The Children's Hospital of Philadelphia® RESEARCH INSTITUTE



CChIPS | Center for Child Injury Prevention Studies

Gelebrating 10 Years of Discovery Annovation! Driving Industry and Academia Forward



Since 2005, the Center for Child Injury Prevention Studies (CChIPS), a National Science Foundation Industry/University Cooperative Research Center (I/UCRC), has been a hub of innovation and collaboration for industry members and academic researchers committed to improving the safety of children and adolescents. Located at The Children's Hospital of Philadelphia and The Ohio State University, CChIPS' mission – to advance the safety of children, youth, and young adults by facilitating scientific inquiry into childhood and young adult injuries and translating these findings into commercial applications and educational programs for preventing future injuries – dovetails with the Center's Research-to-Action-to-Impact model. Discover how CChIPS has advanced the science around child injury prevention as we look back on 10 years of moving the needle in child injury prevention research and advocacy, and look forward to the future.

Who's Who in CChIPS?

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• The Children's Hospital of Philadelphia (CHOP)

CHOP was established in 2005 as the original academic site of CChIPS. CHOP is one of the country's leading pediatric hospitals and is a worldclass research institution. CChIPS at CHOP runs administratively under the auspices of the Center for Injury Research and Prevention (CIRP), a Center of Emphasis at CHOP Research Institute.

The Ohio State University (OSU) •

The Injury Biomechanics Research Center at OSU was added as a second research site in 2010. The Center, comprised of the Injury Biomechanics Research Lab and Skeletal Biology Research Lab, brings to CChIPS an interdisciplinary team of engineers, anatomists, physicians, computer modelers and technicians with expertise on mechanisms of injury and injury thresholds of the human body.

National Science Foundation (NSF)

The NSF, created by the US Congress in 1950, is the only federal agency whose mission includes support for all fields of fundamental science and engineering. CChIPS was founded by an NSF grant as the only I/UCRC dedicated to injury prevention, among the nearly 80 in the country. The NSF provides annual funds for the Center's administrative costs as well as programmatic oversight.

Industry Advisory Board (IAB)

Comprised of industry, nonprofit, and government members, the IAB funds research, establishes investigative priorities, and advises on strategic direction. IAB members meet twice annually to review the research portfolio and vote on new projects, and volunteer to serve as mentors to the research investigators, providing guidance and critical insight throughout the life of each project.

CChIPS is entering its next five-year phase of 15 years of NSF support.







Current and Former IAB Members



































Current IAB Members

A Decade of Child Injury Research

Since 2005, CChIPS has conducted over 106 research projects. The following are a sampling of the innovation that could only be fostered by CChIPS.

Data Linkage: Catalyzing Advancements in Teen Driver Safety

While much of CChIPS fundamental research has focused on how children's bodies respond to a crash and technological solutions for injury prevention, there is a growing body of Center research on human behavior related to driving and safety technology and the evaluation of safety-oriented interventions. In particular, CChIPS investigators are exploring innovative ways to analyze traffic safety data to more effectively understand driver behavior and make tailored recommendations for training and policy change.



While state- and nationallevel crash report data are invaluable to the traffic safety community, these data in isolation prohibit traffic safety researchers from placing a teen driver's crash event in the context of previous or future experiences and events. In the New Jersey Traffic Safety Outcome Program, led by CHOP's

Dr. Allison Curry, crash, citation and licensing data were linked for all NJ drivers, generating a more complete assessment of teen drivers' relevant history and experiences on the road. These linked data led to a first of its kind analysis of NJ's Kyleigh's Law, which requires youth 16 to 20 years holding a learner's permit or intermediate license to display a decal on the license plates of their vehicle.

That project led to further questions about how certain medical conditions influence a young person's licensing and driving behavior. To explore this novel research area, CChIPS provided support to link the NJ traffic data to the electronic health records for over 113,000 NJ teens and young adults who were seen in the CHOP healthcare network. This study represented a methodological advancement in the field of young driver research that will inform the development of licensing and learn-to-drive efforts that are tailored to specific medical conditions.

