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Investigating the Emotional Context of Pediatric Critical Care Telemedicine Consultations

Completed Research Paper

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Abstract

Patient-present physician-to-physician telemedicine consultations have been shown to be effective, yet diffusion is not widespread. While much prior research has investigated how computer anxiety affects acceptance and usage of telemedicine and other systems, few prior studies have addressed the impact of situational anxiety (e.g., anxiety caused by the stress of treating a critically-ill child under time pressure) or other emotions on telemedicine acceptance and ongoing use. We report on findings from an embedded-cases study of four hospitals that participate in a telemedicine consultation service provided by a rural tertiary-care hospital. Interviews revealed that telemedicine can help clinicians cope with emotions such as anxiety, grief, and anger that arise from the high-stakes pediatric critical care context. Study findings point to design principles for telemedicine and for collaborative systems in other domains, in and beyond health care.

Keywords: Telemedicine, emotions, technology acceptance, technology diffusion

Introduction

In a physician-to-physician patient-present telemedicine consultation a “hub” specialist (usually at an urban tertiary-care hospital) uses two-way video to see the patient and to collaborate with “spoke” clinicians; necessary data about the patient’s condition are reported orally by the spoke clinicians, sent electronically to the specialist, or both. In this form of telemedicine, a potentially life-saving form of computer-mediated collaboration takes place, sometimes under great duress. For example, when a pediatric intensivist (a specialist who has completed a post-residency fellowship in pediatric critical care) advises on the treatment of a critically ill child, a young life hangs in the balance. Because a child’s condition can deteriorate rapidly (much faster than adult patients), this is a stressful situation and participants (hub and spoke clinicians, support personnel, patient, family members) are likely to experience intense emotions. Do these emotions affect telemedicine acceptance? Can a telemedicine consultation help clinicians cope with these emotions, and improve patient care?

While much prior research has examined how *computer* anxiety affects acceptance and usage of telemedicine and other collaboration systems, the impact of *situational* anxiety (such as anxiety caused by the stress of caring for a critically-ill child under time pressure) and other emotions has received little attention. One investigator called for research on “cognitive-emotional aspects of user acceptance” of telemedicine (Buck, 2009). We answer that call by reporting on an embedded-cases study that explored the emotional context of critical-care tele-pediatrics, from the points of view of spoke clinicians who use telemedicine to collaborate with hub specialists. Interviews revealed that telemedicine can help clinicians cope with emotions such as anxiety, grief, and anger that arise from the high-stakes pediatric critical-care context. Study findings point to design principles for telemedicine and for collaborative

systems in other domains, in and beyond health care. Based on these initial findings, suggestions are offered for further research aiming to extend theories of technology acceptance and diffusion.

Our research is driven by a conviction that, when used appropriately, telemedicine is an invaluable addition to the clinician's arsenal of weapons against disease and trauma. To understand the value of telemedicine in pediatric critical care, it is necessary to note that critically-ill or severely injured children are not frequently seen in rural emergency departments (hereafter, EDs). Traditionally, an attending ED physician or pediatrician will telephone a tertiary-care hospital to arrange to transfer such a patient to the care of a pediatric intensivist. In a conventional pre-transfer telephone consultation, this specialist provides guidance on how to stabilize the child. An intensivist describes one such episode, which had a poor outcome:

"It was like the blind leading the blind. ... I ask them about the EKG and they reply 'We think it looks like this,' but I can't see it. (A fax of the EKG isn't going through)... Suddenly the doctor says, 'Wait a minute; this kid is getting bruises all over her body!' Now I realize the heart is not the problem; the child is ... dying of sepsis. I try to offer recommendations over the phone, but she eventually dies."

Had this episode been supported by telemedicine, the specialist would have been able to observe the EKG data, see the child's bruises, and possibly recognize the child's true condition (sepsis) quickly enough to make a difference.

Gogan et al. (2009a) reported that some pediatric intensivists believe that acceptance and use of telemedicine for critical care consultations is impeded by spoke clinicians' feelings of anxiety or embarrassment; other intensivists believe spoke clinicians feel reassured when helped via telemedicine. The hub specialists further reported that during telemedicine consultations spoke clinicians' anxiety sometimes led to tunneling of attention (overlooking important clinical details). In contrast, the hub pediatric intensivists "are able to keep an emotional distance from the situation and... feel less anxious." That study concluded: "Both emotional distance and higher skill level seem to help the specialists to take in more clinically-relevant information and use this to guide the generalists." (Gogan, et al., 2009a). Another study explored emotional aspects of telemedicine for acute stroke consultations (TeleStroke). This is also a high-stress domain (Gogan and Garfield, 2010), since before initiating a consultation, spoke clinicians must quickly (within a three-hour window since onset of symptoms) identify whether a patient is a possible candidate for thrombolytic treatment. If the patient is suffering from a different condition, thrombolytics could be harmful -- even deadly. In that study spoke physicians reported strong emotions associated with this stressful decision. Nurses and support personnel also discussed a range of emotional responses; some impeded TeleStroke use and some were alleviated as a result of TeleStroke use. To our knowledge, no other study has examined emotional aspects of telemedicine consultation from the viewpoint of participating spoke clinicians. More broadly, the literature of computer system acceptance and use yields few findings on emotional aspects (except for computer anxiety, computer playfulness, and enjoyment; see literature review below).

Whether or not telemedicine is used, the pediatric critical care context is likely to give rise to strong emotions. So, our first research question addresses the situational context of pediatric critical care (apart from telemedicine):

1. *During pediatric critical-care episodes, what emotions do clinicians experience?*

Our second question explores spoke clinicians' emotions during telemedicine consultations:

2. *Does telemedicine influence how spoke clinicians feel (the emotions they experience)?*

Our last research question considers the implications of the emotional context of telemedicine use:

3. *How can an understanding of the emotional context of telemedicine inform system and process designs?*

We report on an embedded-cases study of a telemedicine consultation service provided by pediatric intensivists at a tertiary-care center (RuralHub) to spoke hospitals (located one to three hours from RuralHub). Interviews with ten clinicians at four spokes explored emotions that doctors experience during critical-care episodes, and revealed that telemedicine consultations provide some measure of reassurance. Our findings have theoretical implications which can be examined in further studies, as well as practical implications for how telemedicine consultation services are designed, delivered, and managed.

Literature Review

In this section we briefly review several streams of research relevant to this study: factors affecting the acceptance and diffusion of telemedicine and prior research on emotions, learning, decision-making, and collaboration.

