Safe and Sound

The Center for Child Injury Prevention Studies 2011 Annual Report

The Children's Hospital *of* Philadelphia®
RESEARCH INSTITUTE

The Ohio State University Medical Center

Partnering for Safety

A MESSAGE FROM OUR DIRECTORS

Kristy Arbogast, PhD, John H. Bolte IV, PhD, and Flaura Winston, MD, PhD , co-directors, CChIPS

Safe and Sound. That's what parents hope for and our Center works toward. In fact, the future is bright as we continue to advance child safety through evidence to inform action. The Center for Child Injury Prevention Institute (CChIPS) hosted by The Children's Hospital of Philadelphia Research Institute is proud of its achievements in 2011. Through a unique partnership with our Industry Advisory Board (IAB), our researchers are pinpointing and assessing the causes of injuries to children and young adults. With this knowledge, we can prevent injuries and engineer solutions that save children's lives. On behalf of the IAB and our dedicated team of researchers, we are excited to share research highlights and summary updates from CChIPS' past year in this annual report:

- **CChIPS Overview & Financial Update: Pg. 2**
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- **Industry Advisory Board Members: Pg. 6**
- **CChIPS In the News: Fold-out**

Founded in March 2005 with a grant from the National Science Foundation (NSF), CChIPS is one of over 50 Industry/University Cooperative Research Centers (I/UCRC) funded by NSF in the country and the only one focused on preventing child and young adult injuries. CChIPS is currently in the second year of the five-year grant renewal, allowing us to continue our important work.

With the addition of The Ohio State University (OSU) as our second research site in 2011, CChIPS has expanded and established itself as a multi-university Center. This new partnership has strengthened our resources with leading investigators and cutting-edge facilities, as well as diversified our research portfolio with new research thrust areas, including sports injury prevention. To celebrate this successful partnership, the OSU site, led by John H. Bolte IV, PhD, will host the fall IAB meeting in November.

CChIPS hosted the Advances in Child Injury Prevention (ACIP) Conference this past May in Plymouth, MI. The goal of this annual conference is to share the latest research on occupant safety and other road traffic injury issues for children and adolescents with professionals from industry, government, and research organizations. Over 90 attendees from 20 organizations heard a dozen presentations from experts at The Children's Hospital of Philadelphia (CHOP), The University of Michigan, OSU, the National Highway Traffic Safety Administration, and TASS Americas. David Champion, senior director of Consumer Union's Automotive Test Division, served as the keynote speaker.

With a strategic plan co-developed by the faculty and IAB last year serving as a guide for achieving our goals, CChIPS continues to spread its important mission and message of injury prevention worldwide. Center faculty and investigators have presented at the Association for the Advancement of Automotive Medicine (AAAM) meeting in Paris, France and the Protection of Children in Cars Conference in Munich, Germany and have organized and led the Future Agenda for Child Occupant Protection Workshop in Prato, Italy. The success of CChIPS, as explored in this report, shows the tremendous impact industry and academia can achieve when working collaboratively toward shared goals. We look forward to sharing many more achievements with you in the future.

A Unique Approach to Child Safety Research

Hosted by The Children's Hospital of Philadelphia Research Institute, one of the largest pediatric research facilities in the country, CChIPS takes a unique approach to child safety research. The Center was created to initially address the predominant mechanism of child death – road traffic injury – and has expanded to include sports injury prevention. Our researchers work side by side with industry members to conduct translational research that is relevant to industry. This synergistic collaboration is ideal for generating ideas for new research projects and sharing expertise and resources.

The fundamental idea behind its work is that children are not small adults (mechanically, psychologically, developmentally, and socially). Therefore, child injury deserves to be examined and understood as a distinct branch of science. As automotive design and consumer behavior become increasingly complex, enhanced research, product development and education efforts are necessary to further child safety. In just seven years CChIPS has conducted 51 research projects, with researchers partnering with leading automotive manufacturers, restraint suppliers, insurance providers, and government agencies to translate their findings into tangible innovations in safety technology and public education programs.

The CChIPS research method applies the broad and diverse backgrounds of its investigators to create and implement novel integrated approaches. For example, work in child crash injury applies biomechanical epidemiology, an approach developed by CChIPS investigators.

