Children's Hospital of Philadelphia

Annual Progress Report: 2009 Formula Grant

Reporting Period

July 1, 2013 – December 31, 2013

Formula Grant Overview

The Children's Hospital of Philadelphia received $4,034,902 in formula funds for the grant award period January 1, 2010 through December 31, 2013. Accomplishments for the reporting period are described below.

Research Project 1: Project Title and Purpose

Pediatric Hospital Quality, Safety, and Cost Project - The project will inform the research agenda for pediatric hospital medicine and provide answers to key questions about how we can best organize and deliver hospital care to children in order to improve quality, safety, and outcomes, and reduce costs.

Duration of Project

1/1/2010 - 12/31/2013

Project Overview

The broad objective of the *Pediatric Hospital Quality, Safety, and Cost Project* is to perform research aimed at improving the quality and efficiency of care provided to children in the inpatient setting. The project has three separate but related specific research aims, each with their own sub-aims, that together will inform the research agenda for pediatric hospital medicine, and provide answers to key questions about how we can best organize and deliver hospital care to children in order to improve outcomes and reduce costs.

Specific Aim #1 is a prioritization project. Working with existing detailed administrative data from over 600 hospitals, the researchers will identify pediatric hospital conditions that are prevalent, cumulatively expensive to the healthcare system, and exhibit high degrees of regional variation in cost. Extreme variation across hospitals in resource utilization for the same condition often signals an opportunity for standardization of care, improved outcomes and reduced costs. For prevalent and expensive conditions that exhibit a high degree of inter-hospital variation in cost, the researchers will seek explanations for the variation, both in terms of resource categories (e.g. radiology, laboratory, or length of stay costs) driving variation, as well as organizational factors associated with more cost-effective care (e.g. use of and adherence to clinical practice guidelines).

Specific Aim #2 will explore how provider and hospital volume influence the quality and outcomes of care for specific pediatric conditions. Numerous studies in the adult and surgical worlds have shown that for many conditions higher provider and hospital volume is associated with greater compliance with best practices and improved outcomes. However, very little is known about whether this is true for pediatric conditions and the mechanisms through which increased volumes produce better care. Working with the same administrative databases as Aim #1 the researchers will explore volume/quality/outcome relationships for several common pediatric conditions. They will follow these analyses with surveys of clinician leaders of pediatric hospitals to understand how high volume translates into better quality and outcomes, and also how lower volume hospitals are able to achieve high quality and outcomes.

Finally, Specific Aim #3 will use a combination of quantitative and qualitative methods to evaluate and refine a Rapid Response System (RRS) designed to detect deterioration, activate an expert response team, and rapidly assess, stabilize, and transfer (if necessary) patients on general inpatient wards who are exhibiting signs of clinical deterioration, before critical events occur.

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Expected Research Outcomes and Benefits

By identifying pediatric hospital conditions that are prevalent, cumulatively expensive to the healthcare system, and exhibit high degrees of regional variation in cost, and understanding the reasons for that variation, researchers and funders will be able to more rationally channel research dollars towards pediatric hospital conditions for which elucidation of best practices and standardization of care are likely to yield the greatest improvement in outcomes and reduction in total costs.

Knowing whether higher provider and hospital volume is associated with greater compliance with best practices and improved outcomes for pediatric conditions, and understanding the mechanisms through which increased volumes produce better care, will allow healthcare policy makers to make better decisions about the optimal location (e.g. large academic institution v. small community hospital) for a variety of pediatric conditions.
Effective Rapid Response Systems have the potential to save lives, reduce costs, and make the hospital a safer place for children.

Summary of Research Completed

Specific Aim #1: Prioritization Project.
Aim 1b: To identify explanations for significant regional variation for conditions that are prevalent and cumulatively expensive, both in terms of resource categories (e.g. radiology, laboratory, or length of stay costs) driving variation, as well as organizational factors associated with more cost-effective care (e.g. presence of clinical practice guidelines, presence of medical hospitalist teams, or teaching v. non-teaching hospital status)

The team continued to 'drill-down' to seek explanations for variation in resource utilization for conditions that had been identified as high priority.

Aim 1b: Drill-down #1: Diabetic Ketoacidosis (DKA). A manuscript titled "Variation in resource use and readmission for diabetic ketoacidosis in children's hospitals" was published in *Pediatrics* in August 2013 based on work completed in an earlier review period.

