

# Videoconferencing to Reduce Stress Among Hospitalized Children

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## KEY WORDS

videoconferencing, hospitalized children, stress, propensity score matching, telemedicine, telehealth, pediatrics, health services research

## ABBREVIATIONS

CI—95% confidence interval  
PSM—Propensity Score Matching  
UC—University of California

Dr Yang conceptualized and designed the study, coordinated the data collection process, completed the analyses, interpreted the results, and drafted the initial manuscript; Dr Dharmar conceptualized and designed the study, coordinated the data collection process, assisted with the analyses, interpreted the results, and revised the manuscript; Ms Hojman assisted with the data collection process, assisted with the analyses, and critically reviewed the manuscript; Ms Sadorra coordinated the data collection process, assisted with the analyses, and critically reviewed the manuscript; Ms Sundberg coordinated the data collection process and critically reviewed the manuscript; Mr Wold assisted with the data collection process and critically reviewed the manuscript; Dr Parsapour conceptualized and designed the study and critically reviewed the manuscript; Dr Marcini conceptualized and designed the study, coordinated the data collection process, assisted with the analyses, interpreted the results, and revised the manuscript; and all authors approved the final manuscript as submitted.

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**WHAT'S KNOWN ON THIS SUBJECT:** Previous research has demonstrated that family presence alongside hospitalized patients is associated with improvements in physiologic responses, reductions in anxiety, and expedited recovery. Recently, videoconferencing has been increasingly used for virtual visits to pediatric patients and their parents during hospitalization.



**WHAT THIS STUDY ADDS:** Our study demonstrates that in some cases, the use of videoconferencing by children and their parents for virtual visits is associated with greater reductions in stress during hospitalization compared with children and parents who do not use videoconferencing.

## abstract



**OBJECTIVES:** Family-Link is a videoconferencing program that allows hospitalized children and their parents to virtually visit family members and friends using laptops, webcams, and a secure Wi-Fi connection. We evaluated the association of Family-Link use on the reduction in stress experienced by children during hospitalization.

**METHODS:** We offered Family-Link to pediatric patients who had an expected length of hospitalization equal to or greater than 4 days. We measured the stress levels of hospitalized children at admission and discharge using the previously published Parental Stress Survey. We used propensity score matching and multivariable linear regression methods to evaluate the relationship between the use of Family-Link and stress experienced by children during hospitalization.

**RESULTS:** We included a total of 367 children in the study: 232 Family-Link users and 135 non-Family-Link users. Using the propensity score matching method, we found that the use of Family-Link was significantly associated with a greater reduction in overall mean stress compared with non-Family-Link users among the cohort of patients who lived closer to the hospital and had shorter lengths of hospitalization ( $\beta = 0.23$ ; 95% confidence interval, 0.03 to 0.43;  $P < .05$ ). In this cohort, the reduction in overall mean stress was 37% greater among Family-Link users than non-Family-Link users.

**CONCLUSIONS:** The use of videoconferencing by some hospitalized children and families to conduct virtual visits with family and friends outside of the hospital was associated with a greater reduction in stress during hospitalization than those who did not use videoconferencing.

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Hospitalized children routinely experience stress, fear, and anxiety, regardless of the reason for admission.<sup>1</sup> These emotions are attributable to many factors, including the unfamiliar hospital environment, invasive diagnostic evaluations and treatments, and separation from parents, family, and friends.<sup>1–3</sup> Parents and family members may also experience similar symptoms of stress and anxiety during their child's hospitalization.<sup>4</sup> Visitation and support from family and friends during a child's hospitalization can play a critical role in helping the child and family endure these difficult times. Unfortunately, maintaining this support during hospitalization is often difficult owing to several factors such as geographical barriers, work commitments, and other child care responsibilities. One possible solution is to use videoconferencing, whereby hospitalized children are able to virtually visit with family and friends more easily and intimately, possibly reducing their levels of stress, fear, and anxiety.