Currently, the majority of CChIPS research is focused on preventing road traffic injuries, the leading cause of injury and death for children and young adults. These areas of research include:

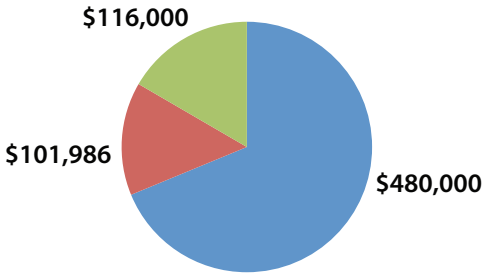
- injury biomechanics, mechanisms, and tolerance
- technological solutions to injury (design, development, and testing)
- how humans interact and behave in relation to safety technology
- safety promotion and education
- the evaluation of safety devices and behavior modification programs

Driven by the addition of The Ohio State University, the Center is also in the process of exploring different research thrusts, including sports injury and orthopedic biomechanics. To learn more about CChIPS or to sponsor research with CChIPS investigators, visit www.chop.edu/cchips or e-mail Meredith Kearney, CChIPS coordinator, at Kearneym2@email.chop.edu.

Funding the Research

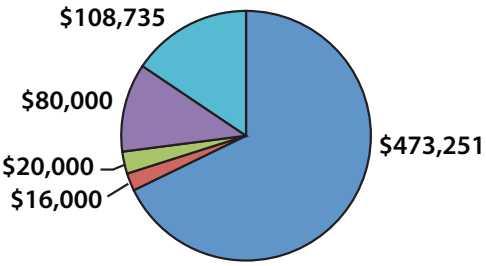
CChIPS is made possible through a grant from the National Science Foundation (NSF), as well as sponsorships from its IAB member companies, comprised of industry and federal agencies that engage in scientific research and development to improve child safety. Each full, voting IAB member contributes $50,000 annually to support the CChIPS mission. Small businesses are also given the opportunity to join as affiliate members for a reduced annual fee. These memberships are designed to boost small business involvement in the CChIPS mission and to spur innovation. To become a member or to sponsor research with CChIPS investigators, contact Meredith Kearney, CChIPS coordinator, at Kearneym2@email.chop.edu.

REVENUE FOR 2011



*Total Revenue: $697,986

EXPENDITURES FOR 2011



*Total Expenses: $697,986

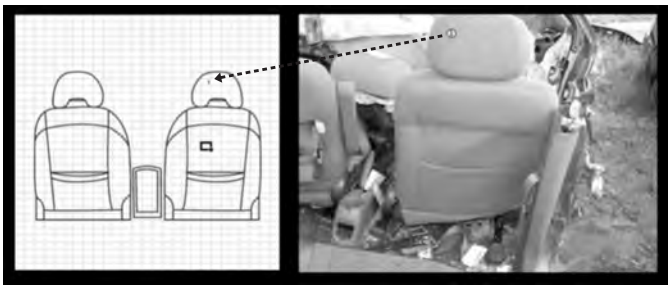
The Children's Hospital of Philadelphia Research Institute waives all overhead expenses for CChIPS.

Research In Action: 2010-2011 Project Highlights

Head Injury Contact Points for Children Seated on the Rear Rows in Frontal Crashes

Principal Investigator:
Kristy Arbogast, PhD, The Children's Hospital of Philadelphia

IAB Mentors:
Uwe Meissner, Technical Advisor; **Rodney Rudd**, National Highway Traffic Safety Administration; **Julie Kleinert**, General Motors Holdings LLC



On the left, you see a line drawing of the interior seat back of a motor vehicle. On the right is a photograph of a vehicle that was involved in a crash, with one or more numbers in the picture. The numbers signify the location inside the vehicle where an occupant contacted the vehicle interior.

Traumatic brain and skull injuries are the most common serious injuries sustained by children in motor vehicle crashes, regardless of age or crash direction. The objective of this study was to delineate the cause and effect of head injury scenarios for rear-seated, restrained children in frontal crashes and to create a contact map of the vehicle interior.

Previous research has investigated the cause of injury for children restrained in child safety systems, booster seats, and seat belts in side impact motor vehicle crashes. This was accomplished by highlighting common injury scenarios among near- and far-sided crash occupants and then providing a detailed contact point map to summarize areas of the vehicle interior contacted by specific body regions. This project utilized this methodology and examined the experience of restrained children in frontal crashes who sustained injuries to the head/face.

