oncologist prepared slides with clinical and laboratory data and shared them with a St. Jude pediatric oncologist in advance of the Web-conferencing sessions. The cases were then presented by the IMIP physician in English, Portuguese, or Spanish. St. Jude physicians offered suggestions on the management of cases, but the decision of whether to implement the changes rested with the IMIP physicians. IMIP residents, nurses, and social workers, in addition to pediatric oncologists from other St. Jude partner sites, attended the sessions and provided their perspective. Patients and caregivers did not participate. The sessions were free for all participants. In addition, the Web-conferencing sessions were followed by frequent telephone and e-mail communication about complex clinical

cases, as needed. Patient consults and discussions between the IMIP and St. Jude staff were documented as PowerPoint presentations or Word documents (Microsoft, Redmond, Washington).

DATA ANALYSIS

We retrospectively analyzed data obtained from documents produced between August 2005 and July 2009. We categorized the documents into three groups: (1) documents dedicated to patient care issues (PTDOCS), such as protocol enrollment, toxicity management, treatment of infections, and relapse; (2) dedicated general documents (GENDOCS) that communicated general topics not related to specific patients; and (3) other documents (OTDOCS) in which both patient care and general issues were discussed. This study was approved by the St. Jude Institutional Review Board.

RISK STRATIFICATION

Provisional risk was determined by the clinical features, blast cell immunophenotype, and molecular genetics of patients as they were first enrolled in the RE-ALL-05 protocol. On the basis of these initial clinical characteristics, pediatric ALL cases were classified as provisionally low risk or high risk (Table 1).

Table 1. Definitive Risk Stratification for Pediatric Patients with Acute Lymphoblastic Leukemia Enrolled in the RE-ALL-05 Protocol

RISK GROUP	CLINICAL CHARACTERISTICS	PATHOLOGIC CHARACTERISTICS	MRD LEVEL ^a
Low (special)	Age 1–10 years	B-lineage ALL	Negative <0.01% blasts
	No testicular disease	WBC <50,000/ μ L	
	No CNS disease	or <i>ETV6-RUNX1</i> /hyperdiploid (maximum age 10 years) ^b	
		No adverse genotypes ^c	
Standard (intermediate)	Age 1–10 years	B-lineage ALL	Positive $\geq$ 0.01% but $\leq$ 5% blasts ^b
	No testicular disease	WBC <50,000/ μ L or <i>ETV6-RUNX1</i> /hyperdiploid (maximum age 10 years) ^b	
	No CNS disease	No adverse genotypes ^c	
High	Age 10–15 years	T-ALL	Any or very high $\geq$ 5% blasts ^b
	Testicular disease	B-lineage ALL	
	CNS disease	WBC $\geq$ 50,000/ μ L	
		Adverse genotypes ^c	

^aMRD was measured on Day 19 of induction chemotherapy.

^bCriteria established after 2008 amendment.

^cAdverse genotypes include *ABL-BCR*, *EA2-PBX1*, *MLL-AF4*, or hypodiploidy <45.

ALL, acute lymphoblastic leukemia; CNS, central nervous system; MRD, minimal residual disease; WBC, white blood cell.

Provisionally high-risk cases were deemed high risk throughout the study period.

Definitive risk was determined on Day 19 of induction therapy, according to the early response of patients to treatment. Provisionally low-risk cases with negative MRD (defined as $\leq 0.01\%$ leukemic cells among bone marrow mononuclear cells) were classified as definitively low (i.e., special) risk. In contrast, provisionally low-risk cases with positive MRD on Day 19 ($> 0.01\%$ leukemic cells) were reclassified as definitively standard (i.e., intermediate) risk. The MRD level at Day 19 did not affect provisional or definitive high-risk stratification. The intensity of chemotherapy was tailored for each patient according to the MRD results, as we have previously described.¹⁰ We compared the mortality rates of each risk group with those in previous studies and before and after implementation of the St. Jude–IMIP telemedicine program.

