LONG WAY FROM MY DISSERTATION BUT STILL AN ENGINEER AT HEART

1989

Lesson:
Follow your passion
Value your strengths

2019

The Modulation of Intracellular Free Calcium Concentration by Biaxial Extensional Strains of Bovine Pulmonary Artery Endothelial Cells
Flaura Koplin Winston
A DISSERTATION in Bioengineering
FINANCIAL DISCLOSURES

• I am the Chief Scientific Advisor and co-Founder of the CHOP spin-out, Diagnostic Driving, Inc.

• My work has been funded by a variety of sources: NIH, NSF, PA Department of Transportation, PA Department of Health, State Farm Insurance Companies, and a consortium of industry/government/non-profit sponsors.
“ACADEMIC DISCLOSURES”
TRUTH ABOUT SUCCESS

• I cannot take sole credit for anything.
  o I worked with many people - thank you!
• I had many failures along the way to success.
  o Failures shaped me and I embrace them.
• I did not pursue one path for career.
  o Goal: Research → Action → Impact

I’ll approve it, but
why would someone study accidents?
– Chair of CHOP IRB ~1993
Dedicated to advancing the safety of children, youth and young adults through research and action.

Learn more: injury.research.chop.edu
GRATITUDE:
STANDING ON THE SHOULDERS OF GIANTS
LEARNING OBJECTIVES

Upon completion of this session, participants will be able to:

• Define primary, secondary and tertiary prevention objectives for Traffic Medicine.

• Define period of highest lifetime crash risk and important reasons behind these crashes.

• Define “innovation” and gain familiarity with the concept of the “Valley of Death” for innovation and how it can become a “Challenge Basin”.

PROBLEM:
YOUTH ARE DYING PREVENTABLE DEATHS

Causes of Death
Ages 1-19 Years
2016

Disease
Injury

FIREARM
CRASH
OTHER INJURY

CHILD & ADOLESCENT SAFETY: COMPLEX

Individual
- Physical
- Cognitive
- Biomechanical
- Emotional
- Social

Social
- Family
- Peers
- Community
- Society
- Advocacy

Technology/Environment
- Crash avoidance
- Crashworthiness
- Occupant protection
- Road
- Connected Cars/ Bikes

Medical
- Emergency Medical Services
- Acute Care
- Rehabilitation
PROBLEM STATEMENT:
Injury is the leading cause of child death yet the scientific foundation is insufficient. My work aims to reduce the burden of injury through research and action.
3 AIMS OF TRAFFIC MEDICINE: PRIMARY, SECONDARY, TERTIARY PREVENTION

1. Prevent the crash

2. Given a crash, prevent crash injury

3. Given a crash injury, resuscitate, rehabilitate, & optimize recovery
OVERARCHING STRATEGY:
FOCUS ON IMPACT
OVERARCHING STRATEGY:
PLAN BACKWARDS

Inputs  Actions  Process Outputs  Short-term Objective  Medium-term Objective  Long-term Objective IMPACT
OVERARCHING STRATEGY: MEASURE & LEARN
DECIDE: CONTINUE, PIVOT OR END
APPROACH: RESEARCH
A CYCLE RATHER THAN A STRAIGHT PATH
APPROACH: SOLUTIONS
SMALLER DESIGN CYCLES
FIRST FOCUS: CRASH INJURY

1. Prevent the crash

2. Given a crash, prevent crash injury

3. Given a crash injury, resuscitate, rehabilitate, & optimize recovery
CHILD DEATH FROM AIRBAGS
SENTINEL CASE: JULY 1995

Infant fatality
• 20-day old in rear-facing infant seat
• Survivable crash
  o Rear-facing child safety seats – highly effective
  o Collision at 23 mph
  o Driver survived

Take-away:
Investigate when mechanism and expected outcome do not match clinical presentation.
CRISIS: NO SCIENTIFIC FOUNDATION
NEED: CHILD-FOCUSED CRASH SURVEILLANCE
(WITH DURBIN, ARBOGAST AND OTHERS)

• Created child-focused crash surveillance system
  o Partner: large insurer
  o Case finding & consent

