# Children's Hospital of Philadelphia

# Annual Progress Report: 2009 Formula Grant

**Reporting Period**

January 1, 2010 – June 30, 2010

**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.

**Anticipated 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 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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**Other Participating Researchers**

Christopher P. Bonafide, MD, Lisa M. McLeod, MD, Kathryn E. Roberts, RN, MSN, CRNP, CCRN, CCNS: Co-Investigator, PICU Clinical Nurse Specialist, Nursing Leader of Rapid Response System implementation at CHOP; Emily Huang, Study coordinator—all employed by Children's Hospital of Philadelphia
Russell Localio PhD – employed by University of Pennsylvania

**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

The aim of the prioritization project is to (1) identify pediatric hospital conditions that are prevalent, cumulatively expensive to the healthcare system, and exhibit high degrees of inter-hospital variation in resource utilization; and (2) identify explanations for high inter-hospital variation for these conditions. Conditions that demonstrate high inter-hospital variation in resource utilization may represent high yield targets for research into best practices and standardization of care. Below the researcher describes the work on this project to date.

The study protocol was granted exempt status from the Children's Hospital of Philadelphia (CHOP) Institutional Review Board. The Child Health Corporation of America (CHCA) provided the researcher with comprehensive hospital billing data from the Pediatric Health Information System (PHIS) on all children age 1 mo to 18 years of age hospitalized at one of 40 CHCA free-standing children's hospitals during calendar years 2005 – 2009. The researcher's statistical programmers assembled a list of primary discharge diagnoses that account for 80% of all costs and a list of primary discharge diagnoses that account for 80% of all admissions to CHCA hospitals during this time period. Two investigators reviewed this list of diagnoses and grouped them into clinically sensible "conditions" – defined as diagnoses that share the same pathophysiology and initial management. For example, the various International Classification of Diseases (ICD) 9 codes for asthma exacerbations were grouped together as they are all managed initially with the same initial diagnostic tests and treatments. This list of discharge ICD9 codes sorted into conditions comprises the researcher's ICD9 code "grouper".

The researchers then calculated the cumulative cost across all hospitals for each of these conditions and identified the 100 most expensive conditions. For each of the 100 conditions the researchers: (1) Excluded extreme cost outliers-- admissions whose costs were greater than the 99$^{th}$ percentile for that specific condition. These admissions were excluded to reduce the impact of extreme outliers on the researchers' analyses and to assemble cohorts of children whose cost distribution is more normally distributed; (2) evaluated the distribution of costs for remaining admissions in order to determine the best statistical approach for analyzing the data; and (3) binned admissions into quintiles of cost/admission.

For each condition, the researcher first calculated and plotted the number and proportion of admissions with costs in each of the five quintiles for each of the hospitals. Figure 1 provides an example of this plot (for acute appendicitis without peritonitis). These figures visually demonstrate the degree of inter-hospital variation in hospitalization costs for specific conditions. For each condition the researcher then used a non-parametric approach to calculate and compare the degree of inter-hospital variation in resource utilization (costs). The researchers simply counted the number of hospitals that had more than 30% of their admissions with hospitalization

costs greater than the 80th percentile or more than 30% of their admissions with hospitalization costs less than the 20th percentile. The researchers repeated this exercise increasing the "outlier" threshold to having more than 35% or 40% of admissions with costs in the top or bottom quintile of cost. The researchers then used intra-class correlation coefficients and chi-square statistics to quantify the degree of inter-hospital variation in cost/admission and compared those results with the researchers' more simple non-parametric approach.

The next step in the researchers' work is to take conditions that demonstrate high inter-hospital variation in hospital costs, and determine what factors are driving this variation: length of stay, laboratory tests, radiology tests, pharmaceutics, surgeries, pricing, etc. The researchers will repeat these analyses in another set of hospitals that contribute data to the Premier database. The researcher has purchased 3 years of these data from Premier in preparation for conducting those analyses.

Specific Aim #2: Patient Volumes and Quality of Care for Hospitalized Children

The goal of this project is to study the relationship between condition-specific hospital and physician volumes, quality of care and outcomes. The results of this initial phase will be used to further explore structural factors within hospitals that may be in the causal pathway of the volume-outcome relationship or that may be affecting quality independent of volume. The findings of this series of studies will provide a framework to hospitals seeking to minimize variation and improve quality by identifying the most effective interventions worthy of allocated resources.