Aim 1b: Drill-down #2: Hypertrophy of Tonsils and Adenoids. Final analysis and manuscripts were completed for two studies. A retrospective cohort study examined the variation in the quality of perioperative tonsillectomy care at US children's hospitals using an administrative data source. In a cohort of 139,715 children ages 1-18, who underwent same day surgery at 36 children's hospitals from 2004-10 we assessed evidence based process measures (the use of dexamethasone on the day of surgery, recommended by guidelines to reduce postoperative nausea and vomiting, and the use of antibiotics, which are not recommended) and outcomes (tonsillectomy related revisits to hospital within 30 days for complications). Substantial variation in the use of dexamethasone and antibiotics across hospitals (Fig. 1) was shown. Revisits occurred in 7.8% of children and there was substantial variation across hospitals after standardizing for patient covariates and year of surgery. A 2nd retrospective cohort study used the same cohort to look at whether dexamethasone use is associated with increased bleeding risk. Several small trials have shown an association, but were not powered to detect clinically important differences in bleeding risk. The primary exposure variable was dexamethasone use and the primary outcome was revisits for bleeding within 30 days after surgery. We used a time to event approach with discrete time failure models and standardization to adjust for patient level factors, the post-discharge day, year of surgery and hospital. Dexamethasone use was associated with a small absolute increase in risk of bleeding revisits of 0.40% (Table 1), which is less than the minimal clinically important difference of 1.5%. Our results support the safety of dexamethasone and recommendations from national guidelines for its routine use.

Aim 1b: Drill-down #3: Appendicitis. We explored the relationship between standardized overall cost and specific cost categories and readmission/revisit rates in a retrospective cohort study of 37,469 appendectomy patients. The main outcome measures were median standardized cost per case (as a surrogate for resource utilization) and 30-day standardized postoperative readmission rate. The median standardized cost per case was $6,985 which differed by more than 2-fold across hospitals (range: $5,103- $11,588, p<0.001). The overall 30-day readmission rate was 3.0% which varied nearly 7-fold across hospitals (range: 1.0% to 6.7%, p<0.0001). Fifteen (38%) hospitals were identified as outliers by median cost (9 low-cost and 6 high-cost) and 16 (41%) were outliers by readmission rate. Poor agreement was found between quartile-based

hospital rankings based on readmission rates and median cost (weighted Kappa=-0.102 [95% Confidence Interval (CI): -0.227 to 0.201]), and increased resource utilization was not associated with lower readmission rates (figure 2). Three (8%) hospitals were high-performers for both measures. The team concluded that there is poor correlation between resource utilization and readmission following treatment of uncomplicated appendicitis at children's hospitals and increased resource utilization does not lead to better outcomes. Dissemination of best-practice guidelines from "high-value" hospitals may facilitate cost-containment without sacrificing quality of appendicitis care. Two manuscripts reporting the findings of drill-down #3 are in development.

Aim 1b: Drill-down #4: Pneumonia. The team worked to resolve complications in the data cleaning and analysis. They completed an initial round of data analysis on 30,558 patients with Community Acquired Pneumonia (CAP) (79%) or CAP + Asthma (21%). Patients with CAP + Asthma were more likely than those with CAP alone to be <5 years old (51% vs 49%p<.001), and to have government insurance (45% vs. 41%; p<.001). They had longer mean length of stay (LOS) (2.18 days vs. 2.03 days; p<.001), and higher mean total standardized costs ($5259 vs. $4838; p<.001). The range among hospitals for mean LOS for CAP was 1.4-2.6 days, while the mean LOS range for CAP+asthma was 1.5-2.8. The geometric mean cost range for CAP was $3129-$6525, while for CAP+asthma it was $3711-$8146. There were significant differences by metrics of guideline adherence between the 2 groups. In multivariate models, CAP+asthma predicted increased cost for non-intensive care unit (ICU) patients, but not LOS. The team concluded that CAP+Asthma is associated with higher costs among non-ICU patients and that the ambiguity in treating 2 diagnoses may lead to treatment uncertainty and increased resource utilization. An abstract was submitted to the Pediatric Academic Societies May 2014 Annual Meeting and is pending notification. The team is continuing with final data analysis.