• 10 years, 750,000 children in crashes
  o Telephone interviews
  o Crash investigations
MORE PARTNERSHIPS TO ADVANCE SAFETY
NSF INDUSTRY/UNIVERSITY CENTER (CCHIPS)

Faculty, students

Govt, Manufacturers, NGOs

Safer, healthier children & families

[Logos of Children's Hospital of Philadelphia, Penn, Ohio State University]
QUANTIFIED RISKS, EVALUATED TECHNOLOGY

Air bags
Arbogast et al. JAMA Peds 159(4): 342-6, 2005

Booster seats
KEY FINDINGS

• Safety technology designed for adults can kill children.
• Children were not in correct restraint for age/weight.
• But.. prioritize safety messages. (Misused > NOT used)
  1. Restrain on every trip, every time.
  2. Use correct restraint for age and weight.
  3. Seat in the rear.
  4. Use restraints correctly.
• Safety messages evolve with science/tech advances.
  o Newer air bags are less dangerous.
  o RF to age 2; FF past age 4; Booster past age 8
ADVICE FROM BEN:
“Never confuse motion with action.”

Publication was the start, not the end of action.
**ACTION**

Informed Safety Products & Regulations

**Created Educational Resources**

**Advocated for Evidence-based Laws**

**Provided Recommendations**

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**American Academy of Pediatrics**

**Children's Hospital of Philadelphia**

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RESOURCE

Car Seat Safety for Kids

chop.edu/centers-programs/car-seat-safety-kids
IMPACT:
OUR RESEARCH INFORMED

• 2 fed laws, 48 state laws, products, regulations, programs
• >10,000 lives saved since 1997
IMPACT: UPGRADED LAWS

Age Required to be in a Child Restraint
IMPACT: CRASH FATALITY
>50% REDUCTION IN DEATHS TO CHILDREN < 16

Deaths

NHTSA FARS


Children's Hospital of Philadelphia
WHAT WE LEARNED

• Partnerships may be essential.
  o Insurance Claims (field data collection)
  o Public Relations (influence/reach)

• There are limits to what we can do as academics.
  o Stakeholders improve products. (vehicles, CRS).
  o Stakeholders pass laws and regulations.

• Be aware of the unexpected.
  o Sometimes our hypotheses are wrong.
  o Early air bags killed children.

• Strong data are not enough.
  o Prepare messaging and tools for stakeholders.
FEWER DEATHS, BUT STILL SERIOUS INJURY

For every 1 child that dies there are...

25 hospitalizations

925 treated in ER

Many more treated in doctors’ offices

In 2005, injuries that resulted in death, hospitalization or an ER visit cost nearly $11.5 billion in medical expenses.

Sources: Web-based Injury Statistics Query and Reporting System (WISQARS), CDC, 2009.
National Health Interview Survey, 2009 data release, CDC, National Center for Health Statistics.
PIVOT: ADDED SECOND FOCUS – RECOVERY
(WITH KASSAM-ADAMS, MARSAC, AND OTHERS)

1. Prevent the crash

2. Given a crash, prevent crash injury

3. Given a crash injury, resuscitate, rehabilitate, & optimize recovery
INJURY AND TRAUMATIC STRESS
6 MONTHS AFTER CHILD INJURY
15%: TRAUMATIC STRESS REACTIONS & IMPAIRMENT

1 in 6 injured children

1 in 6 parents

KEY FINDINGS

• Need to look beyond the physical injury.
  o Injury severity did not predict traumatic stress reactions.
  o Reactions related to perception of life threat.

• Need to support parents.
  o Parents: primary support for children during recovery.
  o Child reactions tied to parent reactions.

• Parents inaccurate in reporting child symptoms.
  o Need child self-report to get accurate reporting.
ACTION: ENHANCED CARE OF INJURED CHILD

Developed & implemented screening, interventions

RESOURCES

FOR PARENTS: AFTERTHEINJURY.ORG
FOR PROVIDERS: HEALTHCARE TOOLBOX.ORG
COPING COACH

- RCT
- 72 children
  - 36 CC/36 control
  - Feasible to deliver
  - Engaging for kids
  - ↓ traumatic stress

(Kassam-Adams et al., 2016)
STTR-E-SCREEN

- **eScreen**
  - Partnered with Radiant Creative, LLC
  - Awarded STTR
  - Evolving Coping Coach to become a “sticky” child-reported symptom screening collection system
IMPACT: OUR RESEARCH INFORMED

• Trauma-informed care for injured youth
  o Even those with minor physical injuries need support.