The researchers' study protocol was granted exempt status from the Children's Hospital of Philadelphia Institutional Review Board (IRB). To date the researcher formalized the methods for phase one of the researchers' study, extracted the study cohort from the source population, and began analyzing this data. The researcher's first model condition is acute gastroenteritis (AGE) and the primary outcomes are based on adherence to validated practice guidelines published by the American Academy of Pediatrics (AAP) and Centers for Disease Control (CDC). The researchers are using a retrospective cohort design and sampling patients from 2 large administrative databases comprising ~50% of all United States pediatric admissions. The researcher included children 3 months to 6 years of age who have discharge ICD9 diagnosis codes used by the CDC to define AGE admissions. The researcher excluded children from the cohort who had ICD9 codes for: 1) complex chronic conditions identified in any admission over the 3-year study period, 2) comorbid conditions not consistent with routine AGE admission identified in the index admission. From this resulting cohort the number of AGE admissions was determined for each physician and each hospital averaged over the 3-year period (excluding repeat admissions).

In the Premier Perspective database, the researcher's cohort consists of 10,551 patients within 12,699 admissions from January 2007-December 2009. These patients were admitted to 296 different hospitals to over 4,000 physicians. 25% of the patients were cared for at 10 hospitals seeing $\geq 50$ patients/yr with AGE, 50% of the patients were seen at 86 hospitals seeing 15-50 patients/yr, and 25% of the patients were seen at 200 hospitals seeing 1-15 patients/yr. Admissions for AGE by month closely mirror the epidemiologic cycles of AGE incidence with peak admissions in the late winter months and valleys in the summer and fall months (figure 2).

This pattern was consistent across hospital sizes, regions, and locations. The diagnoses assigned to the patients in our cohort also mirrored the epidemiologic trends for etiology of AGE. A large majority of patients carried a principle diagnosis of Dehydration (35%), Intestinal Infection Not Otherwise Specified (NOS) (25%), or Intestinal Enteritis Due to Rotavirus (25%). Again this pattern was consistent across hospitals indicating consistency of coding for this disease process.

Baseline characteristics with respect to the hospitals and patient admissions in the study cohort are listed in Tables 1 and 2. The researcher calculated unadjusted rates of deviation from guidelines - grouped into overuse, misuse or underuse of care. This distinction was made so as not to miss any differences in the relationships of these three modes of variation with volume. Initial estimates show that overuse of care is quite high with 76% of patients having non-recommended blood tests drawn and 65% of patients having a diagnostic stool study sent. Misuse of care was 5.4% with the most common medication being Promethazine. Underuse of care was 75% for Ondansetron and slightly lower looking only at patients who were coded as having vomiting. Of note, this rate decreased over each year of the study whereas misuse of medications has remained fairly constant. Finally, underuse of Lactobacillus was 94%, with uptake of this new therapy constant over the study period. In the coming months, the researcher will examine these covariates across volume and begin to build the researcher's logistic regression model to describe the adjusted relationship between patient volumes and adherence to guidelines.

Specific Aim #3: Evaluation of an Early Warning Scoring System

For logistical reasons the researcher decided to begin work on Specific Aim 3c, rather than 3a. For Aim 3c, the researcher will identify factors that contribute to false-positive and false-negative early warning scores using qualitative methods and evaluate the impact of a rapid response system on the hierarchical and cultural barriers relevant to patient safety.

To that end, the researcher has assembled a multidisciplinary team including, lead investigator Dr. Keren, co-investigator Dr. Bonafide, a Pediatric Intensive Care Unit Clinical Nurse Specialist who is the nursing leader of CHOP's Rapid Response System Implementation; a pediatric clinical nurse specialist; a PhD expert in Qualitative research methods; a research interviewer and qualitative data analyst; and a study coordinator. The researchers developed the interview guide and data collection forms. The researchers wrote the full IRB protocol and submitted it to the CHOP IRB for review. The researcher has purchased audio recording equipment for interviews and scheduled interview training.