Results

FREQUENCY AND NATURE OF MEETINGS AND DOCUMENTATION

The range of data extended over 4 years (August 2005 to July 2009), with at least one meeting held in 45 (93.7%) of the 48 months of the study (*Table 2*). Additional meetings were held as patient census and educational discussions demanded, with an average of two meetings per month (range, 1–6 meetings/month). From the 93 meetings, 112 documents were produced (*Table 2*). Ninety-four described issues raised by the IMIP team about patient treatment and 18 contained minutes of meetings that were recorded in English. The 94 discussion-containing documents included 53 (56.4%) PTDOCS, 28 (29.8%) OTDOCS, and 13 (13.8%) GENDOCS (*Table 2*). In addition to reviews of patient clinical characteristics, the 28 OTDOCS contained discussions of 35 different topics that included enrollment reports ($n=20$), complications ($n=9$), protocol revisions ($n=3$), and outcome data ($n=3$). The 15 topics discussed in the 13 GENDOCS included supportive care (i.e., infection control and social service), quality assurance, data review, protocol maintenance, and various oncologic issues (i.e., leukemia in general, thrombocytopenia, hyperleukocytosis, toxicity, and relapse).

ANNUAL REPORTS

In each year of the 4-year study, an annual report describing IMIP activities was produced in August or September. Information in the report included epidemiologic figures, such as the percentage of patients registered with B cell or T cell lineage ALL, patients who experienced ALL relapse, patients in remission, and patients in each risk group. These data, in addition to mortality and survival data, were extracted from the reports and included in our analysis.

PATIENT REGISTRATION AND CLINICAL CHARACTERISTICS

Twenty-six documents included registration data, which contained the total numbers of new patient admissions to IMIP, patients with newly diagnosed ALL, and patients undergoing chemotherapy. The documents also described a treatment stratification system based on patient genotype, MRD trends, and risk group. Of the 163 new patients discussed during the study period, we retrieved documentation regarding 147 (90.1%). Because many patients were discussed at sequential presentations, we reviewed 286 discussions relating to the 147 patients (*Table 2*). Each patient was discussed a mean of 1.9 times (range, 1–15 discussions/patient). In addition, 93 (57%) of the 163 patients received a provisional low-risk classification and 70 (43%) received a provisional high-risk classification. After further pathologic characterization and determination of patient response to therapy, 26 (16%) cases retained a definitively low-risk classification, whereas 51 (31.3%) were reclassified as definitively standard risk. In addition, 86 (52.7%) cases either retained or received a reclassification of definitive high risk.

TREATMENT COMPLICATIONS

Nine documents included discussions of treatment complications. The documents described neurologic, renal, asparaginase-related, and infection-associated complications. All nine documents containing discussions of complications of therapy included educational components (i.e., education on presentation, diagnosis, and up-to-date treatment modalities for infections such as varicella, leishmaniasis, dengue fever, and fulminant hepatitis). The effect that the toxicity-related discussions had on patient care was not documented and, thus, was unfeasible to evaluate in the context of the telemedicine program.

TREATMENT GUIDELINE DOCUMENTS

The RE-ALL-05 protocol was amended twice during the study period, partially as a consequence of the online meetings. The first amendment was approved on July 7, 2008, and included two changes in risk classification: (1) a maximum patient age of 10 years was established for low-risk cases based on genotype, and (2) all cases with an MRD $\geq 5\%$ on Day 19 of induction therapy were classified as high risk. In addition, two therapeutic changes were introduced in the first amendment: (1) high-dose methotrexate consolidation therapy (instead of reintensification therapy with etoposide and high-dose cytosine arabinoside) would be administered to patients who did not experience initial complete remission, and (2) patients who were critically ill at the completion of