Factors Affecting the Acceptance and Diffusion of Telemedicine

Telemedicine utilizes information and communications technologies to support health care over a distance (Thrall, 2007). As noted above, real time critical care tele-pediatric consultation services often utilize two-way video. Pilot tests reveal that this type of telemedicine is safe and efficacious (Hersh, et al., 2001; Schumaker, 2002; Taylor, 2005) in many specialties, including mental health, cardiology, dermatology, pediatrics, radiology, home health, orthopedics, neurology, oncology, and general surgery (Tulu, et al. 2007). Prior tele-pediatrics studies emphasized technical considerations (Marcin et al., 2004 a, b, c; McConnochie, et al., 2006; Mehta, et al., 2001; Sable, et al., 1999). Today, less than six “hub” hospitals provide critical-care tele-pediatric services in North America, yet neither this nor other forms of telemedicine are widespread. As hospitals invest in internet connectivity, electronic medical records and other foundation technologies, it is anticipated that telemedicine services will increase (for example, some hospitals have replaced expensive ISDN connections with IP connections, reducing one financial impediment).

Experts are divided as to the value of telemedicine for critical care. One study reports that up to 15% of telemedicine consultations involved intensive or urgent care (Chau and Hu, 2004), but another reports: “Tele-consultation collaborative activities were not viewed as useful during emergencies ... (when) time is of the essence ...” (Paul, 2006). Diffusion barriers identified in prior studies include reimbursement, insurance, licensure, and credentialing issues (Barker, et al., 2005; Cho and Mathiassen, 2007; Gamble et al., 2004; Tanriverdi and Iacono, 1999); poor fit with local customs, practices, and roles (Mantzana, et al, 2007; Miscione, 2007; Nicolini, 2007); and relationship challenges such as distrust of hub doctors by spoke doctors (Paul and McDaniel, 2004; Paul 2006). We propose that other emotions may influence telemedicine adoption and continuance, including fear, anxiety, embarrassment, affection, or dislike. Clinicians’ emotions are likely to be affected by situational factors such as time pressure and criticality, user characteristics such as skill level, and technology features -- any of which might impact clinicians’ computer self-efficacy/internal control as well as perceived ease of use – PEU-- and usefulness –U -- of telemedicine systems (dimensions suggested by numerous studies based on TAM -- the Technology Acceptance Model -- and its offshoots. A full review of TAM studies is beyond the scope of this paper - a summary and critique is provided in Lee, et al., 2003). Some TAM studies did investigate the impact of users’ positive and negative attitudes and emotions on PEU and/or U. For example Venkatesh (2000) examined the impacts of computer self-efficacy, perceived internal and external control, computer playfulness (presumably associated with positive emotions) and computer anxiety (associated with negative emotions) on PEU, and also demonstrated how these dimensions interact as a user gains experience with a system. Van der Heijden (2004) reported that user enjoyment (positive emotion) contributes to acceptance of hedonic information systems. However, these and other TAM studies focused on emotional responses *to a system*, whereas we contend that emotions arising from a particular situational context are also likely to influence system acceptance and user behavior. By shedding new light on the emotional context of telemedicine, we hope to identify opportunities to improve clinicians’ training, telemedicine systems design, and supporting structures at both hub and spoke hospitals.

Emotions, Learning, Collaboration, Decision-Making.

A physician-to-physician telemedicine consultation may be sought by a generalist who recognizes that a specialist can help him/her to make one or more important decisions. In this section we briefly review prior studies examining how emotions influence learning, collaboration, and decision making.

Psychologists report that we experience emotion as follows: A triggering event or stimulus (e.g., an alarm on a vital-signs monitor) precipitates a pre-attentional orienting reflex (Roehrbaugh, 1984). The brain attends to key features of the stimulus and matches these to past experiences, evoking a previously learned response. A state of arousal is subsequently experienced as a more refined emotional cognition. So, through *attentional* processes stressors are experienced. Through *cognitive* processes feelings are interpreted as emotions such as fear, anger, or pleasure.

Emotional responses to stressors can impede one’s ability to apply previously-learned knowledge or to learn new material (Warr and Downing, 2000; Taris and Feij, 2004). Thus, during crisis, “people are limited in their information-processing capabilities” (Pearson and Clair, 1989) and may exhibit tunneling or selective attention (Baddeley, 1972; Chajut and Algom, 2003; Zohar and Brandt, 2002). Staal (2004, p. 31) explains:

“Under stress, attention appears to channel or tunnel, reducing focus on peripheral information and tasks and centralizing focus on main tasks ... this tunneling of attention can result in either enhanced performance or reduced performance, depending on the nature of the task and situation. For instance, when peripheral

cues are irrelevant to task completion the ability to tune them out is likely to improve performance. On the other hand, when these peripheral cues are related to the task and their incorporation would otherwise facilitate success on the task, performance suffers when they are unattended.”

Stress-induced anxiety can impede one's ability to process relevant information, and this amplifies stress. Thus anxiety acts both as a response to stress and a cause of it. Those individuals who feel in control of their own responses (high self-efficacy) experience lower anxiety in response to stressors (Endler, et al., 2001).

Stress reportedly impedes participants' ability to collaborate (Patnayakuni et al., 2006). Under the stress of extreme time pressure decision makers seek less information and thus perform worse (Entin and Serfaty, 1990; Wickens, et al., 1991; Van Galen and van Huygevoort, 2000). Experts are able to map salient features of a new situation to prior experiences, while novices are more likely to focus on the wrong aspects of a situation when under time pressure (Flin, et al., 1996; Kaempf, et al., 1996; Klein, 1993; Lipshitz, et al., 2001). Extensive training and rehearsal improves one's ability to work effectively in conditions of high technical complexity, high task interdependence (Sharma and Yetton, 2007), or under high time pressure (Sniezek, et al., 2002). Training is vital because under stress individuals may attend to the wrong cues (Lerch and Harter, 2001) or take inappropriate short cuts (Gogan, et al., 2006). Experts do not need to exert conscious attention over well-learned tasks and can perform multiple tasks simultaneously (Beilock, et al., 2002). Experts' well-rehearsed use of schemas, prototypes, and scripts apparently helps reduce their cognitive load (Neuberg and Newson, 1993). Staal (2004, p. 61) explains:

“Tasks that are well-learned tend to be more resistant to the effects of stress than those that are less well-learned... When tasks are practiced and well-learned, they are likely to be committed to long-term memory, and through their frequent use (activation, rehearsal, recollection) more easily remembered. ... These over-learned behaviors tend to require less attentional control and fewer mental resources, which further results in enhanced performance and greater resistance to stress.”

Because critically-ill children are not often seen in most emergency departments, rural clinicians may not get enough practice in these situations. In contrast, pediatric intensivists at tertiary-care centers do develop significant, well-learned expertise. Much can be learned by examining the emotional side of telemedicine in stressful situations such as critical-care pediatrics, yet (as noted above) the emotional side of telemedicine is largely unexplored.

Critical-Care Tele-Pediatrics: RuralHub and Ten Spokes

Post-residency pediatric critical care programs were first offered in the 1980's by hospitals in Toronto, Philadelphia, Washington DC, Baltimore, Boston, Dallas and Detroit (Epstein and Brill, 2005; Randolph, et al., 2004). In 2010 139 spots were offered in 56 certified pediatric critical care fellowship programs, per the National Resident Matching Program (www.nrmp.org). While 21% of US children live in rural areas (Heath, 2008), only 3% of pediatric intensivists practice in rural areas (Althouse and Stockman, 2006); telemedicine can help bridge this gap.