Aim 1b: Severe Asthma Pathway Project. In the prioritization phase, asthma was identified as the 3rd most common and the 6th most costly reason for hospital admission in Children's Hospital Association (CHA) hospitals. Moderate variability in costs for asthma admission (Intraclass correlation coefficient (ICC) = 0.09) was noted, prompting us to investigate the reasons for variability. Given the lack of granularity with regard to frequency and duration of inpatient therapies within the Pediatric Health Information System (PHIS) database, we used data from the electronic medical record at Children's Hospital of Philadelphia (CHOP). In this retrospective cohort study, we investigated how demographic, clinical presentation, or treatment factors contributed to individual level outcomes, such as prolonged therapy, ICU transfer, adverse medication effects and LOS, using a dataset developed from the CHOP Data Warehouse. 4921 patients were admitted to CHOP for asthma over a 2-year interval, 3003 of whom met our criteria. Children treated for severe asthma with continuous aerosolized albuterol (CAA) had higher rates of transfer to the ICU, as well as LOS that were approximately 17 hours longer than for those treated with intermittent therapy (57.0 vs 40.2, p<.001). 25% of patients who received CAA were treated for more than 24 hours and preliminary cost estimates indicate that prolonged CAA therapy leads to nearly twice the amount of hospital charges and insurance payments.

Specific Aim 2. Patient Volumes and Quality of Care for Hospitalized Children.
Aim 2b: To examine the relationship of provider and hospital patient volume of gastroenteritis,

asthma and bronchiolitis admissions with outcomes, such as length of stay(LOS), readmission, resource utilization and transfer to higher level of care.

Researchers completed complex adjusted analyses relevant to aim 2b demonstrating significant outcomes variation for children undergoing spinal fusion procedures. Administrative data from the PHIS database was used to identify hospitals that were outliers for adjusted rates of surgical site infection (SSI). Children ages 10-18 years who had undergone an elective spinal fusion procedure for either adolescent idiopathic (AIS) or neuromuscular scoliosis (NMS) between 2007-2012 were selected using a previously described algorithm. The final cohort included 13,112 children with AIS and 7,560 children with NMS. Multivariable logistic regression was used to determine the rates of SSI, reoperation, and readmission at 14, 30, 60, and 365 days post-discharge, adjusted for patient medical and surgical comorbidities, age, and year of procedure. Statistical analyses for determining Predicted vs. Expected ratios (*pe)* were then performed to determine the deviation of each hospital's adjusted rate of SSI from what would be expected for all patients with similar combinations of characteristics across all hospitals. Examples of plots illustrating the unadjusted and adjusted outcomes rates, as well as the deviations of hospital rates from what would be expected for the hospitals given case-mix are shown in Figure 3. Variation across hospitals in unadjusted rates of SSI at 60 days was significantly greater in the NMS vs. AIS population, ranging from 1.6-10.9%. Seventeen hospitals had better than expected outcomes (*pe* <1.0), and 15 hospitals had worse than expected outcomes (*pe* <1.0). A manuscript reporting these results is currently in progress. Results from research completed in the prior reporting period were published in the Journal of Spine Disorders and Techniques October 2013 issue.

<u>*Specific Aim 3*</u>. <u>Evaluation of Rapid Response Systems</u>.
*Aim 3a: To evaluate the effect of the implementation of a Rapid Response System on costs, resource utilization, and clinical outcomes for children urgently transferred to the pediatric intensive care unit (PICU) for clinical deterioration.*
Aim 3c: Using semi-structured interviews of physicians and nurses, to identify factors that contribute to false-positive and false-negative early warning scores, and to evaluate the impact of a Rapid Response System on the hierarchical and cultural barriers relevant to patient safety.
A manuscript and accompanying editorial was published in Journal of the American Medical Association (JAMA) Pediatrics, based on findings from sub-aim 3a-- the effect of implementation of a pediatric rapid response system on clinical outcomes. Analysis for the 2nd aspect of sub-aim 3a- the impact on cost outcomes- was completed and a manuscript is in development. Data from 1,396 patients was used to determine the excess cost associated with critical deterioration events compared with other unplanned transfer events. We performed a cost-benefit analysis of rapid response system operation. After adjustment for potential confounders, patients not meeting critical deterioration criteria generated an average cost of $85,278, and patients meeting critical deterioration criteria generated average costs of $185,052 (difference of $99,773/patient, 95% CI, $69,431 – $130,116, P<.001). For example, in a hospital with 300 unplanned transfers from ward to ICU/ year and a 30% critical deterioration proportion, reducing that rate to 20% would result in reducing costs by $2,993,190/year, for a net savings of $687,732 when that reduction occurs using a freestanding rapid response team, and a net savings of $2,416,825 when that reduction occurs using a team with other clinical responsibilities.