Three major injury causation scenarios were identified, including head contact with the back of the seat and head contact with the side interior. For some scenarios, head/face injury occurred with no evidence of head contact. In a majority of the cases, injury to the head/face was the most severe type of injury sustained by the child, with serious injuries to other body regions uncommon. This finding suggests that efforts to mitigate head injuries for child occupants would greatly improve their overall safety. The majority of the head/face contact points were to the first row seat back and B-pillar (second pillar of the passenger compartment used to house the hinges for any rear doors). In these frontal crashes, the importance of head/face contact with the vehicle side structure suggests that deploying a curtain air bag in frontal impacts may help manage the energy of impact. These data advance the current understanding of injury patterns and causation in frontal crashes involving restrained, rear row occupants and can be used to develop solutions to eventually lessen the incidence and severity of injuries sustained.

Comparing FMVSS 213 Sled Test to the Full-scale Vehicle Crash Environment

Principal Investigator:
Matthew R. Maltese, MS, The Children's Hospital of Philadelphia

IAB Mentors:
Uwe Meissner, Technical Advisor; **Rajiv Menon**, Dorel Juvenile Group; **Eric Dahle**, Evenflo Inc.; **Ken Wittenauer**, Britax Child Safety Inc.

Motor vehicle crashes persist as the leading cause of death for all children over age 3 years in the US. Aftermarket child restraint systems (CRS) provide protection but are evaluated by a regulatory sled test that may differ from full-scale vehicle crash conditions in important ways. It is vital to understand CRS performance in a full-scale crash test as this is more representative of the actual crash conditions. This project aimed to quantify the extent to which the C/FMVSS 213 sled test simulates a frontal vehicle crash test.

To accomplish this objective, the research team divided the study into two components -- one focused on the sled pulse and one focused on the test bench used in the regulatory sled test. For the sled pulse evaluation, over 1,400 vehicle crash tests were analyzed over a variety of barrier conditions (offset and full-frontal rigid barrier) and over a range of impact speeds (40, 48 and 56 kmph) and vehicle types (SUV, sedan, minivan, etc.). For the test bench evaluation, the research team mounted a selection of vehicle seats and the C/FMVSS 213 bench seat to a crash sled, and mounted child restraints on the seats exposed both to an identical sled acceleration pulse.

Tests were performed in groups, mounting the same model CRS to various vehicle seats and to the sled test bench. The analysis revealed significant differences between the vehicle and bench, depending on how the seats were attached to the vehicle. Differences were also found in performance metrics for the same model forward-facing CRS tested on the vehicles seats and sled bench. The kinematics of CRS attached by LATCH and tether revealed that CRS rotation was uniformly positive (CRS rotates backward) on the bench and overwhelmingly negative (CRS rotates forward) on the vehicle seats. According to the researchers, these fundamental differences in CRS kinematics between the bench and vehicle seat may be highly dependent upon the difference in the location of the tether anchor between the bench and vehicles.

This study helped to quantify the differences between the vehicle and bench seats, and a follow-up study is currently underway to understand why the differences occur. The second phase of this project will determine which design elements (bench cushion stiffness, belt/tether/LATCH anchor, seat angle, etc.) of the bench cause the differences in performance when compared to the vehicle seats. This research was conducted in collaboration with the Government of Canada, with all testing conducted at Transport Canada and data analysis conducted primarily at CChIPS.

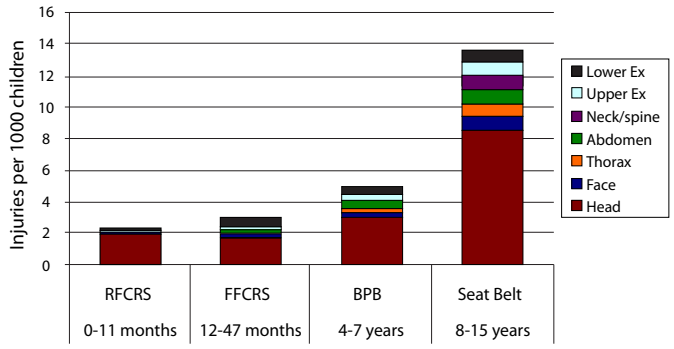
Injury Risk to Belted Occupants

Principal Investigator:

Kristy Arbogast, PhD, The Children's Hospital of Philadelphia

IAB Mentor:

J.T. Wang, General Motors Holdings LLC; **Julie Kleinert**, General Motor Holdings LLC



Children with add-on, harness-based child restraints have a lower injury risk than older children and adults in seat belt restraints.