What is next for this line of research? The study's principal investigator has gone on to garner substantial grant funding from the National Institutes of Health (NIH) to continue analyzing this linked data, focusing on attention deficit hyperactivity disorder and driving. The team also completed a CHOP-funded pilot study which uses the linked data to examine autism and driving, which in turn led to another NIH grant submission. CChIPS' seed funding supported fundamental work in the realm of traffic safety, and these deepening ties will continue to pave new ways for continued work in improving the safety of children and youth on the roadways.



Human Volunteer Testing

Automobile safety engineers use anthropomorphic test devices (ATDs), or crash test dummies, to test the effects of crashes on the human body. Historically, ATDs were designed based on adult data and scaled down to represent a child size. But, children are not simply "small adults." Since its inception, CChIPS has been committed to improving pediatric ATDs. To be an effective tool, pediatric ATDs must accurately mimic how child occupants move and respond to the forces of a vehicle crash. The research being conducted through CChIPS is delivering the fundamental data needed to improve specific body regions of the pediatric ATDs and to develop innovative restraint products to make vehicles safer for children in the future.

In 2006, CHOP/CChIPS researchers, led by Dr. Kristy Arbogast, collaborated with founding CChIPS IAB member TK Holdings Inc. (Takata Corp.), Rowan University, and University of Virginia researchers to develop a low-speed human volunteer sled to test pediatric subjects. Since this could not be performed at real crash speeds for safety reasons, the team designed a crash sled to mimic the crash experienced by children and adults when they ride an amusement park bumper car; it is the first and only effort to test pediatric subjects in this manner and has allowed CChIPS to collect the only known data on the kinematics and kinetics of restrained 6- to 14-year-old pediatric human volunteers in low speed impacts. This data set represents a valuable and unique source for comparison of human and ATD response.

Capable of delivering up to 4 g's of acceleration to volunteers from six years of age through adult, the sled buck can be rotated to allow for frontal, near-side, far-side, and rear impact tests. Data are collected using motion capture technology that tracks movement from external markers on volunteers or ATDs. To date, the crash sled has been used in several CChIPS studies, allowing researchers to compare child and adult volunteers' heads, necks, and spines during a bumper car's safe crash, as well as the same body regions on pediatric ATDs. By identifying key kinematic differences across ages and between humans and ATDs, priorities for design improvement to the ATDs have been identified.

Giving the Podium to Student Researchers

The second CChIPS research site was established in 2010 at The Ohio State University (OSU), under the leadership of John Bolte, PhD, Director of the Injury Biomechanics Research Center. OSU has been an asset to CChIPS and has broadened its reach – in terms of faculty expertise, student mentoring, facility capabilities, and geographic range. One of its distinctive offerings is the Injury Biomechanics Symposium (IBS), which was established in 2004 to specifically meet the needs of students pursuing a career in injury biomechanics.



The aim of the IBS is to provide student researchers with a welcoming, non-threatening platform to present their research and have meaningful conversations with experts in the field and industry partners. After a competitive review of submitted abstracts, graduate and undergraduate students from around the world are invited to present their ongoing research in the field of injury biomechanics. Topics have included bone properties, head and brain injury, thorax and pelvis modeling, dummy and model biofidelity analyses, extremity injury, and child safety. The IBS offers other opportunities to discuss ideas and receive helpful feedback such as networking sessions among students, researchers, and industry members -- a key feature of the annual event. After its first ten years, attendance at the IBS grew nearly three-fold, from 50 attendees in 2004 to over 130 in 2015. In that period it gave nearly \$150,000 in student stipends and hosted 230 student presenters from 45 universities across 8 countries. The IBS is a rare platform geared specifically for students pursuing a career in injury biomechanics to present work, receive vital critique and create ongoing mentoring relationships that could improve their research and set them on a fruitful and realistic career path into the future. Past student participants in IBS have gone on to become physicians, professors, research engineers, and scientists, all focused on reducing injuries and saving lives.