Several telehealth programs have used videoconferencing technologies to connect neonatal and pediatric patients with family members during hospitalization. For example, it is increasingly common for health systems to facilitate virtual visits for parents and families with their children in the NICU and other inpatient wards using webcams or other mobile devices.<sup>5–7</sup> Such programs enable enhanced communication between patients, parents, families, and friends, hopefully improving the spirits and wellbeing of both those in the hospital as well as those who live far away or are unable to visit the hospital. However, despite the common use of these videoconferencing systems, little is known beyond anecdotal experience about their potential impact on the stress experienced by children during hospitalization.

In this study, we sought to evaluate the impact of a videoconferencing program, "Family-Link," which allows hospitalized children and their parents to visit other family members and friends, on the stress experienced by hospitalized children. To accomplish this, we compared stress levels measured using a previously published stress survey completed by parents at admission and discharge, between those who used Family-Link and those who did not use Family-Link. To reduce biases inherent to our observational data, we evaluated this association by using a propensity score matching (PSM) method and adjusted our analyses to potential confounders using multivariable linear regression.

## METHODS

### Study Design and Setting

This was a prospective cohort study conducted at the University of California, Davis Children's Hospital (UC Davis Children's Hospital), a comprehensive tertiary pediatric hospital that serves a 33-county, 65 000-square-mile region in Northern California.

### Family-Link Program

Family-Link is a videoconferencing program that uses laptops, webcams, and a secure internet connection with Wi-Fi provided by the UC Davis Children's Hospital. The program's aim is to allow hospitalized children and their parents to connect with other family members and friends using computers and mobile devices, in any location. As a routine practice, a child life specialist from the Children's Hospital identifies patients admitted to the hospital ward or pediatric ICU with an expected length of stay greater than 4 days who may need a Family-Link laptop. We then offer families a loaner Family-Link laptop pre-installed with a variety of commercial videoconferencing packages, and encourage them to use the

Family-Link laptops to connect with family and friends outside the hospital. The rationale for installing several software packages was to provide a variety of options for the families to choose based on personal preferences. A Family-Link laptop is only offered to the patients and/or the patient's parents/guardians, and participation is voluntary. All Family-Link laptops are installed with a security program that restores the computer back to its original configuration each time the computer is restarted.

### Selection of Study Participants

Between February 1, 2011 and May 31, 2013, during weekdays, we approached the parents/guardians of hospitalized children to participate in the survey measuring the stress experienced by their child during hospitalization. We limited our enrollment to parents/guardians of children younger than 18 years of age and those who had an expected length of hospitalization  $\geq 4$  days. Because of the possibility of length-of-stay outliers to bias the data, we decided a priori to exclude patients who had a length of stay above the 95th percentile. In all cases, we simultaneously offered families the opportunity to participate in the Family-Link program and the stress survey. We then considered the parents/guardians of children who participated in the stress survey in 1 of 2 cohorts: those who participated in the Family-Link program were Family-Link users, and those who declined participation in the Family-Link program were non-Family-Link users. The patient and/or parent/guardian were allowed to use their own laptop(s) when available; however, these families were not included in the study. All parents/guardians completed an approved human subjects consent form before participation in this study. Families who had previously participated in

the study were not eligible during subsequent hospitalizations.

### Measuring Stress Level

We measured the levels of stress experienced by hospitalized children using a selection of questions from the previously published and validated Parental Stress Survey, containing 7 domains and 36 items.<sup>8</sup> For the purposes of our study, we selected 4 of the 7 domains (resulting in 23 items) because these domains were most relevant to the stress we believed the Family-Link program could impact. The final survey, shown in Supplemental Information Appendix 1, consisted of the following 4 domains: Child Behavior and Emotions (12 items), Staff Communication (5 items), Sight and Sounds (3 items), and Child's Appearance (3 items). We rated each item using a 6-point Likert scale, 0 (not experienced) to 5 (extremely stressful). We calculated a mean stress score for each domain (range, 0–5), as well as an overall mean stress score, calculated as the average of all 23 items (range, 0–5).