According to a past study, children seated in add-on, harness-based child restraints have a lower injury risk than teenagers and adults wearing seat belts. It is crucial to understand the key contributors to injury risk of those occupants following best practice recommendations for seat belt restraint. This study aimed to compare the injury and fatality risk for both children and adults who are age-optimally restrained.

Researchers found an elevated injury risk experienced by 8- to 12- year-old child occupants who followed best practice recommendations for seat belt restraint as compared to the risk experienced by younger children. Using Partners for Child Passenger Safety (PCPS) data, the study revealed that 8- to 12- year-olds placed in seat belts in the rear seat are 1.9 times more likely to suffer a significant injury (an Abbreviated Injury Scale, AIS, 2 or greater) when involved in a crash as compared to children in forward-facing child restraints.

Adult injury risk in crashes varies by whether a child is also a passenger in the vehicle. This is due to differences in key vehicle and crash characteristics when adults drive alone or with child occupants. In crashes involving adults with a child present, rear-seated 8- to 12-year-olds had a lower injury risk than rear-seated adults. This finding suggests that the seat belt provides at least equivalent and perhaps better protection to the pre-teen occupant than to the adult in similar crashes.

This study laid the groundwork for phase two of this project that is now underway. Its purpose is to explore injuries and their causation experienced by rear-seated, seat belt-restrained occupants – both adults and children – to understand if pre-teens and adolescents sustain different types of injuries in crashes. In year two, the project will specifically focus on thoracic injuries, including lung contusions versus skeletal injuries.

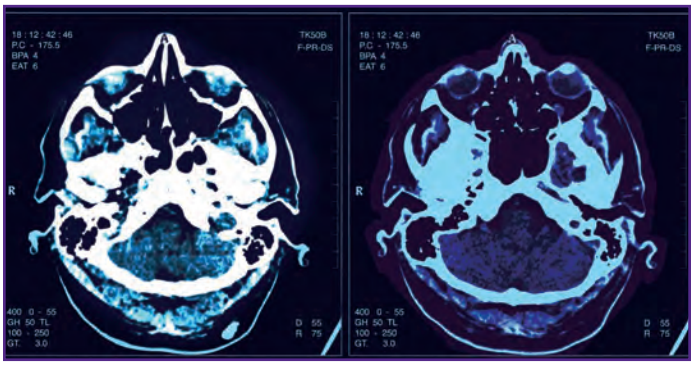
Neurocognitive Evaluation of Mild Traumatic Brain Injury in the Pediatric Emergency Department Population – Part II

Principal Investigator:

Michael L. Nance, MD, The Children's Hospital of Philadelphia

IAB Mentor:

Stephen Rouhana, PhD, Ford Research & Advanced Engineering



Head injuries are the leading cause of death and a frequent source of injury for pediatric patients, with falls and road traffic crashes the primary cause. These types of injuries account for over 500,000 emergency department (ED) visits annually, 95,000 hospital admissions and 7,000 deaths. However, since 75 percent of these injuries do not result in persistent loss of consciousness, some classify them as "mild" (mild traumatic brain injury, mTBI). By comparing injured children with mTBI with those who suffered fractures without mTBI, this study aimed to characterize important deficits that can be attributed to mTBI.

Building off of last year's study, this project was based in an ED setting, and evaluated the frequency of neurocognitive deficits present in children evaluated and discharged from the ED with mTBI as compared with those with extremity fractures. The researchers also attempted to document the timing and extent of recovery from mTBI through follow-up neurocognitive testing in those patients with proven insufficiencies.