A Risk-free Environment to Observe Teen Drivers

Five times more deadly than cancer, motor vehicle crashes remain the number one cause of death for teens ages 15 to 19. At CChIPS, we're going beyond analyzing data collected after teen crashes occur. The purchase of an advanced driving simulator from IAB member company Realtime Technologies Inc. in 2010 opened new doors for CChIPS to study and better understand the circumstances that cause teens to crash, and inform product design, advocacy efforts, and training for teen drivers—with the hope that one day we can prevent the crash altogether.



The driving simulator provides an unparalleled opportunity to systematically evaluate realistic behavior of drivers in a safe environment. Several lines of CChIPS research, led by CHOP's Dr. Yi-Ching Lee, have utilized the simulator to observe the impact of distractions such as peer passengers and technology – both integrated into the vehicle and external, such as cell phones –on the behavior of young drivers. One early study examined how young novice drivers (16- to 20-year-olds who had their license for six months or less) handled typical stressful traffic events. For example, participants drove a simulated route that included events such as a motorcycle running a red light or a car backing out of a driveway, while being concurrently distracted; they were asked to quickly provide a verbal answer to math questions that appeared on the simulator screen while driving the route. A subsequent study included two teens in the simulator, one as the driver and one as a passenger, having to work together to navigate to different locations.

An emerging line of teen driving simulator research being pioneered at CChIPS utilizes machine learning models, where state-of-the-art experimental and analytical techniques are used to create accurate models of teenage drivers' behavior. The research is exploring how these models can be used to predict the future behavior of a driver. As vehicles are becoming increasingly autonomous with blind spot detection and parking assistance, machine learning techniques could similarly be utilized as invehicle technology to detect potentially dangerous situations before they actually occur and provide crucial assistance to the driver when they need it. Although this research is geared toward the young driver population, it ultimately can be used beyond teens to assist other vulnerable driving populations such as the elderly or drivers with ADHD or other medical conditions.



Partners for Child Passenger Safety

In 1997, The Children's Hospital of Philadelphia (CHOP), the University of Pennsylvania, and CChIPS founding IAB member company State Farm Mutual Automobile Insurance Company joined forces to create Partners for Child Passenger Safety (PCPS), a unique industry/academic research partnership with the goal of providing the nation's only large-scale child-focused crash surveillance data system. When data collection was completed at the end of 2007, more than 875,000 children involved in 600,000 crashes reported to State Farm were enrolled in the study. Led by CHOP's Drs. Flaura Winston and Dennis Durbin, for more than a decade, findings from PCPS research informed new product development, test protocols and federal motor vehicle safety standards, public education and curricula, policy, and medical practice to improve child restraint use and advance the safety of children in motor vehicle crashes.

Thanks to educational and legislative interventions brought about by PCPS research coupled with outreach efforts by child passenger safetyfocused organizations targeting families and caregivers, child restraint use (including booster seats) among 4- to 8-year-olds increased from 15 percent to 63 percent between 1999 and 2007. Child restraint use for all children through age 8 rose from 51 percent in 1999 to 78 percent in 2007. Through research, advocacy/outreach, and policy impact, PCPS research has set the global standard in child occupant protection knowledge.

Data on real world crashes like that from PCPS are critical to understanding how vehicles and child restraints provide protection on the road – outside the design laboratory. CChIPS researchers have used PCPS data and other crash investigation databases – most notably CIREN and NASS which are maintained by IAB member NHTSA, in numerous projects to

study real world injury risks and mechanisms of injury. These have spanned topics from extending rear-facing recommendations in motor vehicles to children over age one (which helped to lay the foundation for revised child passenger safety best practice recommendations from the American Academy of Pediatrics in 2011), to quantifying characteristics of seat and seat belt geometry that may lead to abdominal injury in seat belt-restrained child occupants, to identifying injury causation scenarios for restrained children involved in side-impact motor vehicle crashes. Delineation of how injuries occur in crashes provides valuable data to the CChIPS members by identifying aspects of their products in need of targeted design and improvement as well as opportunities for regulatory enhancement, new laws and public education messaging.