Table 2. Characteristics of Online Meetings and Retrieved Documents										
YEAR (AUGUST– JULY)	MEETINGS AND RELATED DOCUMENTS			NATURE OF DISCUSSIONS (n=107) FROM WEB-CONFERENCE DOCUMENTS (n=94) ^a			DISCUSSIONS OF PATIENTS			
	MM/TOTAL	TOTAL MEETINGS (PER MONTH)	MEETING- RELATED DOCUMENTS	GENDOCS	OTDOCS	PTDOCS	TOTAL PT DISCUSSIONS	NO NEW PTS DISCUSSED	NO NEW PTS DISCUSSED WITH DOCUMENTS	NO REPEATED PT DISCUSSIONS
2005–2006	10/12	29 (2.9)	PPP:26	0	2	27	124	41	36	83
			WD: 5							
2006–2007	11/12	19 (1.7)	PPP: 19	1	5	16	47	35	32	12
			WD: 5							
2007–2008	12/12	16 (1.3)	PPP: 15	1	18	4	54	47	41	7
			WD: 6							
2008–2009	12/12	26 (2.1)	PPP: 30	13	10	10	61	40	38	21
			WD: 6							
Total	45/48	93 (2)	PPP: 90 ^a	15	35	57	286	163	147	123
			WD: 22 ^a							

^aWe retrieved 112 Web-conferencing documents, but 18 consisted of minutes of meetings.
GENDOCS, general documents; MM, meeting months; NO, number of patients; OTDOCS, other documents; PPP, PowerPoint presentations; PTDOCS, patient documents; PTS, patients; WD, word documents.

induction therapy would receive advanced interim maintenance before consolidation therapy. The second amendment was approved on February 20, 2009, and included a recommendation that six additional intrathecal doses of chemotherapy be administered during the second year of therapy for patients with high-risk ALL to prevent central nervous system relapse. Minor treatment modifications were implemented as needed after discussions in online meetings. Potential and implemented modifications, in addition to reports of exchange visits by St. Jude healthcare providers to IMIP, were included in the analyzed documentation.

MORBIDITY AND MORTALITY DOCUMENTS

Four discussions were dedicated to reviewing survival, morbidity, and mortality data. In addition, we retrieved data from the four annual reports provided by the ALL team at IMIP. We collected “pre-telemedicine-era” data on patients with ALL between 1993 and 2005 and compared those data with “telemedicine-era” data collected between 2005 and 2009 in the categories of overall mortality, early death (i.e., death within 30 days of diagnosis), and relapse rate (*Table 3*). Overall mortality was reduced from 31% in the pre-telemedicine era to 12.8% in the telemedicine era. Early death was similarly reduced from 8.1% to 3.6%. The relapse rate was reduced from 10.2% to 7.9% (*Table 3*), with early relapse (i.e., relapse within 30 days of diagnosis) improved from 6.9% to 6.1% and late relapse improved from 3.3% to 1.8%. Overall survival of patients with low-risk ALL in the pre-telemedicine era was 77% compared with that of 100% in the telemedicine era (*Table 3*). However, it is important to note that two patients with low-risk

ALL died after the study ended; thus, the overall survival rate for this group dropped to 92%. Overall survival of patients with high-risk ALL improved from 58% in the pre-telemedicine era to 78% in the telemedicine era.

QUALITY ASSURANCE DOCUMENTS

We identified two documents communicating quality assurance measures to improve the standard of ALL care at IMIP. The first document described a cluster of six children who were first admitted to IMIP and received ALL treatment between May and August of 2009. The patients were evaluated for poor response to induction therapy, as indicated by the inability to clear blast cells on Day 19 of treatment. Five of these children were initially classified as high risk, and four had blast counts higher on Day 26 than on Day 19. In addition, it was noted that five of the patients were poor prednisone responders, requiring a mean treatment period of 11 days to clear circulating blasts. All six patients had considerably higher Day 5 blast counts than that in the mean population of patients with ALL at IMIP. After teleconferencing with St. Jude investigators, it was suggested that a manufacturer error may have affected the prednisone tablets, as the supplier had recently changed. Plans were then made to contact the manufacturer to notify them of the possible error and to notify local clinicians. In addition, a periodic quality assessment of prednisone tablets by the St. Jude pharmaceutical sciences service found the prednisone formulary used at IMIP to be satisfactory.