### Data Collection

We provided all families who consented to participate in the stress study an initial survey with a prepaid postage envelope, regardless of their decision to participate in Family-Link (admission survey). This admission survey measured the baseline stress experienced by the child during the first few days of hospitalization. We again provided the same stress survey and prepaid postage envelope within 1 to 2 days of discharge, which was known from daily communication with the primary medical team (discharge survey). The discharge survey measured the stress experienced by the child within a few days of discharge. We also collected information on the age and gender of the children, length of hospitalization, and the distance

from the children's home to the hospital, as these are potential factors related to stress experienced by the child. We encouraged parents to complete and mail the surveys in a timely manner to the Pediatric Telemedicine Program at the UC Davis Children's Hospital. We considered parents who returned both admission and discharge surveys by mail as respondents and those who did not return both surveys as non-respondents.

### Satisfaction Survey of the Family-Link Program

We also created a survey to evaluate the Family-Link users' satisfaction of the visual images, audio, and overall experience with the Family-Link connection (Supplemental Information Appendix 2). We rated each question using a 7-point Likert scale, 1 (very dissatisfied) to 7 (very satisfied). In addition, the survey evaluated whether Family-Link helped the child stay connected with other family members and the importance of the Family-Link program during hospitalization. We provided the satisfaction survey to the Family-Link users at the same time as the discharge stress survey.

### Outcome Measures

Our primary outcome of interest was the reduction in mean stress scores during hospitalization, defined as the mean stress scores at admission minus the mean stress scores at discharge. We calculated the reduction in mean stress scores for each domain as well as the overall mean stress scores.

### Statistical Analysis

We compared descriptive data by using a  $\chi^2$  test and Student's *t* test where appropriate. We compared mean stress scores, reduction in mean stress scores, overall mean stress scores, and the reduction in overall mean stress scores between Family-Link and non-

Family-Link users using a Student's *t* test.

### Propensity Score Matching

Because participation in Family-Link was not randomly assigned, we used the PSM method to overcome the potential biases generated by the non-randomized design. We calculated the propensity score using logistic regression to predict the probability of using Family-Link among both Family-Link and non-Family-Link users. Based on previous research and expert opinion,<sup>9,10</sup> we included length of hospitalization and the distance from a child's home to the hospital to estimate the propensity score. We matched Family-Link users and non-Family-Link users using nearest neighbor matching. We then categorized the matched pairs into 3 cohorts based on the distribution of their propensity scores. To evaluate the relationship between the overall reduction in stress and the use of Family-Link, we used multivariable linear regression analysis adjusting for potential confounders including age, length of hospitalization, and the distance from a child's home to the hospital.

We performed all analyses by using Stata v12. All statistical tests were 2-sided at a significance level of 0.05. This study was approved by the UC Davis Human Subjects Review Board.

## RESULTS

A total of 488 children participated in this study. We excluded 3 children because of extreme length of hospitalization (104 days, 128 days, and 156 days). Among the remaining 485 children, we received 367 (75.7%) paired admission and discharge surveys from respondents and received only 1 of the 2 surveys from 118 (24.3%) non-respondents. Among the 367 paired surveys, 232 (63.2%) were Family-Link users and 135 (36.8%) were non-Family-Link

users. As shown in Table 1, Family-Link users were significantly older (10.8 years vs 7.8 years;  $P < .05$ ) and had a longer mean length of hospitalization (13.2 days vs 9.7 days;  $P < .05$ ) than non-Family-Link users. There were no significant differences between respondents and non-respondents when comparing their mean age, gender, mean length of hospitalization, and mean distance from their home to the hospital.

### Stress Level Measurement

Table 2 shows the mean stress scores at admission and discharge, reduction in mean stress scores across the different domains, and the reduction in overall mean stress scores between Family-Link and non-Family-Link users. Although the reduction in stress scores across all domains was greater among Family-Link users compared with non-Family-Link users, these differences were not statistically significant.

### Propensity Score Matching

Among the 367 children with paired surveys, we included 366 children in the propensity score matching analysis. We excluded 1 non-Family-Link user because of the missing distance from the child's home to the hospital. Our propensity score model resulted in 3 matched cohorts based on the distribution of their propensity score. Table 3 describes the propensity scores and demographics among 3 cohorts. The first cohort included 93 Family-Link

users and 76 non-Family-Link users with a mean propensity score of 0.58 (range, 0.56–0.60). The second cohort consisted of 120 Family-Link users and 57 non-Family-Link users with a mean propensity score of 0.66 (range, 0.60–0.80). The third cohort consisted of 18 Family-Link users and 2 non-Family-Link users with a mean propensity score of 0.88 (range, 0.81–0.95). Figure 1 shows the distribution of the propensity scores among the 3 cohorts. Children in the first cohort were significantly older (10.3 years vs 9.5 years;  $P < .05$ ), had a shorter mean length of hospitalization (5.5 days vs 14.3 days;  $P < .05$ ), and lived a shorter distance from the hospital (34.8 miles vs 74.3 miles;  $P < .05$ ) than those in the second cohort.