RuralHub is a tertiary care teaching hospital with a catchment area covering about one million people in 13 counties in its state and six counties in an adjacent state. Its department of pediatric critical care, with three intensivists, won a federal grant to conduct a pilot test of a 24/7 critical care tele-pediatric consultation service, which ran from March 2006 to March 2008. Six rural emergency departments in RuralHub's state and four in the adjacent state participated (all but one spoke site had its first tele-pediatrics consultation in 2006). RuralHub continues to offer the telemedicine service, even though they are not directly reimbursed for consultations (many consultations result in transfer of the patient, and they do get reimbursed for care provided at RuralHub).

In the spoke hospital emergency department, clinicians attempt to stabilize a critically-ill child and decide whether to request a transfer to RuralHub. At any time during this episode the spoke pediatrician or emergency physician can request a telemedicine consultation with a specialist (sometimes the RuralHub specialist suggests this option). Generally, a nurse makes the necessary phone call to locate the specialist and establish the telemedicine connection.

Research Methodology: Embedded Cases Study

This embedded-cases study, part of a broader study of telemedicine consultation services in several clinical domains and provided by several hospitals (Garfield, et al., 2008; Gogan et al., 2009a and b; Gogan and Garfield, 2010), was undertaken in two phases. First, two members of the research team visited RuralHub and conducted face-to-face interviews with the pediatric intensivist who launched the tele-pediatrics consultation service, the hospital's director

of telemedicine, several technical support personnel, and a grant administrator (7 interviewees). Later, two team members visited four spoke hospitals to conduct face-to-face interviews. We sought spokes representing a range of heavy to light usage and varying degrees of current participation. RSpoke1 is the most active user of the tele-pediatrics service, with more than 20 telemedicine consultations, including seven in the past two years. RSpoke2 is the second-most active, with more than 10 telemedicine consultations since the start of the service, but none in the past two years. RSpoke3 has participated in 8 consultations, four of which occurred recently, and RSpoke4 has participated in five telemedicine consultations, with just one in the past two years. Access to interviewees was affected by patient volume on scheduled visit days. Ten clinicians (1 nurse, 3 pediatricians, 6 emergency physicians), one IT director, and an administrator were interviewed at the spokes. Table 1 summarizes data for these four spoke hospitals and (for comparison purposes) for the six spoke hospitals where we did not conduct interviews.

Using a set of guiding questions, interviews were conducted in a conversational style. Interviewees were told that our purpose was to explore challenges and issues in using telemedicine to participate in pediatric critical care consultations; we did not highlight our interest in emotional aspects of telemedicine. Given that emergency clinicians' training and experience deals with critical-care situations, we anticipated that directly questioning them about negative or stressful emotions might yield responses that reflect an image these interviewees want to portray, rather than an accurate description of their felt emotions. Interviewees were asked to describe telemedicine consultations in which they had participated (without revealing patient-specific information). As they did so, we probed to learn their recollection of the patient's condition, decisions they made, care they provided during the episode, and how they felt at the time. We also asked how, when not using telemedicine, they feel when a similarly critically-ill child is brought in. Time permitting (interviews with clinicians were usually conducted just before or immediately after a shift) we asked their opinions regarding other telemedicine application areas, and their thoughts on barriers to and facilitators of telemedicine. Most interviews ran from 30-60 minutes.

Data Analysis

Interviews were recorded and transcribed and interviewers also took field notes. Contextual notes (e.g., medical terminology definitions) were added to transcriptions. All three team members participated in four rounds of coding:

- **Factual coding** of key events and facts (e.g., cost of equipment, number of ED physicians on duty per shift, date of first telemedicine consultation). Information from interviews was triangulated against publicly available documents such as web pages, presentation materials, planning reports, news accounts and journal publications. One member of the research team had primary responsibility for this round of coding.
- Consistent with grounded theory methodology, **comparative coding** captured interview segments that are or are not consistent with previously-identified themes from earlier rounds of data gathering (in this embedded case study as well as other studies in our broader telemedicine program of research). Examples: reimbursement issues, interpersonal trust, hospital strategy and mission. All three team members participated in this round, with extensive discussion to reconcile coding differences.
- **Open coding** categorized interview segments into new themes or sub-themes (such as in this study a theme about clinician fear and another theme about information handoffs during patient transfer). Each member of the team contributed their open codes. Discussion led the team to re-categorize some open code candidates into earlier codes and to accept other open codes as representing new aspects.

Several passes were made through the interview data to accomplish this coding and a process of **interpretation** (identifying linkages across and between themes, and probing deeply into the significance of various events, opinions, and contextual aspects to the case overall; see Stake 1995). Each round of coding entailed comparison across researchers and extensive discussion until consensus was achieved regarding classification of data from interviews and other sources, and our interpretation of the relationships among topics and their deeper meaning.

In the next section we present evidence regarding the questions posed in the introduction.

Hospital/ Date of first TelePediatrics Consultation	Total Teleped Episodes	Usage Last 2 Years	Beds	Yearly ED Visits	Interviewees
RuralHub			560	54,300	MDIntensivist, MDTelemedDirector, GrantAdmin, TechDirector, TechManager, TechSupport1, TechSupport2
RSpoke1 /2006	24	7	340	50,700	Pediatrician1, EmergencyMD1-1, EmergMD1-2
RSpoke2 /2006	12	0	45	16,500	Pediatrician2, EmergencyRN2, EmergMD2-1, EmergMD2-2
RSpoke3 /2006	8	4	75	13,900	EmergMD3-1
RSpoke4 /2006	5	1	40	15,800	Pediatrician4, EmergMD4-1, TechDirector4, Admin4
RSpoke5 /2007	8	2	75	30,000	No interviews
RSpoke6 /2006	7	2	60	12,100	No interviews
RSpoke7 /2006	5	1	15	7,600	No interviews
RSpoke8 /2006	5	0	95	14,600	No interviews
RSpoke9 /2006	3	0	190	35,000	No interviews
RSpoke10/2006	2	0	95	21,500	No interviews

Usage data provided by RuralHub. Number of beds and annual ED visits obtained from hospital web sites, and rounded.

Table 1 RuralHub Critical-Care Tele-Pediatrics Service: Ten Spoke Hospitals

Findings

During pediatric critical-care episodes at spoke hospitals, what emotions do clinicians experience?

Interviewees described the context of pediatric critical care, apart from telemedicine use. At RuralSpokes 1, 2 and 3, clinicians stated that pediatric critical care cases were infrequent. At RuralSpoke 4, an emergency doctor and a pediatrician stated this was a fairly frequent occurrence – possibly because in the six months before our interview they had seen an unusually high number of young children with severe respiratory distress due to H1N1 flu in their catchment area. Table 2 presents evidence about the frequency of pediatric critical-care episodes.