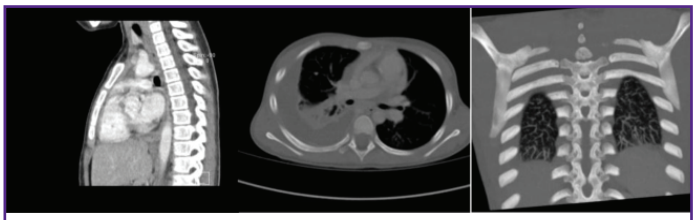
The study population included pediatric patients (ages 5 to 18 years) with mTBI (and by comparison, those with extremity fractures) who were treated and released from the ED. Researchers assessed patients utilizing a sequence of neurocognitive tests to identify deficits and, through follow-up testing, the extent of recovery. A computer-based software program designed, validated and extensively tested in athletes with concussion injuries called Immediate Post-concussion Assessment and Cognitive Testing (ImPACT©) was used as the assessment tool.

ImPACT identified significant differences between children with mTBI as compared to non-concussed children who sustained extremity fractures, pointing to a need for the prevention and treatment of mTBI. This study also helped demonstrate the potential utility of ImPACT as an ED assessment and triage tool.

Development of Premature Infant Anthropomorphic Test Device (ATD)

Principal Investigator:
Sriram Balasubramanian, PhD, Drexel University and The Children's Hospital of Philadelphia

IAB Mentors:
Steve Oltman, Dorel Juvenile Group; **Dan Robertson**, Toyota Motor North America Inc.; **Uwe Meissner**, Technical Advisor



CT scans were processed using specialized software to visualize, divide and render (3D) images of the premature infant.

Infant crash test dummies, also known as anthropomorphic test devices (ATDs), are currently used to evaluate the effectiveness of child restraint systems (CRS). Due to the fragile nature of their bodies, proper fit in the CRS may be particularly important for premature infants; improper fit may cause an increased burden to their skeletal structure and organs. If represented accurately, the shape and structure of a premature infant ATD may help to increase the effectiveness of CRS for this age group. The aim of this study was to quantify the shape and structure of a premature infant in sufficient detail to inform the development of a new premature infant crash test dummy.

Whole body computed tomography (CT) scans of three infants (gender/age at time of scan: M/5 days, F/47 days and F/58 days) with gestational ages of less than 40 weeks at birth (i.e., premature) were obtained from the radiology database at The Children's Hospital of Philadelphia (CHOP). Height and weight information at the time of scan was recorded for all three infants. The CT scans were processed using specialized software (Analyze, Mayo Clinic, Rochester, MN) to visualize, divide and render three-dimensional (3D) images of the premature infants. These 3D computational models can be used to guide the manufacture of a plastic prototype of a premature infant crash test dummy.

Obtaining the shape and structure information based on medical imaging data is a critical first step in the development of a realistic premature infant dummy that will be used to test the fit and effectiveness of CRSs. This approach overcomes limitations associated with current designs of a low birth weight infant ATD.

Examining Cognitive Variables and Decision-making Strategies Related to Adolescent Driver Performance

Principal Investigator:
Jessica Mirman, PhD, The Children's Hospital of Philadelphia

IAB Mentors:
Christina Mullen, State Farm Insurance Companies; **Doug Longhitano,** Honda R&D Americas Inc.; **Steve Roberson**, State Farm Insurance Companies

A main reason why teens crash is that they have a greater tendency for risky behaviors, as well as an increased susceptibility to peer influence relative to other age groups. It is thought that risk perceptions, the extent to which behaviors are perceived as risky, have a lot to do with adolescents' intentions to perform risky behaviors and how these intentions are realized by their peers. The intent of this research was to better understand the relationship between risk perceptions and risky driving behaviors within a peer setting and to inform the development of a training program for teens learning to drive.

The study assessed risk perceptions of 17-year-olds and 18-year-olds recruited from the general population (i.e., DMVs, schools, etc.). At the beginning of the study, participants were asked to complete written surveys and the Balloon Analog Risk Task (BART, a validated measure of risk-taking). The surveys contained items that measured demographic characteristics, risk perceptions, self-reported engagement in risky driving behaviors, and resistance to peer influence using the Resistance to Peer Influence (RPI) survey. For example, the quantitative items asked respondents to estimate their risk of crashing using percentages (e.g. 20 percent). Specific risk items asked respondents to evaluate their risk within a specific time frame and utilized a likert-type scale for collecting responses. In order to determine which risk items best predicted risky behaviors, participants completed the surveys a second time using an online survey tool three months later.