Table 4 describes the results of the multivariable linear regression model, adjusting for age, length of hospitalization, and the distance from children's a child's home to the hospital for the first and second cohorts. In the first cohort, the use of Family-Link was significantly associated with a greater reduction in overall mean stress by 0.23 points ( $\beta = 0.23$ ; 95% confidence interval [CI], 0.03 to 0.43;  $P < .05$ ). Of note, for each 5-year increase in age, there was a smaller reduction in mean overall stress by 0.15 points ( $\beta = -0.03$ ; 95% CI,  $-0.05$  to  $-0.01$ ;  $P < .05$ ). In this cohort, the reduction in mean overall stress was 37% greater among Family-Link users than non-Family-Link users for a hypothetical patient

with the overall mean for age (9.7 years), length of hospitalization (11.9 days), and distance from the child's home to the hospital (72.9 miles). In the second cohort, the reduction in overall mean stress was not significantly associated with the use of Family-Link ( $\beta = 0.02$ ; 95% CI,  $-0.24$  to 0.28;  $P = .91$ ). We could not analyze the third cohort because of the small number of cases.

### Parents' Satisfaction of Family-Link Program

The majority of parents reported either "very satisfied" or "satisfied" in regard to the quality of visual images (86%), the quality of audio (84%), and their overall experience with Family-Link (85%). Furthermore, 71% of parents agreed that Family-Link helped them to stay in touch with their family and friends more than usual, and 76% of parents reported that participating in Family-Link was either "extremely important" or "important" for their children during hospitalization.

### DISCUSSION

In this study, we found that the use of Family-Link, a videoconferencing-based program meant to increase the quality and frequency of communication between hospitalized children, family, and friends, was associated with a greater reduction in overall mean stress during hospitalization compared with non-Family-Link users. Specifically, using a PSM method to overcome potential biases generated by the non-randomized design and multivariable analyses to adjust for confounders, we found that on average, the reduction in mean overall stress from admission to discharge was 37% greater among Family-Link users than non-Family-Link users among the cohort of patients who had shorter durations of hospitalization and shorter

**TABLE 1** Patient Demographics of Family-Link and Non-Family-Link Users

	Total (N = 367)	Family-Link (N = 232)	Non-Family-Link (N = 135)
Age in years*	9.7 (5.2)	10.8 (4.6)	7.8 (5.7)
Gender, N (%)			
Female	172 (46.9)	112 (48.3)	60 (44.4)
Male	195 (53.1)	120 (51.7)	75 (55.6)
Length of hospitalization in days*	11.9 (11.1)	13.2 (12.3)	9.7 (8.3)
Distance from child's home to the hospital in miles	72.9 (219.6)	81.2 (269.5)	58.5 (76.7)

All data are expressed as mean (SD) unless otherwise noted. \* $P < .05$

distances from their home to the hospital. The parents and children using Family-Link to videoconference with

family and friends also reported very high levels of satisfaction with the program.