The second quality assurance document described the causes of ALL treatment failure at IMIP since introduction of the RE-ALL-05 protocol. It was noted that the primary contributing factor to treatment failure was advanced disease at the time of referral to IMIP. This document was a PowerPoint presentation describing an initiative that was begun in 2002 and recognized by the Secretary of Health of Pernambuco in July 2006 to train healthcare providers and agents in rural and urban primary care centers to recognize the signs and symptoms of ALL for early referral.

Discussion

Our study documents the improvement in survival of children with ALL in a poor-resource institution located in northeastern Brazil. Implementation of telemedicine allows a close collaboration to persist between physically distant medical teams. This study describes one of the largest and most comprehensive telemedicine-based initiatives in pediatric oncology in general^{2,4–9} and in pediatric leukemia specifically.^{12,13}

The comprehensive discussions of clinical issues for specific patients positively influenced the care of children with ALL at IMIP. The fact that the cure rate of low-risk ALL in an area with

Table 3. Effect of Telemedicine on Outcomes of Pediatric Patients with ALL

OUTCOME MEASURES	PRE-TELEMEDICINE ERA (%)	TELEMEDICINE ERA (%)
Overall mortality	31	12.8
Early death	7.8	3.6
Relapse	10.2	7.9
Early relapse	6.9	6.1
Late relapse	3.3	1.8
Overall survival		
Low-risk ALL	77	100 ^a
High-risk ALL	58	78

^aTwo patients died after the study period.
ALL, acute lymphoblastic leukemia.

few resources is now similar to that in developed countries (i.e., 92–100%) is an indicator of this. Other indicators are improved overall survival, decreased overall mortality, and decreased early- and late-relapse rates. However, other factors may have contributed to the positive outcome, such as improved infection control, diagnostic services, supportive and critical care, and nurse-to-patient or pediatric oncologist-to-patient ratios. Moreover, it is well established that patients who are treated according to a specific clinical protocol generally experience improved outcomes.^{14–16} In addition, other initiatives occurred between St. Jude and IMIP during the study period, such as improved pathologic diagnosis^{8,17} and early cancer detection campaigns.¹⁸

The role that telemedicine-based twinning initiatives play on improved patient outcomes has also been documented for other diseases, including acute promyelocytic leukemia,^{12,13,19} retinoblastoma,^{2,4} and brain tumors.⁵

Another important benefit from telemedicine is its effect on building local capacity. This was evident at IMIP by the gradually decreased number of recurring discussions and documents about patient care. This trend was most likely due to advancements in clinical aptitude and experiential learning of the IMIP team as they strengthened their collegial relationships with St. Jude physicians. Continuous communication and feedback between the two groups allowed formative modifications in the RE-ALL-05 protocol, with each modification serially evaluated according to the mortality rate before and after its introduction. This resulted in a very functional patient care model. As the twinning program continued, the partnership's focus shifted from case-by-case patient discussions to a more systematic and topical educational forum.

In addition to protocol issues and individual case management, this twinning program exemplifies how such a partnership can benefit the medical community as a whole. Additional benefits included, but were not limited to, a quality assurance project for chemotherapeutic agents, a cost-effective flow cytometry assay,¹⁷ a cancer awareness campaign,¹⁸ and improved pathology services.⁸ In addition, the program improved the culture of discussions, leading to better corrections of errors and more efficient approach changes by the team. The online presentations also provided continuous education at the institutional level for many healthcare providers at IMIP. Although the online meetings and discussions specifically focused on ALL, colleagues from other disciplines (i.e., infectious diseases, laboratory services, and nursing) attended many of the meetings. Healthcare providers, technicians, and trainees then recapitulated these cultural changes in their services and departments, thereby improving the collective knowledge and collaborative environment at IMIP.