• Recognition of psychosocial needs in recovery
  o Both injured child & their parents need support.
WHAT WE LEARNED:
STAKEHOLDERS NEEDED, DESPITE HOME INSTITUTION

• Clinical care change is disruptive.
  o For adoption, need internal stakeholders, tools and processes.

• Research and clinical/operations can be siloed.
  o Adoption after evidence is difficult.

• Always think about the end-game.
  o How will the research be implemented and sustained?

• Continue to measure and learn.
  o Initial screener results did not replicate well.
  o Refined screener/tools and continue to develop better tools.
DESpite success, too many deaths/injuries
ADOLESCENT DEATHS: CRASHES ACCOUNT FOR 1 IN 3

“Conrad sped up, but it was so dark, he didn't see the pothole. Next thing I knew, we were flying through the air. ...My heart is broken and shattered.”

– 17 year-old sole survivor, only occupant using belt
ADDED THIRD FOCUS: PREVENT THE CRASH
(WITH DURBIN, CURRY, MCDONALD, AND OTHERS)

1. Prevent the **crash**

2. Given crash, prevent crash **injury**

3. **Resuscitate** and ensure recovery & rehabilitation
BACKGROUND

Learner
Acquiring skills

Independent Driver
Inexperienced with skill deficits

Children's Hospital of Philadelphia
HIGHEST LIFETIME CRASH RATE
MONTHS AFTER LICENSURE

Crash rates /10k NJ young drivers licensed, 2006-09

Months Since Licensure

Curry, 2015
CRASHES ARE NOT ACCIDENTS
HOW TO AVOID A CRASH

*Pay Attention
*Scan
  • Far ahead
  • To the sides
  • In the rear
*Anticipate Hazards

*Recognize & *Predict Hazards

*Decide to act
*Choose action
*Execute

SCAN | DETECT | REACT
TEEN DRIVER CRASHES: POOR SKILL, INEXPERIENCE
RESEARCH WITH DURBIN, CURRY, MCDONALD, OTHERS

95% of teen crashes due to driver ERROR

Most Common Critical Errors “Big 3”:

21% Scanning/hazard detection

21% Too fast for conditions

19% Distraction

Source: Curry, Hafetz, Kallan, Winston, Durbin Dennis. AAP 2011.
KEY FINDINGS

• Yes, peers matter, but so do parents.
  o If teen saw parent as supportive but having clear rules, 
    $\frac{1}{2}$ risk of: crash, speeding, more.

• Novice teen crashes are not due to “invincibility”.
  o Crucial to improve poor skills, inadequate experience.

• License ≠ adequate skill and experience
  o Need to focus on the “peri-license” period.
  o NEED better way to assess preparedness for safe driving.
**ACTION**

- Developed and evaluated resources for parents
  - Improve driving practice.
  - Improve monitoring after license.
- Advocated for upgraded licensing laws
- Spread messages through campaigns
  - Parents are important for safe teen driving.
  - Early licensure period is critical.
  - Quantity & variety of practice is needed.
  - Scanning and speed management are key skill deficits to address with novice drivers.
IMPACT: OUR RESEARCH INFORMED

- Advances in teen driver safety
  - Laws and National Teen Driver Safety Week
  - Increased role of parents in teen driver safety

RESOURCES

FOR PRACTICE DRIVING:
Teen Driving Plan

FOR PARENTS:
teendriversource.org

Simulator:
Free assessments (time permitting)
CRITICAL NEED: ASSESS PREPAREDNESS
FOCUS ON TIME OF LICENSURE

Learner

Time Zero
Independent driving

Independent Driver

Children’s Hospital of Philadelphia™
KEY ROLE FOR ASSESSMENT

• Asthma

Spirometry
KEY ROLE FOR ASSESSMENT

• Cardiovascular Disease
KEY ROLE FOR ASSESSMENT

• Driving
CREATED A SIMULATED DRIVING ASSESSMENT

• **Scenarios**: Serious potential crash scenarios
  • from National Motor Vehicle Crash Causation Survey