Fear was explicitly mentioned (without interviewer prompting) by the nurse interviewee and two of the three pediatricians that we interviewed. A nurse stated, *“It’s always a scary time when we have a very sick baby or child here...Kids are different; kids are scary to everybody in small hospitals because they are different little animals.”* A primary-care pediatrician (RS2Ped1) amplified on the nurse’s remarks:

“It is incredibly terrifying to be in an outside institution with a kid who is really, really sick. We’re used to thinking of really sick people being in places that have really high levels of technology and really smart people... It’s very, very scary to have a very sick kid, specifically, on your hands. You’re waiting for the team to come or you’re trying not to accidentally kill them between the time that you get them and the time that you got them out of here. I am not a critical care person; I am not an intensivist. I am a primary care pediatrician who’s far better at treating diaper rash than I am at treating status epilepticus or God forbid, a kid that’s in cardiac arrest. I don’t do it enough to be good at it. Anything that you do regularly, you stay competent at. You just don’t stay competent at the things you don’t do very often. ... Children are incredibly scary. They’re not little adults and they don’t act like little adults.... An adult who’s crashing will lie down, but a child who’s crashing will sit up. Children go from breathing to not breathing and alive to dead like that! They’re very frightening. Adults will dwindle; children just fall off the cliff. They’re very, very scary.”

In this quote we see that fear arises out of a concern that the child may be harmed, combined with the pediatrician’s recognition of personal accountability and skill set shortcomings, due to lack of training and practice. Also, time pressure is evident in the remark about not wanting to “kill” the child before transfer to a tertiary-care center. A pediatrician (RS1Ped1) in another rural town also emphasized time pressure as a stressor:

“What stresses me is the distance to definitive care; that’s what worries me. For short term stuff, we can do okay ... we can stabilize the patient. But when we really need them out of here and somewhere else so that they can get the definitive care they need, what makes me nervous is that time we’re waiting.”

Case Site/ Frequency	Sample statements regarding infrequent pediatric critical-care episodes
RSpoke1/ Infrequent	RS1ER1: <i>Children are more difficult than other patients, especially because we don’t see quite that many sick children.</i>
RSpoke2/ Infrequent	RS2ER1: <i>The biggest challenge in a rural small ER is, it’s hard to keep experience with those rare events, because it’s not very common that a child is in a critical condition. It’s just rare, so unless you’re working in a really busy ER, you’re not going to see it much. ... Things that aren’t done frequently don’t go smoothly.</i> RS2ER2: <i>21 Luckily we don’t get that many critically sick kids. ... It’s nice to have [telemedicine] for critical care pediatrics, but we just don’t get a lot of critical care (cases).</i> RS2RN1: <i>It’s been years since I’ve seen a little kid like that ... that’s good. That certainly would be the kind of thing where you might want a consult with somebody on telemedicine.</i> RS2Ped1: <i>I am a primary care Pediatrician who’s far better at treating diaper rash than I am at treating status epilepticus or God forbid, a kid in cardiac arrest. Though I do it, I don’t do it enough to be good at it.</i>
RSpoke3/ Infrequent	RS3ER1: <i>It’s uncommon to have critical care Pediatrics. ... I would say from the ER here, we probably transfer about 6 critical Pediatric cases a year. Not all require teled.</i>
RSpoke4/ Frequent?	RS4ER1: <i>This fall to the beginning of January, we had really bad flu-type illnesses, I think we had H1N1 in our area ... babies got really bad viral, respiratory illnesses. We saw quite a few that got really bad. ... So, we see quite a few, it goes in spurts, more in fall and winter. ... We get a lot of sick babies. We transfer them a lot. ... Me personally, I transfer one or two really, really sick babies a month to a tertiary care center. That’s just me; there are other doctors on other shifts. We do a few a month, so it’s quite a bit.</i> RS4Ped1: <i>On average we probably transfer one or two babies per month to the [RuralHub] PICU... somewhere between 12 to 24 per year. But we don’t need telemedicine all the time; most of the time we’re able to just give the impression on the telephone and make the decision based on the telephone.</i>

Table 2. Case Evidence re Frequency of Pediatric Critical-Care Episodes:

Three emergency department physicians, from RuralSpokes 1 and 2, also mentioned fear/anxiety:

RSpoke1ER2: *“People tend to be more nervous and upset [during pediatric critical-care episodes]. It’s definitely not frequent enough that everybody’s comfortable doing it.”*

RSpoke2ER1: *“Everyone freaks out when it’s a sick kid; there’s more at stake. ... It’s rare enough that it’s definitely out of my comfort zone. Maybe once a year I get a really, really sick kid ... When a grey infant comes in, it’s like Oh, my goodness.... it’s always a bit nerve wracking... When somebody that’s 80 dies in the ER it’s a terrible thing, but boy, when a three year old dies ... you just don’t want it to happen ... it’s just stressful. ... Everything is harder ... intubations are harder, assessments are harder, trying to do procedures ... when they’re awake they’re thrashing about. Just everything about it, the stress level is higher.”*

RS2ER2: *That’s kind of scary. That’s why it is kind of nice to have [an intensivist] giving us real time feedback [via telemedicine]... [Critical-care cases] are rare enough that it’s definitely out of my comfort zone.*

Two ER doctors were less forthcoming about their feelings, yet their remarks hint at their emotional responses:

RS1ER1: *“Children are more difficult ... because we don’t see quite that many sick children.”*

RS3ER1: *“When a young child is coming in critical, we rally the troops ...”*

One ER doctor (RS4ER1) gave no indication of experiencing stress, fear or anxiety in pediatric critical care cases. We observe two things about this doctor’s background: a) He sees “quite a few” critical-care cases (see Table 2/RuralSpoke 4) and b) Before coming to RuralSpoke 4, this doctor trained at an especially busy ED in a large US city (where presumably he became accustomed to treating a variety of very challenging cases).

Thus, our findings indicate that during pediatric critical-care episodes, many clinicians experience fear/anxiety and other discomfort. We next examine whether telemedicine adds to or diminishes spoke clinicians’ discomfort.

Does telemedicine influence how spoke clinicians feel (i.e., the emotions they experience)?

The pediatrician (RS1Ped1) who expressed concern (above) about “time to definitive care” stated:

“I think the benefit of telemedicine was just reassuring me ... I don’t know if it changed my treatment plan... but it made me feel a whole lot better that I probably wasn’t missing something ... It’s just reassuring that (the intensivist is) looking at (the patient) ... hours sooner than they would be without it.”