On sub-aim 3c, we continued to evaluate the feasibility and acceptability of a video method to study false physiologic monitor alarms and their consequences in children with heart and/or lung

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failure. Data was collected on 45 patients, 44 parents, and 44 nurses. A manuscript focused on methodology is in press and a 2nd focused on the relationship between false alarm exposure and response time is in development. We reviewed 210 hours of video and analyzed data from 4,962 alarms. Among heart and lung failure patients, 76% of clinical alarms were valid (appeared to correctly identify the physiologic status of the patient), but only 8.5% led to an intervention and only 13.3% were actionable (relevant to the patient's safety, defined as alarms that either led to intervention or consultation, or should have led to intervention/consultation but did not, either because the alarm was unwitnessed or misinterpreted). Among ward patients, 41% of clinical alarms were valid, but only 0.6% led to intervention and 1.0% were actionable. 86.7% of alarms in heart and lung failure patients were false, and 99.0% of alarms in ward patients were false. We discovered preliminary evidence of a relationship between the number of false alarms generated by a patient in the 120 minutes preceding an alarm, and the nurse's response time to critical alarms, which increased as the number of false alarms increased. For example, median response time for a nurse in the pediatric ICU exposed to 0-29 alarms in the preceding 120 minutes was 1.61 minutes, but was greater than 15 minutes when 80 or more alarms occurred in the preceding 120 minutes. This relationship was similar among ward patients, and was statistically significant in regression analysis in both the pediatric ICU (p=0.001) and ward (p<0.001) populations. This preliminary data appears to support the concept of alarm fatigue.

Figure 1. Variation in perioperative dexamethasone and antibiotic use across 36 children's hospitals
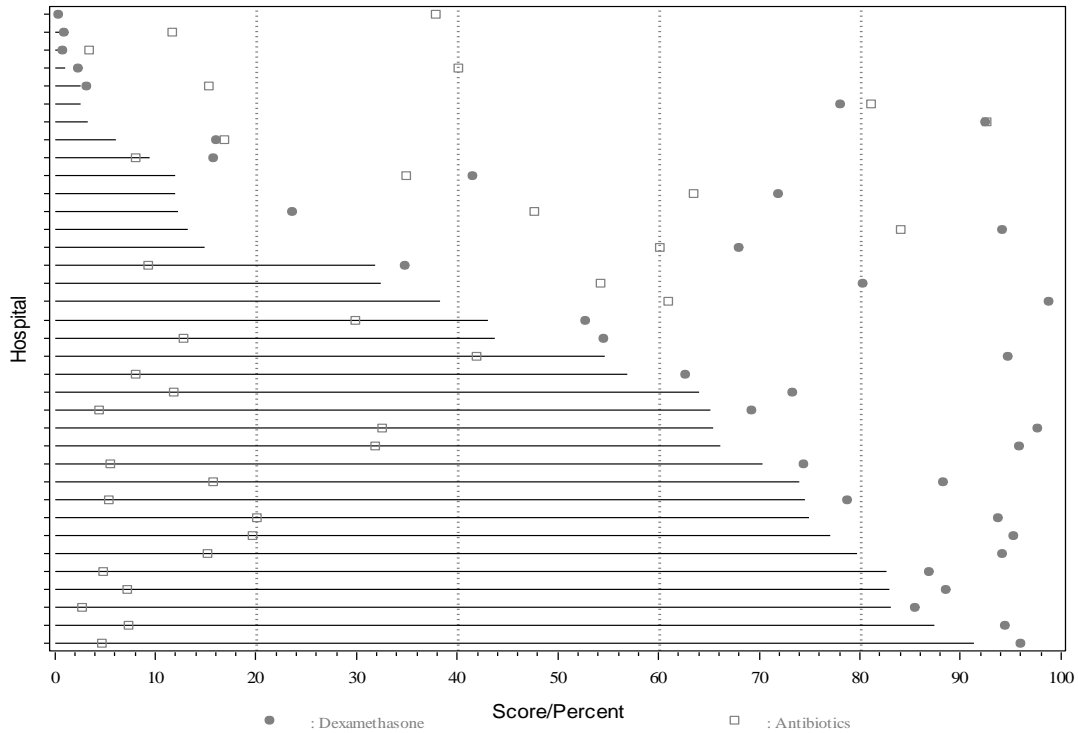
Legend: Each hospital's dexamethasone use, antibiotic use, and summary score is indicated by a shaded circle, open square, and horizontal line respectively. The dexamethasone use indicates the percentage of patients in each hospital that received perioperative dexamethasone. The antibiotic use indicates the percentage of patients in each hospital that received perioperative antibiotics. The summary score is the number of times a hospital performed the appropriate action i.e. the number of times a hospital administered dexamethasone but not antibiotics to an individual child, divided by the number of children who had a tonsillectomy at the hospital, multiplied by one hundred.Table 1. 30-day Cumulative Risk of Revisit for Bleeding by Age and Dexamethasone Treatment Group*