**TABLE 2** Mean Stress Scores and Reduction in Mean Stress Scores Among Family-Link and Non-Family-Link Users

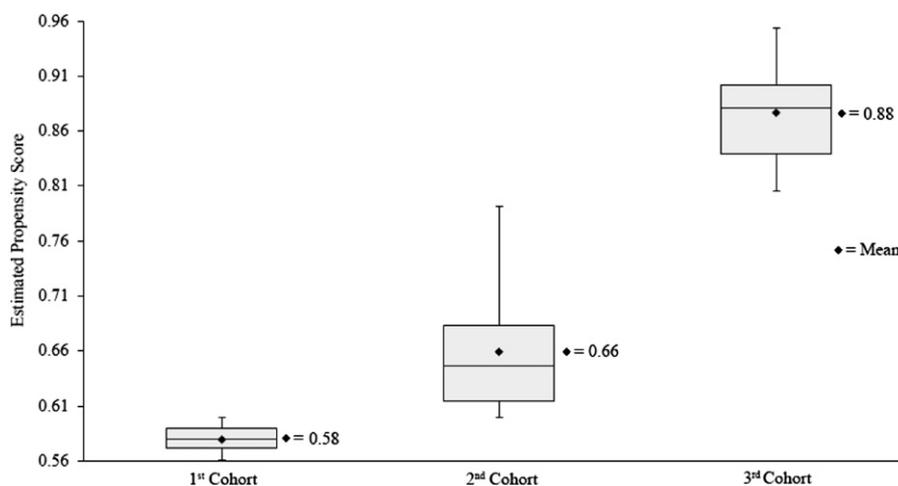
	Family-Link			Non-Family-Link		
	Admission	Discharge	Reduction in Stress	Admission	Discharge	Reduction in Stress
Child behavior and emotions	1.61 (0.96)	0.84 (0.77)	0.77 (0.99)	1.65 (0.98)	1.01 (0.84)	0.64 (0.86)
Staff communication	0.55 (0.82)	0.41 (0.70)	0.14 (0.77)	0.49 (0.81)	0.36 (0.59)	0.13 (0.75)
Sight and sounds	1.32 (1.15)	0.86 (0.89)	0.46 (1.23)	1.49 (1.36)	1.13 (1.21)	0.36 (1.20)
Child's appearance	1.26 (1.28)	0.55 (0.88)	0.71 (1.34)	1.22 (1.33)	0.67 (1.03)	0.55 (1.29)
Child behavior and emotions, and child's appearance	1.54 (0.89)	0.78 (0.74)	0.76 (0.94)	1.56 (0.94)	0.94 (0.80)	0.62 (0.80)
Overall mean stress score	1.29 (0.74)	0.71 (0.64)	0.58 (0.75)	1.32 (0.80)	0.84 (0.69)	0.48 (0.66)

All data are expressed as mean (SD).

**TABLE 3** Patient Propensity Scores and Demographics of 3 Matched Cohorts

	1st Cohort (93 Family-Link and 76 Non-Family-Link Users)	2nd Cohort (120 Family-Link and 57 Non-Family-Link Users)	3rd Cohort (18 Family-Link and 2 Non-Family-Link Users)
Propensity score*†‡§	0.58 (0.01)	0.66 (0.05)	0.88 (0.04)
Age in years*§	10.3 (5.1)	9.5 (5.2)	6.4 (4.9)
Gender, N (%)			
Female	84 (49.7)	77 (43.5)	11 (55.0)
Male	85 (50.3)	100 (56.5)	9 (45.0)
Length of hospitalization in days*†‡§	5.5 (1.2)	14.3 (7.0)	45.5 (17.4)
Distance from child's home to the hospital in miles*†‡§	34.8 (33.6)	74.3 (99.6)	381.9 (843.2)

All data are expressed as mean (SD) unless otherwise noted. \* $P < .05$ , comparison between first cohort and third cohort. † $P < .05$ , comparison between first cohort and second cohort. ‡ $P < .05$ , comparison between second and third cohort.



**FIGURE 1**

Propensity score distribution among the 3 matched cohorts.

Our study results are consistent with previous publications documenting positive physiologic changes experienced by children whose family members are present during hospitalization.<sup>11,12</sup> Hepworth et al<sup>11</sup> reported that family presence during hospitalization resulted in lower intracranial pressure, improved heart rate, and improved blood pressure for patients in the ICU. Simpson et al<sup>12</sup> showed that family presence improved hemodynamic parameters among patients in the cardiac ICU. The fact that family presence can improve a patient's physiologic parameters would suggest that frequent family presence could impact a hospitalized child's perception of stress, fear, anxiety, and pain.