RS1Ped1 reflected on the intensivist’s ability to take in information that the pediatrician didn’t see:

“This (teenage) patient with an overdose, who was very somnolent ... Dr. R had that outside perspective looking at her and seeing some things she was doing that I wasn’t seeing ... He (said)’... She’s going to be okay.’ ... He was less worried because he could see some things she was doing on her exam that I couldn’t see. That was reassuring, (to know) that it was a little less serious than I thought ... Maybe if I had another pediatric colleague here, they would have seen the same stuff; just having two heads instead of one....”

Note that RS1Ped1 was not sure whether telemedicine’s value came from the specialist’s expertise or merely “having two heads.” Regarding another case RS1Ped1 did point to the specialist’s expertise as an important benefit:

“I’m good at toddlers with constipation; I don’t see 25 status asthmaticus a day ... (Intensivists) do it all the time, so part of it is their expertise saying ‘These are the tests we need to do.’ Whereas we’re ... going to have a book open ... looking up what we’re supposed to do next.”

Another pediatrician (RS2Ped1) felt a telemedicine consultation provided some reassurance, even though she figured out a difficult diagnosis before the specialist did:

“I could have been wrong just as easily I had about a one in 50 chance of being right... To actually have somebody who’s got a cooler head than mine who’s separate, who can generate a differential diagnosis, who can make sure that I’ve done the right things in the right order, who can suggest to me the next thing to do, and who can basically calm me down when I’m having a panic attack, is very useful.... It’s very useful to have that other person there thinking when you’re not necessarily able to think because you’re too busy panicking. ... In medicine you’re trying to predict the future; constantly reaching for that piece of information you don’t yet have. You’re trying to get that gestalt sense of ... what part of this novel have I not read? You always feel like somebody has handed you a novel on page 60. You know that the first sixty pages had a lot of information that you really would like to know, but you don’t have. Just having that extra person in telemedicine, who can kind of step back and say ‘Have you considered drawing the following labs?’ ... To have that calmer experienced person who does this all the time ... is really the benefit.”

A third pediatrician (RS4Ped1) did not explicitly state that he experienced fear doing critical-care, but did speak of the reassurance he felt during a telemedicine consultation when a baby was having difficulty breathing. He knew this patient needed to be transported quickly, but that helicopter transport carries some extra risk (of a crash).

“... It was rather reassuring, because that takes some liability off your shoulder. I am not the only person deciding whether this patient should (be transported) by road or by helicopter. It gives you a little peace of mind there.... I think it’s a very useful thing for us living in a small rural area; a very useful thing.”

An ED doctor (RS2ER2) implied that perfect technology is not essential to effective telemedicine use. Recalling a case when the video worked only in one direction, he said the specialist could see rural clinicians, but not vice-versa:

“It was kind of nice to have them giving us real time feedback, even if I couldn’t see them. ... If it’s just me (on duty) in the middle of the night, it’s nice to have someone else who can see what’s going on.”

A prior study (Gogan et al., 2009a) reported that some hub specialists believe spoke generalists feel embarrassed about being observed making mistakes. However, only one spoke clinician mentioned concern about being observed by a RuralHub intensivist -- a pediatrician who was otherwise enthusiastic about telemedicine. Although apparently not concerned about embarrassment, this doctor (RS1Ped1) was reluctant to be observed in the act of “running a code” (resuscitating a child) because of possible information overload issues:

“I’ve wondered if I’d really want someone talking to me while I’m trying to intubate ... I just don’t know if that would be too much external stimulus... It’s such a chaotic environment ... usually you can barely get around the table because so many people are working on the child and it’s just pretty chaotic. I don’t know what it would be to have someone trying to talk to you as well.”

An emergency physician (RS2ER1) did use telemedicine while attempting to resuscitate a child (once nurses established the connection for him). This doctor had a positive response:

“They finally got (telemedicine) all hooked up and I remember basically it was just kind of nice having that voice ... We would say, ‘We are going to give the kid .4 of EPI IV’ and he’d say, ‘Yeah, that sounds like the right dose.’ It was kind of reassuring to have somebody over your shoulder just double-checking.”

In this particular episode, the child died. Yet, RS2ER1 felt telemedicine helped both him and the patient’s family (who were in the treatment room throughout the episode):

“...Having [the specialist] say, ‘You’ve done everything you can’ [was helpful]... When it’s a young child, it’s not very easy; ... you’d hate to think ‘Oh, I may have stopped a little too soon.’ ... For me, having somebody over my shoulder who’s sitting up at what we call the Miracle Center saying ‘Yes, you’ve done everything you’re supposed to do,’ I think would be reassuring to the family.”

These latter quotes point to other emotions besides fear during critical-care telemedicine consultations. Regret over actions not taken, grief when a patient doesn’t survive, empathy for a grieving family – all evident. Telemedicine consultations apparently help clinicians deal with these emotions. Several interviewees explained that telemedicine is initiated primarily in dire cases, so it is not a surprise that the outcomes are often poor:

RS4Ped1: *“I did not require telemedicine because the baby was not very sick. I was able to (use) the phone.”*

RS2Ped1: *“We only call telemedicine for kids that are trying to die... if we’re going to intubate a child or if they’re really, really sick ... when I’m out of my comfort zone. ... when the kid is really falling apart.”*

RS3ER1: *“Teled is for the critical complex cases.”*

RS2RN1: *“This kid was sick but we weren’t sure they were stable enough to transfer, and we knew we weren’t going to keep them here. That was a logical situation, then, to get telemedicine on the line.”*

RS1ER1 described a difficult situation when telemedicine was used for a child with severe asthma:

“I used ... telemedicine ... for a consult with the pediatric intensivist. The child was rather critical; he was having a lot of difficulty breathing.... I was wondering if the child needed to have a protected airway for the transport. I didn’t have any doubt about the child needing to be transported but the question was: What should we do before we transport him? Do we need to intubate him? ... Intubating patients with asthma is not an easy call; ventilating them can actually make them much worse ... That is a very difficult decision to make. On the other hand ... [RuralHub] is more than an hour away --... what if, during transport, the patient fails? They would [need to intubate] in much worse conditions in the ambulance ... The intensivist was extremely useful, extremely supportive; it was very helpful that she could see the patient... when you can see how much difficulty they had breathing, how much they fight, what their stance is, and so on... My describing it would have been much less relevant than her being able to see for herself and talk to the patient and the family, who was in the room, and reassure them and make a decision on what was the best thing to do.”

Spoke clinicians also indicated the belief that hub intensivists also responded positively to telemedicine use, thanks to their ability to see the patient before transport to RuralHub:

RS3ER1: *“They can see what we’re talking about ... It’s good for continuity of care because ... they were able to actually know what we were talking about. ... The opportunity to see for themselves how the patient looked ... I assume if I was in their shoes that would help me.”*

RS1ER2: *“We can speak directly to them and they can speak to us, and they can make recommendations with all that extra information that you can’t just get on the phone.... I thought it went very well.”*

RS2ER1: *“It’s just for the overall feel of what’s going on and what else should be done before transfer.”*

RS4Ped1: *“[Hub intensivists] can control the camera as to what view of the baby they want, and they can talk to us also at the same time.”*

Thus, the evidence from our embedded cases study suggests that when using telemedicine to collaborate with specialists, many spoke clinicians feel reassured and their anxiety diminishes. Spoke clinicians further believe that in the collaboration the hub specialists also benefit, by receiving valuable information in advance of patient transfer. Still, this is a simplified version of a complex story; personalities and other aspects of the clinical context may affect the emotions clinicians feel and whether they see telemedicine as helpful. We consider these contextual aspects next.