		Treatment Group			
		Dexamethasone	No Dexamethasone		
				Difference	
Age, y	No.	(N=97 242)	(N=42 466)	(95% CI)	P value
1-3	22 146	1.92 (1.73-2.12)	1.67 (1.46-1.87)	0.25 (0.08-0.42)	0.003
4-9	86 758	2.66 (2.53-2.79)	2.31 (2.13-2.50)	0.35 (0.12-0.58)	0.003
10-18	30 804	5.13 (4.84-5.41)	4.48 (4.10-4.85)	0.65 (0.21-1.09)	0.003
All (1-18)	139 708	3.11 (2.99-3.23)	2.71 (2.50-2.91)	0.40 (0.13-0.67)	0.003

*Cumulative risk per 100 patients standardized for sex, gender, race, government insurance, asthma, All Patient Refined Diagnosis Related Groups (APR-DRG) severity status, year of surgery, antibiotic use, and hospital using logistic regression and predictive margins.

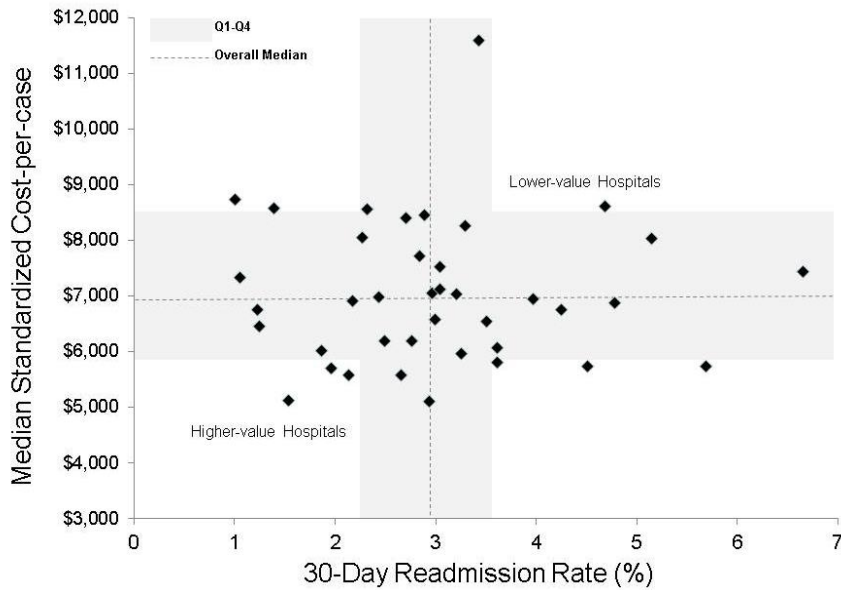Figure 2. Association between Resource Utilization and Readmission Rates in Appendectomy Cohort