This study found that both teens' gist-risk perceptions (e.g. value-based) and their perceptions about their ability to resist the influence of their peers were most protective against engaging in risky driving behavior, speeding/racing, and driving dangerously with peer passengers. These factors are promising targets of possible future interventions to decrease the number of teen crashes, and the research results provide evidence for crafting likely effective messages for this audience.

Keep Track of CChIPS Throughout the Year

There are several ways to keep track of CChIPS news and updates throughout the year. Here's how:

- Visit the CChIPS website: www.chop.edu/cchips
- Subscribe to *Research in Action,* CIRP's enewsletter: http://injury.research.chop.edu/newsletter/
- Follow Dr. Winston's Twitter account, *Safety MD*: https://twitter.com/safetymd
- Join the CChIPS LinkedIn Group: http://www.linkedin.com/groups/CChIPS-2882094?trk=myg_ugrp_ovr

Supplemental Research Funding

As part of CChIPS' designation as a National Science Foundation (NSF) center, Center faculty are eligible to apply for supplemental funding from NSF to advance the mission of CChIPS. Often this supplemental funding involves partnerships with other research organizations or university research centers across the country. In 2010-2011, these projects included:

- ***Research Experiences for Undergraduates***

  After a very competitive application process, CChIPS faculty were awarded a new National Science Foundation Research Experiences for Undergraduates (REU) Site for Injury Science. In our inaugural year 120 students applied for these prestigious internships, and eight talented undergraduate students were selected to spend the summer working side-by-side with researchers as part of the Center for Injury Research Prevention's (CIRP) REU program.

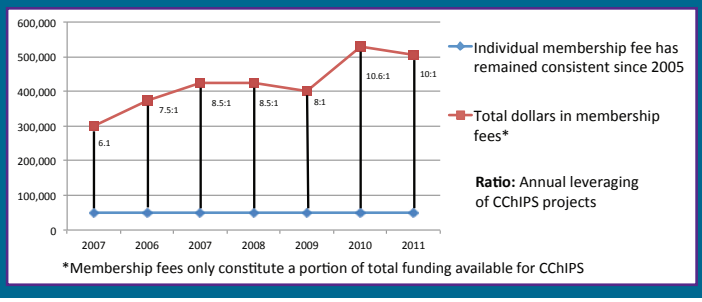
  CIRP's 10-week REU program provides a diverse group of student scholars from schools across the country with mentorship and hands-on research experience in the fields of Engineering, Behavioral Science, Education, Population Science, and Statistics. Each student is paired with a CIRP mentor to work on specific projects and also receives formal training in research ethics, research methodology, and the presentation of research findings.

- ***Adaptive IT Application for Collaborative Review of Child Fatality Cases***

  With funding from NSF and guidance from I/UCRC Industrial Advisory Boards, a team of researchers from two I/UCRCs, a team of researchers from CChIPS and the Center for Autonomic Computing at the University of Florida, another I/UCRC, developed a Web-based application to enable a secure, remote, and collaborative review of mechanisms of injury to children in motor vehicle crashes. With additional funding, this innovative application was adapted to facilitate reviews of child fatalities. The Telecenter for Child Fatality Review enables: 1) the distributed, asynchronous (operates independently of other systems) collection of digital content needed for crash case reviews, with consistent organization of content across cases; 2) secure, Web-based, remote participation in review meetings with multi-media sharing of case content via visual images, real-time written and oral communication, and use of Web resources, and; 3) archiving for post-review access and follow-up involving statistics, search and networking.

  Initial real world results demonstrated that the Telecenter for Child Fatality Review could help states enhance the quality of reviews without the financial burden of travel for experts, while also improving efficiency in the timely transfer of information to those who can implement actions to improve the health and safety of children.

Return on Investment



*Membership fees only constitute a portion of total funding available for CChIPS

Synergy In Motion

Sponsoring industry members play an integral role in setting the research agenda for CChIPS. These members comprise the Center's Industry Advisory Board (IAB). Membership is open to all companies, organizations, or federal agencies that have an interest in advancing research and development to further child and adolescent injury prevention. The IAB selects a Chair and Secretary to serve for a two-year term. IAB meetings are held twice a year, in spring (to select the research portfolio for the upcoming year and hear results from projects funded in the previous year) and in the fall, to review progress and provide insights to the current year's research portfolio and to select ideas for proposal submissions for the subsequent year. A formal process of proposal submissions involving extensive discussions with designated IAB mentors immediately precedes the annual spring meeting. At that meeting, investigators present their research proposals to the full IAB and then, in a closed door meeting, the Board votes on the proposals, ranking them based on points allotted.