• **Metrics**: Safety metrics
  • From literature and expert consultation

• **Validated**: Can distinguish drivers
  • Skilled/less skilled
  • Experienced/inexperienced
  • Police-reported crash history
DEVELOPMENT OF SIMULATED SCENARIOS

• Analysis of NHTSA data (NMVCCS) s:
  • 676 teen driver crashes

• Top 4 crash scenarios

<table>
<thead>
<tr>
<th>Crash Type</th>
<th>Weighted %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turn into opposite directions (turning left)</td>
<td>11.9%</td>
</tr>
<tr>
<td>Right roadside departure</td>
<td>10.3%</td>
</tr>
<tr>
<td>Rear-end collision</td>
<td>9.6%</td>
</tr>
<tr>
<td>Left roadside departure</td>
<td>9.6%</td>
</tr>
</tbody>
</table>
NMVCCS EXAMPLE: LEFT TURN ACROSS PATH

Exemplar scenario 1: Left turn at t-intersection with no obstruction
Note: Recreated in Visio from scenario drawing from http://wwwnass.nhtsa.dot.gov/nmvccs_pub/SearchForm.aspx for Case ID 2007005289982
BUT CRITICAL NEED: ASSESS PREPAREDNESS
DEVELOPED SIMULATED DRIVING ASSESSMENT
(WITH MCDONALD & OTHERS)

Standardized & Validated

• Differentiated young novice drivers from experienced adults.
• Correctly classified 87.5% adult driver history of police-reported crashes.
• Identified users with high simulated crash risk.
• Detected specific errors in skills associated with crashes.

McDonald, Winston et al. Injury Prevention 2015
VALIDATED VIRTUAL DRIVING TEST
HOW DO WE HAVE IMPACT?

Simulated Driving Assessment (SDA) for teen drivers: results from a validation study.
McDonald CC1, Kandall H2, Leeb H2, Sepehati TS2, Lee YC2, Winston Z2, Winston FK3.

Abstract
BACKGROUND: Driver error and inadequate skill are common critical reasons for novice teen driver crashes, yet few validate assessments of teen driving skills exist. The purpose of this study is to evaluate the construct and criterion validity of a newly developed

Comparison of teen and adult driver crash scenarios in a nationally representative sample of serious crashes.
McDonald CC1, Durry AE2, Kandall H2, Sonnemos MS2, Winston FK3.

Abstract
Motor vehicle crashes are the leading cause of death and acquired disability during the first four decades of life. While teen drivers have the highest crash risk, few studies examine the similarities and differences in teen and adult driver crashes. We aimed to: (1) identify and compare the most frequent crash scenarios-integrated information on a vehicle’s movement prior to crash, immediate pre-crash event, and

Children's Hospital of Philadelphia
PATHS FROM DISCOVERY TO TRUE IMPACT

New Program

New Policy

Standalone Company

Licenseable Asset

New Care Model
SIMULATED DRIVING ASSESSMENT

Breakthrough in research

BUT

• NOT ready for **impact**.
• Needed further **innovation**.
• Needed **ability to deliver at scale**.
BREAKTHROUGH VERSUS INNOVATION?
INNOVATION: IN A NEW WAY

innovate (v.)
1540s, "introduce as new" (latin: innovatus)

New concepts and knowledge
converted to
New products, services, or processes
which deliver
New end user value

Source: https://www.etymonline.com/word/innovate
WHAT IS A TRUE OPPORTUNITY FOR IMPACT?
DELIVERING INNOVATION, NEW VALUE
BREAKTHROUGH, NEED, NO DELIVERY

PRODUCT/SERVICE THAT CAN’T BE DELIVERED
BREAKTHROUGH, DELIVERY, NO NEED

PRODUCT/SERVICE NO ONE WANTS
ABILITY, NEED, NO BREAKTHROUGH

UNFOCUSED PRODUCT/SERVICE
NEED: MAKE TEST PORTABLE & DELIVER IT
PIVOT: FOCUS ON PRODUCT & PARTNERS
(WITH KANDADAI & OTHERS)

CHOP Research + CHOP Investment =
Portable Virtual Driving Test Spin-out Company

Protected time
Product development
Evaluation
Grow team
PARTNER: OHIO HAD THE NEED AND THE ABILITY TO DELIVER

OHIO NEED (RFA): Virtual Driving Test to enhance licensing exam

OHIO ABILITY: Network of licensing centers
VDT AND OHIO

BREAKTHROUGH + NEED + DELIVERY = OPPORTUNITY TO REDUCE CRASHES
Driver's Ed + 50 hours

< 18 y.o.