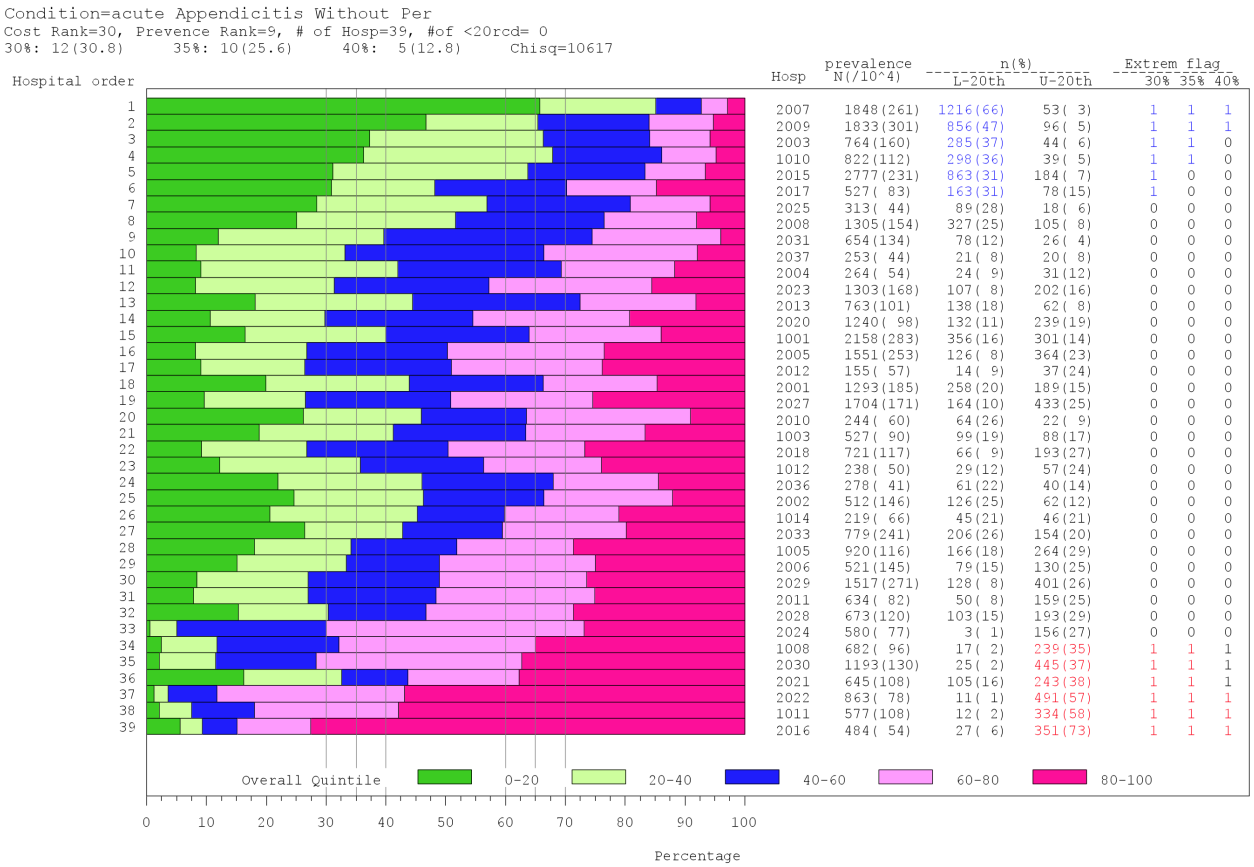
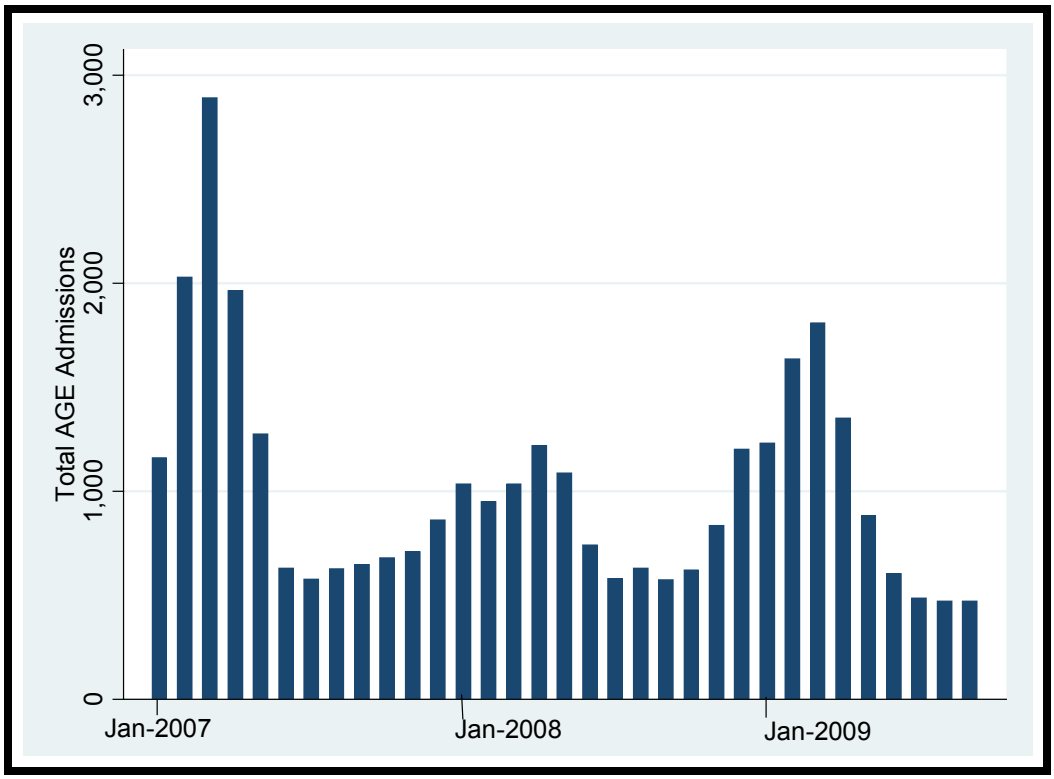