Figure 3: Observed, expected, and predicted SSI rates across 39 children's hospitals from 2007-2012. Red plus signs represented unadjusted SSI rates for the NMS population, blue circles represent the predicted (adjusted) rates of SSI, and green x's represent the expected rates of SSI based on each hospital's particular case mix. Arrows show the deviation of each hospital's adjusted SSI rates from what would be expected from their given case mix. Hospital IDs with red circles on the X axis are currently recruited for the study.
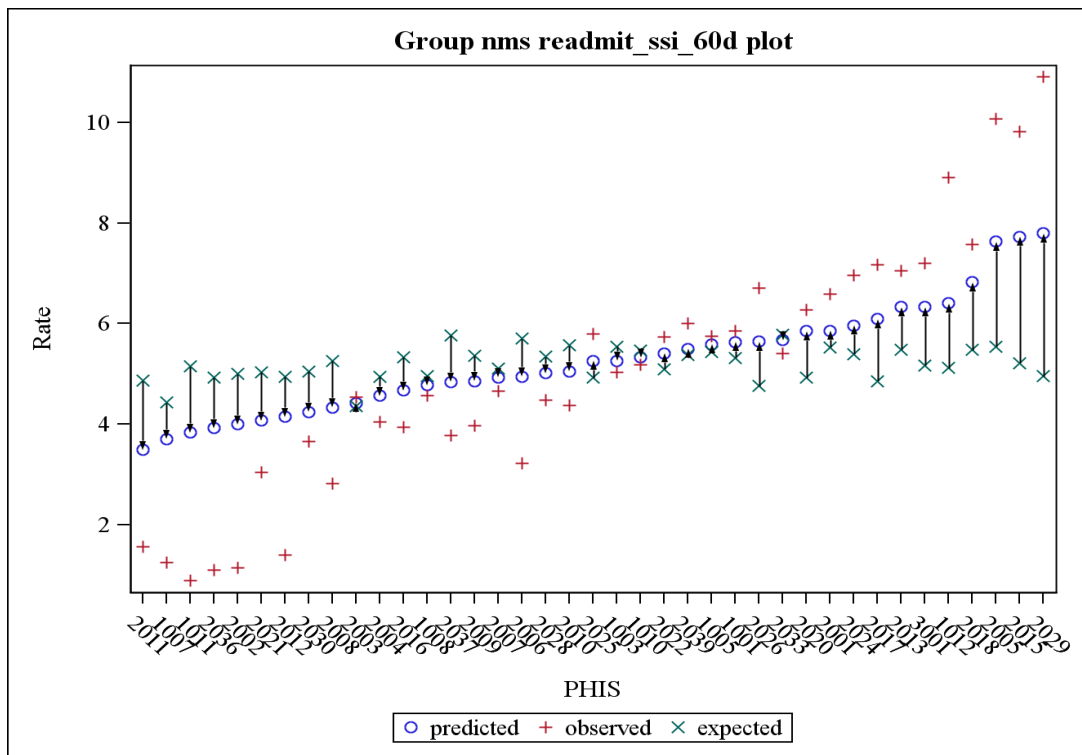
Research Project 2: Project Title and Purpose

Methods to Evaluate the Content and Dissemination of Internet-Based Interventions to Prevent Injury - Decades after the National Academies emphasized the importance of injury prevention for our nation's health, injury prevention science remains an underdeveloped field. As a result, in Pennsylvania, injury remains the leading cause of death for ages 1-44, and 135,334 hospitalizations for injury cost $4.6 billion per year. Children, youths and young adults are the primary victims of injury. With an established highly successful and integrated 50-member multidisciplinary team, the mission of Children's Hospital's injury research program is to reduce the burden of injury through evidence-based prevention. This study aims to leverage this expertise to fill the crucial gap for advancing injury prevention by generating new methods to inform injury prevention interventions that are (1) developed systematically and evaluated and (2) disseminated widely and adopted.

Duration of Project

1/1/2010 - 12/31/2013

Project Overview

The objective of this project is to establish rigorous methodologies for the systematic creation, evaluation and dissemination of Internet-based injury prevention interventions with an initial focus on interventions to reduce young-driver crashes and associated injuries. Specific aims are:

Aim 1: Create and evaluate Internet-based interventions to prevent young-driver crashes
Method 1.1: Review best practices for creating and evaluating theoretically-grounded interventions to promote health and prevent injury, and adapt for Internet-based interventions to prevent young-driver crashes.
Method 1.2: Develop and implement a protocol to pretest content for Internet-based interventions and their component modules to assure that the interventions address the intended goals.
Method 1.3: Assess the feasibility of using a driving simulator for evaluating the efficacy of Internet-based interventions in changing driving performance.
Method 1.4: Test the relative efficacy of an intervention (based on methods developed by the CHOP research team) as compared to that of a currently available intervention.

Aim 2: Establish a best practices methodology for dissemination of Internet-based interventions to prevent young-driver crashes, and methods to evaluate the impact of dissemination strategies
Method 2.1: Create best practice recommendations for dissemination of Internet-based interventions to prevent young-driver crashes.
Method 2.2: Create recommendations and metrics for evaluating dissemination of Internet-based interventions to prevent young-driver crashes (e.g., measuring reach, effectiveness, and unintended consequences).
Method 2.3: Measure the change in use patterns of an Internet-based intervention to promote young driver safety before and after an evidence-based marketing strategy or dissemination campaign.