What contextual features affect clinicians' emotions, and how can an understanding of the emotional context of telemedicine use inform system and process designs?

In this section we examine situational factors that appear to interact with the inherently stressful context of pediatric critical care and clinicians' participation in telemedicine consultations.

Prior Relationships and Trusting Beliefs

Consistent with prior research reporting that distrust impedes telemedicine use (Paul and McDaniel, 2004), one clinician (RS1Ped1) remarked that interpersonal trust needs to be built before telemedicine can be useful:

"Part of the reason it works really well with us is because we already have an established relationship with those physicians; we already trust them. ... The medical legal stuff ... might be a little murky and ... makes you a little nervous. So, if I didn't know these guys and didn't trust that what they were saying was probably good advice, I don't know that I'd like them telling me ..."

One spoke pediatrician (RS2Ped1) explained that trust can be built through frequent telephone consultations (which are far more frequent than telemedicine consultations). This doctor explained, *"I pick a hospital [for patient referral] based on ... who I think is best"* (referring to the competence dimension of trustworthiness), an opinion formed through previous interactions. Conversely, another pediatrician (RS1Ped1) mentioned unpleasant telephone conversations with doctors at a tertiary-care center (referring to the benevolence dimension of trustworthiness):

"I had the worst experience ... Some of the physicians... were really not nice. That does not happen face-to-face as much as it does over the telephone ... I thought: I would like you to ... look at me while you're saying this stuff.... You can roll your eyes, but I can hear it in your voice, you just may not realize it!"

A spoke ER physician (RS1ER2) also emphasized visual cues and suggested that telemedicine can improve the relationship between hub doctors and spoke doctors, even when telephone communication is frequent:

"I talk to doctors on the phone all the time at other institutions and arrange transfers, but there's something very different when you can actually see someone's face ... It's almost like a friendly thing. I think people are more polite and friendlier when actually looking at someone's face."

These findings hint that spoke clinicians' telemedicine adoption decision is influenced by their perceptions of hub specialists' trustworthiness (in terms of perceived competence and benevolence). The findings further indicate that telemedicine use can sustain or increase trust between hub and spoke physicians, perhaps due to the richer communication media and ability to see visual cues. Ongoing telemedicine usage seems to reinforce trusting beliefs.

Organizational Context and Episode Frequency

The organizational context may affect the emotional context of telemedicine use. As seen above in Table 1, spokes ranged in size from a tiny 15-bed hospital (RSpoke7) with fewer than 8000 ER visits/year, to a substantial hospital (RSpoke1) with 340 beds and nearly as many ER visits as RuralHub. While smaller spokes had a single ER doctor on duty at night, RSpoke1 had three doctors on duty until midnight, and two for the rest of the night. One of those doctors stated, *"we're lucky there's always a colleague here ..."* The implication here is that when another colleague is on site, a clinician might be inclined ask for their assistance instead of using telemedicine.

Thankfully, pediatric critical care episodes are infrequent. However, because they are infrequent, spoke clinicians do not always think to initiate a telemedicine consultation when the need arises. A RuralSpoke2 emergency physician (RS2ER1) confirmed that critical cases *"are pretty rare,"* so skill sets get rusty. *"I had three critically ill kids in a row. The first one was really tough ... the second one, we had all just recently practiced, so the lines went in easily."* This doctor generally *"doesn't like"* telemedicine for adult trauma because it *"adds to the complexity of what's going on;"* however, he does use it for pediatric critical-care case and finds it useful in that context. He explained, *"We'll call [RuralHub] and say, 'We really want this patient to go up there to be seen. He's critically ill and such-and-such.' [The intensivist] will say, 'Why don't we do the telemedicine?'"* A pediatrician at another spoke (RS1Ped1) said *"Usually I would forget that we have it ... We make a phone call and [the intensivist] would say 'You want to turn on the telemedicine? ... That's when I would remember and it would happen."*

The above remarks show that telemedicine use is not routine, since spoke clinicians need reminders by the hub specialists. To raise awareness of the service RuralHub encourages spoke clinicians to utilize the telemedicine equipment for routine activities such as twice-yearly transport conferences, in which hub specialists inform spoke clinicians about patient outcomes. A pediatrician (RS2Ped1) explained: *"It's sort of a morbidity and mortality*

conference. We go back over and review all the neo-natal patients that have been transferred [to the hub]. It's incredibly useful." When discussing potential other uses of telemedicine, this pediatrician gave a particularly detailed description of the context of neo-natal care at RuralSpoke2 (the neo-natal unit is located at a distance from the ER and the telemedicine setup, so real-time neo-natal telemedicine consultations are not yet done):

"...In a big hospital like [RuralHub], you have a nurse who knows how to put in an IV, a respiratory therapist that knows how to deal with a little kid, ... and generally either a resident or fellow who ... can be your second set of hands. Here, we are it. We have to put in the IV, bag the baby, do the intubation. Half the time, I have to put all of my own lines in; I'm trying to manage a kid and... manage their airway at the same time. You just don't have the hands. ... If I could just stand at the edge of the bed and say, 'Put in the umbilical-venous catheter' my life just got a whole lot easier. [Instead] when I say, 'We need to put in an inter-osseous line' they say, 'Okay, doctor, the tray is over there, go for it.' I'm now distracted from the management of the kid [as I] try to put in the inter-osseous line. We're filling multiple roles and it's very hard to step back because we don't necessarily have all the pieces of the team that you have in an ideal resuscitation setting.... You really are on your own trying to manage this. It would be so useful to have telemedicine in those situations."

This latter comment adds to the evidence that some spoke clinicians would welcome further access to telemedicine.