Figure 1. Distribution of costs/admission across CHCA hospitals for the diagnosis of acute appendicitis without peritonitis.

Hosp: Hospital number
Prevalence: Number of appendicitis admissions/10,000 hospital admissions
L-20$^{th}$: Number and percent of admissions with costs in the lowest quintile (across all hospitals)
U-20$^{th}$: Number and percent of admissions with costs in the highest quintile (across all hospitals)
Extrem flag: "1" indicates that the hospital has more than 30%, 35%, or 40% of admissions with costs either in the highest or lowest quintile.

Figure 2: Total AGE Admissions by Month for 297 Hospitals




| Table 1: Hospital demographic statistics for represented hospitals and patient admissions within hospitals | | |
|---|---|---|
| **Covariate** | **Hospital-level N (%)** | **Patient-level N (%)** |
| Median Total Hospital Beds (range) | 391(25-1836)* | --------- |
| Region | | |
| Midwest | 66(22) | 2,149(17) |
| Northeast | 35(11) | 2,254(18) |
| South | 142(48) | 6,914(54) |
| West | 53(20) | 1,382(11) |
| Teaching Status | | |
| Yes | 79(27) | 5,677(45) |
| No | 217(73) | 7,022(55) |
| Location | | |
| Urban | 209(71) | 10,635(84) |
| Rural | 87(30) | 2,064(16) |

*mean/median numbers of patients per hospital in Northeast and South are larger but ranges of hospital volumes are comparable.

| Table 2: Patient demographics and admission characteristics by patient admission | |
|---|---|
| **Covariate** | **Patient-level N (%)** |
| Hospitalization Summary | |
| LOS (days), Mean(range, SD) | 2(1-12, 1.13) |
| Cost /admit, Mean(range, SD) | $2,584(500-27147, $1692)* |
| Age | |
| 0 | 3,520(30) |
| 1-3 | 6,736(57) |
| 4-6 | 1,574(13) |
| Race | |
| Black | 1,760(14) |
| White | 6,921(55) |
| Hispanic | 1,733(14) |
| Asian | 257(2) |
| American Indian | 96(1) |
| Other | 1,942(15) |
| Admission Source | |
| Primary Care Center | 4,803(38) |
| Emergency Department | 7,266(57) |
| Hospital Transfer | 482(4) |
| Other | 148(1) |
| Attending Physician Specialty | |
| Pediatrics | 9,946(78) |
| Family Practice | 793(6) |
| Internal Medicine | 306(2) |
| Hospitalist | 589(5) |
| Other | 1,065(9) |
| Primary Payer | |
| Medicare/Medicaid | 5,838(46) |
| Private | 6,259(49) |
| Other | 602(5) |
| APR-DRG Severity | |
| Minor | 9,670(76) |
| Moderate | 2,859(23) |
| Major | 131(1) |