A major challenge we experienced in our study was the discovery and collection of all documents related to the online meetings. We explored the computers of the healthcare providers participating in these conferences, yet we could not find any detailed source documents relating to the discussion and treatment plan for 10% of the patients. However, the main objectives of the online meetings were to improve clinical care and education, and build local capacity. Publishing the meetings as a telemedicine experience was not a primary objective, which most likely accounted for the initial lack of a standard repository for agendas and minutes. Future telemedicine initiatives should consider a dedicated repository for source documents and administrative support to maintain such data.

All pediatric oncologists should strive to participate in telemedicine opportunities when they are available to improve the survival of children with cancer not only in developing countries but also in disadvantaged areas within developed countries. Many telemedicine programs are readily available and may prove valuable for future pediatric oncology twinning initiatives, including the Extension for Community Health Care Outcome (ECHO²⁰) project and the iPath²¹ platform. The ECHO project connects primary care providers in rural and underserved communities around the world with specialists in academic centers.²⁰ The iPath platform provides expert pathologic review for colleagues in developing countries.²¹ In addition, the SickKids-Caribbean Initiative²² is a regional program sponsored by the Hospital for Sick Children in Toronto, Canada, to build capacity in six Caribbean countries to improve the outcomes of children with cancers and blood disorders. Other projects to improve care for specific underserved areas within the U.S. include the Pacific Island Health Care Project,²³ which provides expert care to the indigenous people of the U.S.-associated Pacific Islands, and the Kansas University Center for Telemedicine & Telehealth,²⁴ which provides clinical and educational support for several underserved areas in Kansas. Such telemedicine initiatives provide excellent opportunities for pediatric oncologists to participate in or launch new twinning initiatives.

In conclusion, this study demonstrates the positive impact of telemedicine on patient care, distant learning, local capacity building, and cultural changes. In addition, it highlights that the commitment of collaborators is a central factor in maintaining an effective telemedicine partnership. It emphasizes that disciplined planning, sustained meeting attendance, and dedicated patient care by staff at both sites are necessary for such a project to flourish.¹⁹ Institutional support is also essential for success.

Acknowledgments

This work was supported by grant CA21765 from the National Institutes of Health and by ALSAC. The authors thank Nisha Badders for editing the article.

Disclosure Statement

No competing financial interests exist.