Ease of Use and/or Transparency

Comments by two physicians and a nurse suggest that for telemedicine to succeed, the system needs to be completely transparent to the clinicians, who are focused on treating the child:

RS1ER1: *"It was already set up ... I personally didn't do anything, which is a good thing, since I wouldn't have any idea what to do. Fortunately ... the nurses set it all up. We just look pretty on the TV ... the nurses work the buttons, we don't have to do anything."*

RS1ER2: *"My experience has been that the charge nurses turn on the equipment and these people appear on the screen somehow. I don't know if ... phone calls (are made) ahead of time or whatever...."*

RS2RN1: *"I must have been busy with a baby because all of a sudden they [the hub intensivist] were there. I don't recall who said 'Turn the thing on.' ... That sounds crazy, I'm sure, but I don't recall that at all."*

An RSpoke2 nurse explained what happens behind the scenes: *"The ER doctor would say to our communications lady, 'I need the pediatric attending on call.' She makes one phone call and within 15 minutes [the intensivist] would call back."* If the hub specialist suggests a telemedicine consultation, he can establish the connection remotely. The nurse appreciated this aspect: *"Our general staffing here is basically two nurses and an ER doc, so if somebody is really sick, we're really busy, not fiddling around with the TV."*

These remarks point to several observations:

- 1) Hub investments in complementary systems – such as the system which made it possible for a spoke nurse to phone a single RuralHub number and have the request routed to the on-call pediatric intensivist – can improve the usability of telemedicine and increase the likelihood of it being used.
- 2) To the extent that spoke doctors can be shielded from involvement with the telemedicine equipment and establishing connections, they will be more receptive to using it.
- 3) Ease of Use and Transparency are not one and the same. A system can be somewhat difficult to use, yet if one or more members of the telemedicine team (at hub or spoke) are skilled in establishing the connection and manipulating the system during use, then transparency may be achieved for other clinician "users".

Presence of Family Members

Another important aspect of the emotional context of critical-care pediatrics is the presence of a patient's family. RS1ER1 stated, *"People get very anxious ... Basically it's much easier to deal with the child without the parents in the room, but that's not something we usually would do."*

Another doctor (RS2ER1) explained:

"I always have the parents in the room ... I don't want them to have this black box where they don't know what happened and ... all of a sudden they're handed a dead baby.... Studies have shown that while it's emotionally difficult, parents ultimately have better closure if they're involved, in the room."

The family adds an additional relationship layer to telemedicine interactions. Several physician interviewees made comments suggested that the telemedicine system is transparent to family members. For example:

RS1ER1: *“They saw a doctor in the room, and a doctor on TV, and they were concerned about the child. The technical aspects of who was where? They couldn’t care less.”*

RS1ER2: *“The parents ... felt comfortable ... seeing the doctors [at RuralHub] who would be taking care of their child. That was pretty nice. ... Seeing the doctor on the screen, being able to talk, and them seeing us, it’s a nice thing. ... You have this very calm and reassuring face and voice and the families like it a lot.”*

Reassuring Findings

Stepping back, we note that our interviewees described many types of episodes when they do not feel a need to use telemedicine, because at those times they feel fully competent to care for their patients without assistance from the hub. However, during some particularly tough pediatric critical care episodes, when spoke clinicians clearly feel that the stakes are high, many feel anxious or fearful. Using telemedicine, these clinicians receive both assistance and reassurance from hub intensivists. The theme of reassurance was mentioned by many interviewees (Paul, 2006 similarly noted that specialists’ reassurance is helpful to spoke clinicians). Our interviews further revealed that spoke clinicians believe telemedicine helps family members cope. This is consistent with a recent finding (Gherardi, 2010) that patients receive reassurance when using telemedicine to gain access to cardiac specialists.

Discussion and Conclusions

Interviews at four spoke hospitals shed light on our three research questions in this embedded-cases study:

The results provide clear evidence that the stress of treating a critically-ill child causes some ER physicians, pediatricians and nurses to feel anxious and fearful, for several reasons. Since these episodes are infrequent, clinicians at some rural hospitals have few opportunities to practice applicable skills, and their knowledge of diagnosis and treatment options in such circumstances is also limited. Their recognition that they lack necessary skill and knowledge, combined with their recognition of the child’s grave condition and parents’ concern, as well as the added stress of time pressure, makes clinicians feel a loss of control which gives rise to fear and anxiety.

Previous research based on interviews with hub specialists (Gogan, et al., 2009a) reported that experts believe that fear and anxiety motivates spoke clinicians to use telemedicine in critical-care episodes. Indeed, spoke clinicians in this study clearly described the emotional intensity they feel in pediatric critical care episodes. These infrequent cases definitely bring them outside of their comfort zone; some stated that these episodes can be terrifying and nerve wracking. Even though they know they will transfer most such cases to RuralHub, they feel somewhat anxious while stabilizing the child and quite anxious about whether the child will survive the trip (due to the “distance to definitive care”). We note that once the child is in the ambulance en route to RuralHub, it is now RuralHub’s responsibility. While some spoke clinicians may draw some reassurance from being released of legal liability at that point, most of them remain deeply concerned for the welfare of the child.

Using telemedicine to confer with specialists, clinicians report that having a “second set of eyes” to attend to aspects of the patient’s condition is of great help. They report receiving reassurance -- either because the intensivist confirms they made the right treatment choices, or because this hub specialist provides valuable guidance. Both aspects help the spoke clinician regain a feeling of control over the situation, which reduces their fear and anxiety.

A hub clinician in another study stated: “In the emergency room in the [rural areas] as far as I’m concerned, there has always been one decision: I keep or I send. If they send, they shouldn’t be screwing around (with telemedicine) ...” (Paul, 2006 p. 166). While that and another study (Paul 2004) found that telemedicine is not useful for emergency care, several clinicians in our study explicitly stated that telemedicine is *especially* useful for difficult and complex critical-care cases, because of their lack of practice with such infrequently occurring cases and their heightened emotional state (and felt loss of control). These clinicians value the assistance they receive from hub specialists, who observe clinical details that they overlook (due to tunneling of attention, lack of expertise, or both); this makes them feel more confident that they are transferring the patient in the best possible condition. Furthermore, our interviewees reported that specialists tend to reassure them that they have done all they could for their patients. These findings close the loop on our earlier study (Gogan, et al., 2009a), which reported that hub specialists feel they play an important role in coaching rural clinicians through difficult procedures and in reassuring them that

difficult decisions (e.g., to discontinue a code; whether/ when to transfer a patient) are correct. Spoke clinicians discussed examples in which the hub specialists' skills augmented theirs, and many examples of feeling reassured that they had done the right things, even when the outcome was negative.

While some hub specialists believe spoke clinicians are reluctant to participate in telemedicine out of concern that they will be embarrassed (Gogan, et al., 2009a), this theme did not emerge in our interviews with spoke clinicians. Instead, they provided alternative reasons for low usage: forgetting they have access to telemedicine (because it is used so infrequently; a vicious cycle), uncertainty about whether a telemedicine connection can be quickly established and will work correctly, concern that it will be a distraction in an already-chaotic context. Most spoke physicians stated that if they didn't have to worry about the technical side of telemedicine, and if it didn't take them or other clinicians (such as nurses) away from their primary care tasks, and if they were certain that a specialist would be readily available, they would use it more often and they expect it would be helpful. These findings suggest that even a small amount of uncertainty about the usability and reliability of the technologies supporting telemedicine, combined with uncertainty about the availability of a hub specialist, can have a disproportionately strong inhibiting effect. We thus conclude that if telemedicine is to be widely adopted and frequently used, it has to be as seamless and transparent as a telephone call. Careful attention must also be given to staffing patterns and facilities at hubs to ensure that when a spoke clinician requests a consultation, it will be immediately provided.