*~200 admissions were censored due to incomplete cost data

## 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.

### Anticipated 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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**Other Participating Researchers**

Yi Ching Lee, PhD - 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**

The Center for Injury Research and Prevention (CIRP) at The Children's Hospital of Philadelphia has met its first two year one (2010) milestones to 1) start expert interviews and literature reviews 2) select and purchase a high fidelity, commercially available driving simulator and set up simulator for use with young drivers.

*I. Milestone 1: Start expert interviews and literature reviews*

To achieve the first milestone, a systematic approach to review best practices for creating and evaluating theoretically-grounded interventions to promote health was developed and implemented. This plan necessarily incorporates Method 1.1, *Review best practices for creating and evaluating theoretically-ground interventions to promote health and prevent injury and adapt for Internet-based interventions to prevent young-driver crashes.*

*Planning and Implementation*

The implemented plan consists of identifying and recruiting two primary groups:

1) Internal experts – based at The Children's Hospital of Philadelphia (CHOP). Interviews with this group will provide baseline knowledge and allow for ongoing surveillance with the aim of determining existing research, identifying other experts, developing questions to ask those experts, detecting gaps in information and knowledge, and reviewing and prioritizing information.

To date, eight Internal Experts including the Principal Investigator and Co-Investigator on the project have been identified. Preliminary interviews to obtain recommendations for additional experts lead to the identification of four of five Local Experts. Assistance was provided by three Internal Experts with developing a draft listing of expert questions. This group also identified a research assistant candidate for the project. That candidate is now moving through the interview process for employment.

Internal Experts:
Allison Curry, PhD, is the director of Epidemiology and Biostatistics at the Center for Injury Research and Prevention at CHOP. She serves as an injury epidemiologist on several projects aimed at preventing motor vehicle-related injuries to children and CIRP's Young Driver Research Initiative (YDRI).

Dennis Durbin, MD, MSCE, who serves as co- Scientific Director of CIRP. He is a pediatric emergency physician and clinical epidemiologist. He is a Professor of Pediatrics and Epidemiology at The Children's Hospital of Philadelphia (CHOP) and The University of Pennsylvania School of Medicine.

Dr. Nancy Kassam-Adams is Associate Director for Behavioral Research at CIRP and a pediatric psychologist. With colleagues at CHOP, she has developed innovative web-based tools for parents (www.AfterTheInjury.org) and health care providers (www.HealthCareToolbox.org) that promote secondary prevention of traumatic stress in ill or injured children.

Dr. Jessica Hafetz, PhD, is a behavioral researcher and applied developmental psychologist at CIRP. As the lead behavioral scientist on the Young Driver Research Initiative (YDRI) team at CIRP, she focuses on designing and evaluating programs and interventions aimed to prevent crashes and reduce injuries among teens.

Suzanne Hill is the Director of Outreach and Advocacy at CIRP. She and her team work directly with the Center's interdisciplinary researchers to translate child and youth injury prevention

research into action through health promotion strategies that involve public policy advocacy, public relations, social marketing, and web-based communications.

Lela Jacobsohn, Ph.D. is a communications researcher at CIRP and behavioral scientist on the Young Driver Research Initiative.

2) Local experts – based in Philadelphia and/or Pennsylvania. This group assists with determining existing knowledge, gaps and opportunities, identifying other experts or fields to assist in the building of the expert support network, providing recommendations for literature, methods, and best practice models. The researchers are currently in the process of confirming their interest in providing ongoing support:

1. Allow follow-up interviews
2. Become a volunteer "mentor" to the project
3. Collaborate as a co-investigator

Of the five Local Experts preliminary interviews were conducted with three people. The purposes of these interviews were to the build the network of experts and inquire as to the level of involvement they would like to have on the project. In addition, one local expert was identified through this process.