REFERENCES

- Masera G, Baez F, Biondi A, et al. North-South twinning in paediatric haemato-oncology: The La Mascota programme, Nicaragua. *Lancet* **1998**;352:1923–1926.
- Wilimas JA, Wilson MW, Haik BG, et al. Development of retinoblastoma programs in Central America. *Pediatr Blood Cancer* **2009**;53:42–46.
- Howard SC, Pedrosa M, Lins M, et al. Establishment of a pediatric oncology program and outcomes of childhood acute lymphoblastic leukemia in a resource-poor area. *JAMA* **2004**;291:2471–2475.
- Qaddoumi I, Nawaiseh I, Mehary M, et al. Team management, twinning, and telemedicine in retinoblastoma: A 3-tier approach implemented in the first eye salvage program in Jordan. *Pediatr Blood Cancer* **2008**;51:241–244.
- Qaddoumi I, Mansour A, Musharbash A, Drake J, Swaidan M, Tihan T, Bouffet E. Impact of telemedicine on pediatric neuro-oncology in a developing country: The Jordanian-Canadian experience. *Pediatr Blood Cancer* **2007**;48:39–43.
- Rivera GK, Quintana J, Villarreal M, et al. Transfer of complex frontline anticancer therapy to a developing country: The St. Jude osteosarcoma experience in Chile. *Pediatr Blood Cancer* **2008**;50:1143–1146.
- Hazin R, Qaddoumi I. Teleoncology: Current and future applications for improving cancer care globally. *Lancet Oncol* **2010**;11:204–210.
- Santiago TC, Jenkins JJ, Pedrosa F, et al. Improving the histopathologic diagnosis of pediatric malignancies in a low-resource setting by combining focused training and telepathology strategies. *Pediatr Blood Cancer* **2012**;59:221–225.
- Alfaar AS, Kamal S, Abouelnaga S, et al. International telepharmacy education: Another venue to improve cancer care in the developing world. *Telemed J E Health* **2012**;18:470–474.
- Rivera GK, Ribeiro RC. Improving treatment of children with acute lymphoblastic leukemia in developing countries through technology sharing, collaboration and partnerships. *Expert Rev Hematol* **2014**;7:649–657.
- Quintana Y, O'Brien R, Patel A, et al. Cure4Kids: Research challenges in the design of a website for global education and collaboration. *Inform Des J* **2008**;16:243–249.
- Testi AM, Al-Hadad SA, Al-Jadiry MF, Moleti ML, Mandelli F, Foà R. Impact of international collaboration on the prognosis of childhood acute promyelocytic leukemia in Iraq. *Haematologica* **2006**;91:509–512.
- Al-Hadad SA, Al-Jadiry MF, Al-Darraj AF, Al-Saeed RM, Al-Badr SF, Ghali HH. Reality of pediatric cancer in Iraq. *J Pediatr Hematol Oncol* **2011**;33:S154–S156.
- Meadows AT, Kramer S, Hopson R, Lustbader E, Jarrett P, Evans AE. Survival in childhood acute lymphocytic leukemia: Effect of protocol and place of treatment. *Cancer Invest* **1983**;1:49–55.
- Wagner HP, Dingeldein-Bettler I, Berchthold W, et al. Childhood NHL in Switzerland: Incidence and survival of 120 study and 42 non-study patients. *Med Pediatr Oncol* **1995**;24:281–286.
- Murphy SB. The national impact of clinical cooperative group trials for pediatric cancer. *Med Pediatr Oncol* **1995**;24:279–280.
- Coustan-Smith E, Ribeiro RC, Stow P, et al. A simplified flow cytometric assay identifies children with acute lymphoblastic leukemia who have a superior clinical outcome. *Blood* **2006**;108:97–102.
- Workman GM, Ribeiro RC, Rai SN, Pedrosa A, Workman DE, Pedrosa F. Pediatric cancer knowledge: Assessment of knowledge of warning signs and symptoms for pediatric cancer among Brazilian community health workers. *J Cancer Educ* **2007**;22:181–185.
- Veerman AJ, Sutaryo, Sumadiono. A rewarding scenario for development of oncology services in transitional countries. *Pediatr Blood Cancer* **2005**;45:103–106.
- Zhou C, Crawford A, Serhal E, Kurdyak P, Sockalingam S. The impact of project ECHO on participant and patient outcomes: A systematic review. *Acad Med* **2016**;91:1439–1461.
- Dalquen P, Savic Prince S, Spieler P, et al. Making cytological diagnoses on digital images using the iPath network. *Acta Cytol* **2014**;58:453–460.
- Adler E, Alexis C, Ali Z, et al. Bridging the distance in the Caribbean: Telemedicine as a means to build capacity for care in paediatric cancer and blood disorders. *Stud Health Technol Inform* **2015**;209:1–8.
- Person DA. The Republic of Palau and the Pacific Island Health Care Project (PIHCP). *Pac Health Dialog* **2005**;12:132–140.
- Doolittle GC. Telemedicine in Kansas: The successes and the challenges. *J Telemed Telecare* **2001**;7 Suppl 2:43–46.

Address correspondence to:

Ibrahim Qaddoumi, MD, MS

Department of Global Pediatric Medicine

St. Jude Children's Research Hospital

262 Danny Thomas Place, MS-260

Memphis, TN 38105

E-mail: ibrahim.qaddoumi@stjude.org

Received: December 21, 2016

Revised: February 9, 2017

Accepted: February 10, 2017

Online Publication Date: April 19, 2017