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Linda Fleisher, PhD, MPH – employed by The Children's Hospital of Philadelphia

Expected Research Outcomes and Benefits

This research project will produce evidence-based frameworks, methods and metrics for the creation and dissemination of interventions to reduce young-driver crashes and their related injuries. In particular, the following will be produced:
1. An evidence-based framework for the development and evaluation of theoretically-grounded Internet-based interventions to promote safe behaviors among young drivers and their passengers.
2. An evidence-based protocol for intervention content pre-testing for young driver safety.
3. An evidence-based protocol to assess driving performance and behavior in a simulated environment.
4. An evidence-based framework for the development of a plan for dissemination of Internet-based interventions to promote safe behaviors among young drivers and their passengers.
5. An evidence-based framework for the evaluation of the dissemination strategies via the Internet to promote safe behaviors among young drivers and their passengers.

These frameworks will serve as strong scientific foundations for the development and dissemination of interventions to prevent young-driver crashes and their related injuries.

As road traffic injury is the leading cause of a death and acquired disability for Pennsylvania's young citizens, effective interventions to reduce crashes that are widely disseminated and adopted will improve the health status of Pennsylvania's youth and young adults.

Summary of Research Completed

Introduction
The Center for Injury Research and Prevention at the Children's Hospital of Philadelphia has met

the three milestones for year four (7/1/2013 – 12/31/2013).
1. Analyze the results of the marketing/dissemination study
2. Complete work for all methods
3. Complete final report
4. Prepare presentations and papers for publication

1. <u>Milestone 1: Analyze the results of the marketing/dissemination study</u>

1.1. Purpose

Little is known about the use of Twitter chats to effectively disseminate health information and about how well health-specific content is transmitted within Twitter networks. Methodological techniques involved in evaluating data from Twitter chats for research purposes have been limited. Here we present an evaluation of two objectives: 1) the use of a Twitter chat to raise awareness about teen driver safety and 2) a pilot analysis of Twitter tweet and re-tweet content to better understand how information is disseminated within a novel Twitter re-tweeting network on child and teen injury.

1.2. Methods – Twitter chat

The Center for Injury Research and Prevention (CIRP) facilitated an hour-long Twitter chat during National Teen Driver Safety Week on October 18, 2012 under #teendriving2012. Key stakeholders including State Farm, the National Highway Traffic Safety Administration, Centers for Disease Control and Prevention, AAA, physicians, researchers, and community members were invited to participate. Topics for discussion were developed by CIRP and multiple references to teendriversource.org, a CIRP-maintained website geared towards teen driver safety, were imbedded into tweet content. A combination of Google Analytics and the Twitter Application Programming Interface (API) were used to extract and analyze quantitative data regarding the chat. The following metrics were collected:

• Total # of tweets from all unique users in Twitter chat
• Following base of all unique users in the chat including the average # of tweets they sent
• Total # of re-tweets generated from the chat
• Proportion of unique users that re-tweeted content from @safetyMD
• Unique visitors driven to teendriversource.org before, during, and after the Twitter chat

1.3. Methods – Twitter tweet and re-tweet content

During a four month time period (July-October 2012), the Children's Hospital of Philadelphia's Center for Injury Research and Prevention's (CIRP) Twitter handle, @safetyMD, was monitored for content. Content on tweet and re-tweeting patterns were observed and recorded. We defined our "Layer 0" as the tweets by @safetymd. "Layer 1 Re-tweeting Network" as those who re-tweeted content from @safetymd; our "Layer 2 Re-tweeting Network" as those who re-tweeted content from the Layer 1 Re-tweeting Network. The Twitter Application Programming Interface (API) was used to extract

tweet and re-tweet content from all layers including unique handles, date/time of tweets/re-tweets and the text content. An exploratory round of content analysis was conducted by calculating frequencies of the top re-tweeted words.

1.4.   Results

Twitter chat
A total of 435 tweets were generated from 150 unique Twitter users. These 150 users had a cumulative following base of 658,120 (mean=4,387) and a cumulative history of composing 864,698 tweets (mean=5,765). A total of 137 re-tweets were generated and 10% of the unique users re-tweeted the CIRP facilitator 25 times. This group had a cumulative following base of 61,143 (mean=4,076) and generated a total of 58,796 (mean=3920) historical tweets. Compared to the average number of unique visitors per day for the entire month of October 2012, there was a 41% increase on the day of the Twitter chat.