Local Experts:
Robert Homick, Ph.D. is a professor of communication at the University of Pennsylvania, possesses expertise in public health communication, mass media effects, and research methodology. He conducts evaluations of large scale public health communication interventions, studies of effects of mass media coverage on health behavior, cancer communication.

J. Wesley Hutchinson, Ph.D. is Stephen J. Heyman Professor and Professor of Marketing and Faculty Director, Wharton Behavioral Laboratory at the Wharton School of the University of Pennsylvania. His research focuses on consumer and managerial decision making, particularly the interrelationships among attention, learning, confidence, decision making, and expertise in repeated choice environments.

Christopher C. Yang, Ph.D. is Associate Professor of Information Science and Technology Drexel University College of. His research and expertise include Web search and mining, security informatics, knowledge management, cross-lingual information retrieval, text summarization, multimedia retrieval, information visualization, information sharing and privacy, digital library, and electronic commerce.

Shawndra Hill, Ph.D. is Assistant Professor of Operations and Information Management, Wharton School, University of Pennsylvania. Her research interests include Design Science and Information Systems; statistical relational learning; data mining/knowledge discovery in databases; machine learning; network-based marketing; dynamic networks

Dan Romer, Ph.D, a social psychologist and communications researcher, is director of the Adolescent Communication Institute (ACI) of the Annenberg Public Policy Center. His research

focuses on media and social influences on adolescent health with particular attention to the social transmission of risky behavior.

All six of the internal and two of the external experts have agreed to regular access through meetings, phone calls and/or materials review throughout the course of the grant.

*Literature Review*

Literature reviews are being conducted simultaneously with the planning of and implementation of expert interviews. The purpose of this activity is to review best practices for creating and evaluating theoretically-ground interventions to promote health and prevent injury and adapt for Internet-based interventions to prevent young-driver crashes (Method 1.1). The literature is meant to enhance expert interviews for the purpose of determining existing knowledge, gaps and opportunities (by discovering current published and non-published knowledge) and identifying other experts - those unfamiliar to our recruited team, discover other relevant fields of research and build competency.

Taking on the primary responsibility for literature reviews is the work of the Research Assistant who the researcher is currently in the process of hiring, though development of a literature search and review plan has begun.

Conducting literature reviews encompasses the following tasks:

1) Complete development of and implement the literature search strategy
    a. Determine keywords and authors to direct searches
    b. Determine the range of literature to search (business, medical, psychological, communications, engineering)
    c. Determine on-line and other search resources available at the University
    d. Sign-up for email alerts
2) Develop electronic and hard copy libraries of relevant literature
    a. Create and maintain an Endnote reference library
    b. Create and maintain and hard copy library
    c. Cull relevant literature from research libraries maintained by our Experts
3) Read literature, prepare summaries and report findings to the Co-investigators and research team
4) Identify and track relevant conferences, workshops, lectures and presentations
5) Identify clinical studies evaluating internet based health interventions
6) Assist with identifying experts, ascertain expert biographies and compile contact information

The following titles for categorizing journal articles have been drafted:

Methodology and the Internet
Behavior Change and the Internet
Reviews of Literature Related to Internet Interventions
Scientific Foundation for Developing Internet Interventions
Efficacy of the Internet as a Venue for Interventions

Theoretically Grounded and Evidence Based Internet Approaches
Data mining, searching and search engine optimization

*What has been learned to date:*

Despite the fact that injury is the leading cause of health problems for our nation's children and youth, little scientific behavioral research is being conducted in the area of road traffic injury prevention. An initial review of the literature revealed only a few studies that applied behavior and social science theory to road traffic injury prevention.

In addition, recent experience with the researchers' newly launched website teendriversource.org and our state wide network of driver education instructors reveals that there is growing interest in and need for this information. Since its preliminary launch in April 2010 at the National Lifesavers conference, teendriversource.org has received 3,469 visits by 2,083 unique visitors spending an average time of 11 minutes and 53 seconds on the site. Progressively growing since 2008 the Pennsylvania Teen Driving Safety Alliance, a CHOP led coalition, boasts involvement of eight state based organizations representing over 2,000 members.