Several programs have integrated videoconferencing into their inpatient care units, including the NICU, to enable the parents and family members to be in close contact with their hospitalized family member or newborn. One study demonstrated improvements in length of hospitalization and quality of care received in the neonatal ICU.<sup>5</sup> Gray et al<sup>5</sup> reported that infants <1000 g enrolled in the videoconferencing program trended toward shorter length of stay (77.4 days vs 91.3 days), compared

**TABLE 4** Multivariable Analysis: Association Between Reduction in Overall Mean Stress Scores and the Use of Family-Link in the Propensity Score Matched Cohorts

Parameters	1st Cohort (93 Family-Link and 76 Non-Family-Link Users)			2nd Cohort (120 Family-Link and 57 Non-Family-Link Users)		
	Coefficient	SE	95% CI	Coefficient	SE	95% CI
Use of Family-Link	0.23*	0.10	(0.03 to 0.43)	0.02	0.13	(-0.24 to 0.28)
Age in years	-0.03*	0.01	(-0.05 to -0.01)	0.002	0.01	(-0.02 to 0.03)
Length of hospitalization in days	-0.04	0.04	(-0.12 to 0.04)	-0.002	0.01	(-0.02 to 0.02)
Distance from child's home to the hospital in 100 miles	0.16	0.15	(-0.13 to 0.45)	0.001	0.06	(-0.12 to 0.12)

\*  $P < .05$ .

with those not enrolled in the videoconferencing program. Parents enrolled in this videoconferencing program also reported improved infant's quality of care from the subjective parental survey. Rhoads et al<sup>7</sup> also reported that families using videoconferencing to virtually visit their infants in the NICU experienced significantly higher satisfaction scores than those who did not use videoconferencing. We believe that videoconferencing may potentially impact disease progression and recovery course by affecting a patient's psychological and physiologic responses, as well as improve hospitalized children's overall well-being.

Our findings are also consistent with results found by other investigators using videoconferencing in the adult population. Chiang et al<sup>13</sup> reported that family caregivers of heart failure patients who received telenursing consultations experienced significant reductions in caregiver burden and stress and significant improvements in family function. Morland et al,<sup>14</sup> in a study of veterans who had post-traumatic stress disorder, found that the use of videoconferencing resulted in reductions in anger symptoms. Moreover, many authors have reported that patients enrolled in telemedicine-enabled ICU programs experience improved clinical outcomes, reductions in complications, and improved

evidence-based bundle compliance compared with those not enrolled in programs.<sup>15-18</sup>

Our study has several limitations. First, we did not randomize the children to receive Family-Link, and therefore the potential confounding biases may exist. To adjust for this, we used the PSM method to match patients' likelihood of using Family-Link by accounting for the length of hospitalization and the distance from a child's home to the hospital. To increase the robustness of the study results, we also used multivariable analyses to adjust for potential confounders including age, length of hospitalization, and the distance from a child's home to the hospital. Second, there could have been other factors not accounted for that contributed to a greater reduction in stress, such as availability of family support, or cellphone and telephone communications. Although cellphones are nearly universally used by patients and/or family members, the fact that restrictions on cellular devices allow only some patients to use cellphones may suggest that the impact of Family-Link on stress reduction could be over and above that of cellphone usage. Finally, we only found a significantly greater reduction in stress among patients in the lowest propensity score cohort. This implies that Family-Link's influence on reducing the stress during hospitaliza-

tion primarily impacted those patients and families that had relatively shorter lengths of hospitalization and those living closer to the hospital. There could be a few possible explanations for this in our study. Length of hospitalization may be a surrogate for severity of illness, and children suffering from a more serious illness may not be able to use Family-Link as much as children who are less ill (those with shorter lengths of stay). In addition, families who live farther from the hospital may be more likely to stay by their children's bedsides because of longer commuting times. Lastly, the children in the first and second cohort are significantly older and may tend to be more adept at using technology to communicate with their family and friends. Hence, more research needs to be conducted to better understand which patient population would benefit the most from videoconferencing programs like Family-Link.

## CONCLUSIONS

We found that the use of Family-Link by hospitalized children and families was associated with greater reductions in stress scores compared with those who did not use Family-Link. This reduction in stress could potentially lead to improved patient outcomes and hospitalized children's overall wellbeing. Future research is needed to better understand who would benefit the most from programs like Family-Link and to determine whether other videoconferencing modalities can have a similar impact on the stress experienced by hospitalized children and their families.

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