Twitter tweet and re-tweet content
A total of 6,113 words were tweeted in layer 0. The top words in this layer included teens, driving/drive, safety/safe, and injury and cumulatively represented about 10% of all words tweeted. Within layers 1 and 2, a total of 3,711 and 60,795 words were re-tweeted respectively. The percentage of key words in these two layers dropped to 6% in layer 1 and 2.5% in layer 2.

1.5.   Overall Conclusions

Objective 1: Our results may suggest that a Twitter chat can be a useful technique to disseminate health information. The data presented above may be proximal indicators of greater inclusion, message dissemination and grassroots action. Increases in traffic to our website may indicate that a Twitter chat engaged participants, because they clicked on the links to resources. Twitter can be an important tool in a health communication tool chest, but evaluation needs to catch up with the technology to determine its effectiveness for health promotion. Twitter is free, but using it effectively requires staff resources and a degree of faith. We will continue to monitor our Twitter metrics and general E-Health trends to guide future decisions.

Objective 2: While there was strong initial dissemination of messages from @safetyMD, our preliminary results using the methods developed for this grant indicate a strong dilution effect through the social media network (also known as the "Twitterverse"). Our @safetymd dissemination strategy aimed to utilize the viral nature of Twitter to spread evidence-based injury prevention information. While there was evidence of dissemination, only approximately 2.5% of the content reached a second stage of spread. Further strategies are needed to facilitate more efficient dissemination of health information through Twitter.

This line of research, funded by the Pennsylvania Department of Health, demonstrated the importance of rigorous and novel evaluation methods to ensure that the

communication/dissemination strategies are effective. In our analysis, Twitter had very limited effectiveness in broad dissemination of safety messages and this might also be the case with other Twitter-based health information dissemination strategies. Additional larger studies are needed to corroborate these findings.

Our results were presented as two poster presentations at the 2013 International Society for Research on Internet Interventions (ISRII) in Chicago, Illinois and an oral presentation at the 2013 Medicine 2.0 conference in London, United Kingdom. We have also submitted a manuscript describing the quantitative techniques used to differentiate clusters of a sample Twitter users following @safetyMD based on their tweet content. This work was submitted to the Journal of Medical Internet Research – Research Protocols and is currently pending.

2. Milestone 2: Complete work for all methods

   An official final report has been submitted to the state detailing all of the work and deliverables for each method for both Aims 1 and 2.

3. Milestone 3: Complete Final Report

   An official final report has been submitted to the state detailing all of the work and deliverables for each method for both Aims 1 and 2.

4. Milestone 4: Prepare presentations and papers for publication

   To date, a total of eight manuscripts have been submitted for publication and seven of these have been accepted for publication. Section 20 in Final Report outlines each of the manuscripts, their corresponding journal submission, and their date of submission. In addition to the previously published studies, we are currently in the process of preparing additional manuscripts from our results from Aim 1 and Aim 2.

   Manuscripts submitted during this reporting period:

   1) Winston, FK, McDonald, CM, Kandadai, V, et al., *Headway time errors, safe driving skill, and experience: An initial validation of the Simulated Driving Assessment*. (2014) 93rd Annual Meeting of the Transportation Research Board (TRB) Compendium of Papers.
   2) Winston, FK, McDonald, CM, Kandadai, V et al. *Experience and skill predict failure to brake errors: Further validation of the simulated driving assessment*. (2014). Society of Automotive Engineers - International 2014 World Congress & Exhibition Compendium of Papers. (In Press).
   3) Loeb, H, Seacrist, T, McDonald, CM, Winston, FK. *Simulated driving assessment: Case study for the development of DriveLab, extendable Matlab toolbox for data reduction of clinical driving simulator data.* (2014). Society of Automotive Engineers - International 2014 World Congress & Exhibition Compendium of Papers. (In Press).

4) Kandadai, V, Yang, H, Jiang, L, Yang, C, Winston, FK. *Using clustering techniques to classify tweet content within a Twitter network: A novel approach to measure health information dissemination.* (2014). Journal of Medical Internet Research – Research Protocols. (Submitted).

Talks:

1) Kandadai, V, Yang, H, Jiang, L, Yang, C, Winston, FK. (2013, September). A Content-Based Approach to Identify Target Users for Health Information Dissemination – A Case Study on @SafetyMD. Medicine 2.0: World Congress on Social Media, Mobile Apps, Internet/Web 2.0. London, United Kingdom.
2) McDonald, C.C. (October, 2013). Serious teen crashes: Identification of the most common scenarios and factors. Center for Child Injury Prevention Studies Webinar.