Hub intensivists reportedly find it difficult to offer advice over the telephone, based on spoke clinicians' oral descriptions of the patient (Gogan, et al., 2009a). Telemedicine "allows us to see everything ... (including) a wealth of physiologic data that is unavailable except by direct observation." This statement points to the importance of specific enabling features of telemedicine, especially high quality video, combined with the hub specialist's ability to remotely control the camera in order to confirm a diagnosis and provide guidance regarding treatment.

Our earlier study reported that hub specialists believe they "see the big picture" better than spoke clinicians, who suffer from tunneling of attention (Gogan, et al., 2009). Specialists "step back," remain emotionally cool and focus on important details that escape the attention of anxious spoke clinicians. The current study reveals some evidence that spoke clinicians share this point of view (RS2Ped1: "*You're not necessarily able to think because you're too busy panicking... Just having that extra person in telemedicine who can kind of step back...*").

Use of telemedicine apparently strengthened relationships among hub and spoke clinicians and between parents and clinicians (at hub and spokes). However, relatively minor system flaws impeded telemedicine usage. In emergency medicine, careful attention needs to be given to ensuring a foolproof way to establish the two-way telemedicine connection, assuring that the cameras are mounted such that a hub specialist can see the patient and bedside monitors, and other seemingly mundane details. System shortcomings that might seem minor in other contexts can add to a spoke clinician's anxiety at the very moment when he or she is struggling to stay calm and confident.

Our interviews with clinicians at four spoke hospitals revealed that the infrequent occurrence of pediatric critical-care episodes gives rise to both opportunities to utilize telemedicine to tap specialized expertise and challenges in its use. Spoke clinicians sometimes "forget" about the telemedicine consultation service or – due to lack of practice – are uncertain how to establish a connection. Minor technical glitches can add to their stress during consultations. Several prior studies reported that when target users (first responders, public health officials) do not get enough opportunities to use collaboration systems designed for highly unusual crises, they do not keep their usage skills current (Fedorowicz, et al., 2006; Fedorowicz, et al., 2007; Gogan and Fedorowicz, 2008). System sponsors can address this problem by expanding system functionality to support some routine applications, so that users' skills remain current. Our interviewees pointed to two such avenues for reducing the negative impact of infrequent use: 1) Use the telemedicine equipment for additional purposes (e.g., routine follow ups/ debriefs on patient status and morbidity/mortality conferences). Such routine use should remind spoke clinicians that the system is available and also presumably provide assurance that it is reliable and useful. 2) Designate responsibility for initiating telemedicine use (before authorizing patient transfer, RuralHub specialists often requested that a telemedicine consultation be performed). Having a hub specialist initiate a telemedicine consultation is helpful because the spoke clinician's attention is primarily focused on treating the critically ill child. However, this is an imperfect remedy, since we learned from our interviewees that some spoke clinicians don't contact the hub until they have already stabilized the patient (or until they realize that the steps already taken to care for the patient are not helping). Apparently, then, there are times when telemedicine would be helpful, yet it is either not being used, or it is being used too late. Thus, we believe that hub hospitals need to take additional steps to remind spoke clinicians that the

telemedicine consultation service is available, to make it easier to initiate a consultation, to guarantee system reliability, and to ensure that the hub specialists are available when the spoke clinicians need them.

Study Limitations and Conclusion

The four spoke cases point to fascinating issues concerning the emotional context of critical-care tele-pediatrics. The evidence suggests that spoke clinicians would like to use telemedicine more often to receive help and/or reassurance in complex critical-care cases, but only if the telemedicine system itself does not add to their stress. In the domain of pediatric critical care, it seems that the clinician has a limited reservoir of tolerance for technical or process glitches – probably because so much energy goes into coping with the enormous stress inherent in the treatment situation.

Our findings from this embedded-cases study are straightforward and not startling, yet rich in contextual detail. The findings demonstrate why pediatric critical-care episodes are stressful and why spoke clinicians can benefit from using telemedicine to receive guidance and reassurance from hub specialists. The findings further suggest why it is essential to carefully consider every step involved in introducing telemedicine and encouraging its ongoing use. Many telemedicine pilot tests have demonstrated that this mode of physician-to-physician communication is efficacious, and yet few telemedicine services have reached financial viability. The current study reveals that small technical or process “glitches” can apparently have outsized negative impacts on usage. Thus, we conclude that it is essential to view telemedicine in the context of end-to-end treatment processes in particular settings. For example, a small spoke hospital may not have sufficient resources to assign one individual to be responsible for testing telemedicine equipment, ensuring that connections work, verifying the correct number to call at the hub hospital, etc. Where spoke resources are constrained, it is especially helpful if the hub hospital can set up the telemedicine system in such a way that the spoke-to-hub connection can be made remotely from the hub, spoke equipment can be remotely tested from the hub, and so on. Other situational aspects may also affect the emotional context of telemedicine. For example, clinical personnel at a spoke hospital located less than one hour from a hub may have very different attitudes towards telemedicine than those at hospitals located farther away or in regions where weather is especially volatile. Situational aspects such as this also need to be taken account when planning for effective telemedicine support, since our findings reveal that spoke clinicians view one set of decisions as especially key: whether to transport a patient to the hub and how to prepare the patient for transport. Thus, at the risk of stating the obvious, we emphasize that telemedicine success depends on careful and thorough attention to pertinent technical and contextual details, combined with appropriate structures of authority and accountability.

Several aspects of our study limit our ability to generalize from the four cases and build strong theory from them. First, we were not able to interview spoke clinicians at all ten of RuralHub’s spoke hospitals. However, included in our sample were spoke hospitals that varied in size and other aspects; the four thus seem representative of the larger sample. A second limitation is that our on-site interviews were limited to those clinicians who were available on the day of our visit. Since this was an exploratory case study, we believe the benefits of in-person interviews offset the limitations in terms of statistical generalizability. Another limitation is that we did not directly observe clinicians at work using telemedicine; we relied on their first-hand accounts of telemedicine episodes. Observational study would likely generate additional insights; we hope at some point in the future to receive permission to do this (subject to careful protection of patient confidentiality).

Our early findings suggest that the emotional context of telemedicine deserves further exploration, since in learning about the interplay of emotions, trust, technical, and situational aspects, we have identified important design principles (such as the importance of high-reliability and system transparency). We further believe that our findings in the context of pediatric critical care may point to interesting questions about the emotional side of computer-mediated collaboration in other stressful situations (e.g., online job interviews, newscasters collaborating to accurately report unfolding events during a crisis, network consultants helping organizations respond correctly and quickly to denial-of-service attacks and other adverse events). Thus, our study makes an immediate contribution to the literature of telemedicine diffusion and adoption, and points to avenues for further research on the emotional side of computer-mediated collaboration in a host of other contexts, within and beyond health care.

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