Fostering Collaboration

North America

- Drexel University (Philadelphia, PA, USA)
- Insurance Institute for Highway Safety (Ruckersville, VA, USA)
- Medical College of Wisconsin (Milwaukee, WI, USA)
- The Ohio State University (Columbus, OH, USA)
- Rowan University (Glassboro, NJ, USA)
- Transport Canada (Ottawa, Ontario, Canada)
- University of Alabama Birmingham (Birmingham, AL, USA)
- University of Iowa (Iowa City, IA, USA)
- University of Florida (Gainesville, FL, USA)
- University of Massachusetts (Amherst, MA, USA)
- University of Michigan (Ann Arbor, MI, USA)
- University of Pennsylvania (Philadelphia, PA, USA)
- Virginia Polytechnic Institute and State University (Virginia Tech) (Blacksburg, VA, USA)
- Wake Forest University (Winston-Salem, NC, USA)
- Wayne State University (Detroit, MI, USA)
- Wichita State University (Wichita, KS, USA)

Europe

 Chalmers University of Technology/ SAFER (Göteborg, Sweden)

Middle East

• Bar-Ilan University (Ramat Gan, Israel)

Asia

 Beijing Centers for Disease Control (CDC)

Australia

• Monash University (Melbourne, Victoria, Australia)

We still have work to do!

Should child injury advancements be achieved via new regulations, laws, or public education? What tools – physical or computational – are needed to advance the field, and how do we make sure advances are put into use?

How can we prevent injuries and crashes related to distracted driving? As vehicles and child restraints become more technologically sophisticated, how can their safety be improved? How will automated vehicles affect driver behavior and common injuries sustained in motor vehicle crashes?



Industry Perspective

66 People that aren't in the industry just see that the child goes in the child seat which goes in the car, and you hope they're safer if there's a crash. But at CChIPS, we are identifying all those pieces. The child seat has to be designed correctly. You need a decent dummy to be able to design it... All the research that has been done over ten years has chipped away at those individual pieces... And then over ten years, you move the bar. 99

One great project is Ethe digitization of 1 car seats. Not only would it have been very difficult for the auto and car seat manufacturers to do without CChIPS, the researchers would not have thought of doing it without the influence of the companies. So it worked from both directions; you've responded to the needs of the industry, which you wouldn't necessarily have done if it wasn't for this group. 99

Being involved in the IAB has had multiple benefits for our company. Not just from the value of the research that we've brought back to our company and how that's changed our products, but also, being involved in the IAB has helped us generate other ideas and forge partnerships with other car manufacturers and child restraint manufacturers so that ultimately, we can put together a better product and a safer product for kids.

> 66 I want people to be alive after a crash because of what we did. 99

The scientists are able to evolve with an evolving industry instead of just being focused academically on a scientific problem. Because they collaborate with manufacturers who face real-life consequences of technology — because of that relationship, their research is forever relevant. 99

PREPARING the Next Generation of Scientists

Training students is central to the CChIPS mission and its commitment to creating a diverse, internationally competitive, and globally engaged science and engineering workforce with a focus on injury prevention. Every CChIPS research project includes at least one student, who receives valuable mentorship and brings fresh ideas and energy to the work. To date, 94 students have played key roles in CChIPS research projects.

Be Part of a Safer Future We Need You!

Additional partnerships are needed to successfully and efficiently reduce the burden of child injury. CChIPS looks to broaden its membership by adding new companies and other organizations vested in child safety and seeks to expand its scientific collaboration by linking with new academic partners. If your organization is interested in being part of this exciting movement to address a significant societal problem, please contact us at cchips@email.chop.edu.

Visit our website at **cchips.research.chop.edu** to learn about CChIPS' entire portfolio of research, spanning 10 years and over 100 projects.

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