Besides helping to choose the research to be performed, IAB members provide valuable feedback on projects already underway, both as project mentors and in review of project progress and results, and provide guidance in strategic planning for the Center. "Participation in the IAB serves as such a valuable opportunity for the members to network and collaborate on research in a unique environment," says Ken Wittenauer, current IAB chair and vice president and general counsel of Britax Child Safety Inc. "The regular meetings encourage communication and dialogue among members of the child safety community that could not otherwise occur."

Every membership dollar goes toward research. The CHOP Research Institute, the University of Pennsylvania, The Ohio State University, and other research facilities involved in CChIPS projects waive overhead fees to make this vital work possible. IAB members also can rely on CChIPS' proven track record in successful research partnerships with industry and government. In addition to regular interactions with virtually all automotive-related organizations concerned with child safety, the Center has conducted specific research projects with major original equipment manufacturers, restraint suppliers, insurance providers, and government agencies.

2010-2011 IAB Member Companies included:

- Britax Child Safety Inc.
- Dorel Juvenile Group
- Evenflo Company Inc.
- General Motors Holdings LLC
- Honda R&D Americas Inc.
- The National Highway Traffic Safety Administration
- Nissan Technical Center North America Inc.
- Realtime Technologies Inc.
- State Farm Insurance Companies
- TK Holdings Inc.
- Toyota Motor North America Inc.
- Volkswagen Group of America Inc.

CChIPS In The News

CChIPS has captured a significant amount of media attention and coverage over the past year for several contributions to the field of pediatric injury prevention. Due to the promotion of research papers by the Center's Outreach team, CChIPS' media presence continues to grow. A study published in the December 2011 issue of *Pediatrics* found that children are half as likely to be injured in a crash when driven by their grandparents versus their parents. The study findings appeared in several consumer outlets, including the *New York Times*, *TIME* Magazine, National Public Radio, WebMD, and MSNBC.

This year, the National Science Foundation (NSF) selected CChIPS to be highlighted in its "Behind the Scenes, Behind the Science" video series. CChIPS directors and students, along with Industry members, traveled to NSF headquarters in Arlington, VA, to film a panel discussion highlighting the value of the Center in front of a live audience. The conversation centered on the strong collaboration between academia and industry, as well as the importance of training future injury research scientists.

Preparing Future Injury Scientists

Training students is an important part of the CChIPS mission. We are committed to creating a diverse, internationally competitive, and globally engaged science and engineering work force with a focus on injury prevention. Our talented investigators and IAB members and rigorous, meaningful research projects allow us to attract a diverse pool of talented students. These students also bring fresh ideas and energy to our studies. All of the projects, described on pages 3 to 6 of this report, involved student participation. Many were part of our inaugural Research Experiences for Undergraduates Summer Program. To date, over 50 students have played key roles in CChIPS research projects.

Each spring OSU hosts the Injury Biomechanics Symposium, in which students from universities around the world are invited to present their research projects. Several CChIPS students have participated in this symposium, which provides a unique atmosphere for professional communication between developing and established researchers.

REU students spend the day at CChIPS testing facilities at Rowan University, Glassboro, NJ

Safe and Sound

Center for Child Injury Prevention Studies

The Center for Child Injury Prevention Studies (CChIPS) would like to thank the Industry Advisory Board (IAB) members, our member companies, and the National Science Foundation (NSF) for their generous support and insight.

Our vital work would also not be possible without the generosity of our academic collaborators. These research institutions not only waive their overhead fees, but also provide CChIPS with forward-thinking scientists committed to making the world a safer place for children and adolescents. Many thanks to The University of Pennsylvania, The University of Alabama, and The University of Florida.

Also, thanks to The Children's Hospital of Philadelphia Research Institute and Research Communications for designing this report.

The Children's Hospital *of* Philadelphia®
RESEARCH INSTITUTE

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