Information gleaned from the initial literature search, CIRP and other expert interviews highlight several important factors:

1) Few scientific theoretically grounded studies have been conducted in the area of prevention of road traffic injury, despite the need for such research and interventions to prevent young driver-crashes, particularly those delivered via the internet.
2) There are experts both locally and beyond Pennsylvania within the injury field and outside of the field who expressed an interest in working with us.
3) The gap between research and the need for research based theoretically grounded interventions represents a huge opportunity to have an impact.
4) Much research has been undertaken in other fields that can be leveraged toward preventing teen driver crashes.
5) We can leverage the expertise of a national CDC initiative charged with developing the National Action Plan on Child Injury to support our efforts on this project. (Note Dr. Winston has been asked to head the Communication and Media Workgroup for this effort.)

*II. Milestone 2: Purchase of a high fidelity, commercially available driving simulator set up for use with young drivers.*

A high fidelity, commercially available, multiple-computer driving simulator system was purchased. The driving simulator makes use of an actual partial vehicle cab that has been modified to include instrumentation and audio cueing systems (see Figure 1). Three forward 46" liquid crystal display (LCD) panels display simulated driving environment extending approximately 120° field of view. The cab and the simulated scene together create an immersive visual environment at a resolution of 1280x1024. Using the actual cab structure assures the maximum amount of realism and accuracy with respect to the locations of controls, driver visibility, and feel of the desired vehicle. All electrical components in the center console remain functional. Audio cueing components such as speakers and vibration

transducers are integrated into the cab to further support the simulation. This cab includes the following controls and results in the appropriate vehicle behavior in the simulator:

- Control loaded steering wheel (forced feedback steering system)
- Throttle (active feedback system)
- Brake (active feedback system)
- Gear selector for automatic transmission (P, R, N, D, L1, L2)
- Turn signals
- Seat belt
- Headlights switch
- Ignition switch (status only)

The dash indicators will respond to the status of the simulated vehicle and may be controlled from the scenario control system. These indicators consist of the following gauges:

- Speedometer
- Turn signal indicator
- Engine oil pressure
- Fuel level
- Warning lights

Visual rendering and scenario control is supported by real-time driving simulation software. This software manages the communication between all of the relevant subsystems including visuals, scenario control, audio, motion, control loading, and data collection. Data is collected at 60 Hertz (Hz).

The simulation environment is programmed by placing tiles of roads, roadway objects, and scenario control objects. Tiles are generally 200 meters by 200 meters in size. Once the tiles required to support a given scenario are in place, additional features such as trees, signage, buildings, etc. can be added. Other features such as traffic signal controls, pedestrians, vehicles, and other dynamic elements can be added to create representative driving experience. A set of special objects called scenario control objects are then added to control the actions and behaviors of the vehicles, pedestrians, and other controllable features within the simulator. Scenario control objects are sensors, markers, paths, start points, and end points, etc. Some of these objects have a script attached to them that allows the experimenters to issue commands to the simulator in order to make certain behaviors happen during the simulation, such as making a pedestrian walk or making a lead vehicle brake at a pre-determined location.

Once scenario design is completed, research participants can sit in the driver's seat and drive the scenario by looking at the simulated environment and controlling the vehicle while interacting with the dynamic features in the environment. For example, one scenario could have pedestrians run across the road unexpectedly and test how the research participant reacts to such hazards.

Five cameras are mounted in the driving simulator system to record drivers' performance. This video capture and review system allows capturing and playing back synchronized views of a simulation experience along with recorded data. The system records simulation activity from up

to four vantage points. These views are simultaneously displayed in quad view upon play back. In addition, the video review system supports preliminary data analysis by graphing variables of driving performance over time. Further analyses can be done by utilizing other statistical programs.

Another aspect of the preparation is to test the procedures for playing back a drive in the simulator. This playback function is needed in one of the experiments. The procedures the researchers developed will be used in the planned studies for this work and are as follows. When a participant finishes a drive, an experimenter will transfer the data file generated by the simulator software to then produce a video that is essentially the recording of what the participant saw and did during the drive. The participating subject will then be asked to comment on how and why certain behaviors or decisions were made during the drive. This method will allow the researchers to understand how the participants think of their own driving behaviors (e.g., how fast the subject thought they were driving) and the degree to which this subjective evaluation matches the observed objective behaviors (e.g., the recorded speeds from the speedometer).

Figure 1. The driving simulator cab and three LCD panels.