Written test

VDT Integration

Road exam

18 y.o. and older

Nothing

New step

New step

RESEARCH INTEGRATED INTO WORKFLOW
BUT THE RESEARCH ISN’T DONE
TEEN DRIVER OUTCOME: OBVIOUS? NO!
GAP: CAUSES OF CRASH RISK
PIVOT: VDT AS PROBE - NEUROSCIENCE
(NEUROSCIENCE WITH ROMER, ROBERTS, WALSHE, GAETZ)
THEORETICAL FOUNDATION

Winston-Romer Trait-State Model

Traits (experiential)
- Knowledge
- Driving exposure
- Environment

Traits (biological)
- Brain Development
- Impulsivity +ADHD

States – Stable
- Biological
  - Comorbidities
- Physiological
  - Sleep, DUI
  - Med adherence
- Social/emotional

States - Transient
- Peer passengers
- Electronics
- Mind-wandering
- External conditions

Recklessness
Baseline inattention

Poor situation awareness & response

Task Inattention Impairment

Driver Error

CONVERGENCE NEUROSCIENCE OF DRIVING ENABLED BY THE VDT

• POPULATION LEVEL DATA
  - VDT in licensing workflow
  - Licensing/crash outcomes

• CLINIC LEVEL DATA
  - VDT in clinical workflow
  - Medical and testing data

• NEUROSCIENCE RESEARCH DATA
  - VDT used in research studies
BEYOND INJURY
MANY DISCOVERIES, NEED MORE IMPACT

PIVOT: CHOP INNOVATION ECOSYSTEM
(WITH WOLF, AGOSTO, ROBERTS, FERRO, CHINWALLA, MCCABE,
SULLIVAN, SZE, BRADSHAW, HILL, OPPENHEIMER, ROSENBERG, AND MANY MORE)

- NIH/NICHD FY17 budget: $1,316,607,000
- >13,000 Pediatric articles in 2016
  Google Scholar search (pediatric, child, adolescent, teen)
- Not enough impact
CHALLENGE: CROSSING THE “VALLEY OF DEATH”

Decision space between opportunity recognition and impact

Existing commercialization and operation resources

Existing Research Resources

Resources
CHOP INNOVATION ECOSYSTEM
VISION STATEMENT

We aim to create a connected innovation ecosystem that recognizes the full value & experience of people & teams, and places everyone at CHOP within one degree of separation from a resource who can guide them from breakthrough to impact and help their ideas succeed.
CONVERT VALLEY OF DEATH → CHALLENGE BASIN

Resources

Existing Research Resources

Existing commercialization and operation resources

Decision space between opportunity and impact

Pathways

Capacity

Connections

Culture

OPPORTUNITY

IMPACT

Children's Hospital of Philadelphia
CONNECTIONS:
NEED TO REVEAL AND SUPPORT INFORMAL NETWORK

Hierarchical organization structure

- Management
- Accountability
- Consistency
- Safety

Informal network

- Interconnected
- Creativity
- Innovation
- New value
- Resilient
CAPACITY:
PROVIDE JUST-IN-TIME TRAINING/CONSULTING DELIVERED AT SCALE
CULTURE:
LEARN FROM AND SHARE FAILURES (AND SUCCESSES)
INNOVATE WHILE DELIVERING CONSISTENCY
SOLUTION FOR (RATHER THAN CONTRIBUTING TO) BURNOUT

“The temptation to lead as a chess master, controlling each move of the organization, must give way to an approach as a gardener, enabling rather than directing.”
- Gen. Stan McChrystal
FORMALIZING INNOVATION PATHWAYS
KEY TAKEAWAY: DON’T BE AFRAID TO PIVOT

BUT FOR IMPACT:
PARTNER TO EFFECT CHANGE.