Road Traffic Crashes, Injuries and Public Health

Dinesh Mohan
Transportation Research and Injury Prevention Programme
Indian Institute of Technology
Delhi
“Action in the absence of knowledge can be dangerous and worse than no action at all”

M. K. Gandhi
Ideology

- William J. Haddon, Jr. and others (1960s …..)
  - “accident” vs “injury control”
  - “accident prevention” too limiting
  - “injury” a disease > public health approach

- Charles Perrow (1980s…)
  “...what is attributed to operator error stems primarily from the structure they operate in, and thus, stems from the actions of elites”
Experience

- Policy makers in every country find it very difficult to institute changes which reduce road traffic injuries
- Individuals do not follow all the instructions given to them
- Propaganda and “education” not very successful
- HMC success in controlling RTCs - post 1970s
- No LMC particularly successful in controlling RTCs
- Theoretical base of RTC control in HMCs not widely understood or appreciated
ETHICS OF INJURY CONTROL

We have a societal and moral responsibility to design products, environment and laws so that people on their own find it easy and convenient to behave in a safe manner without sacrificing their needs to earn a living and fulfill their other societal obligations - safety is a fundamental human right.
Death Rates for Measles in Children Under Age 15, England and Wales, 1850-1970

Road traffic injury can be defined as a disease that results from an acute exposure of the human body to transfer of energy from the environment around it.

![Venn Diagram]

**VEHICLE**
- Vehicle type
- Speed
- Seat belts
- Size

**HUMAN**
- Age
- Sex
- Experience
- Alcohol

**ENVIRONMENT**
- Traffic
- Road design
- Enforcement

---

16 December, 2016
Comparative Epidemiology of Malaria and Skull Fracture (as sustained by an unhelmeted motorcyclist crashing into a tree)

<table>
<thead>
<tr>
<th>Pathological Condition</th>
<th>Host</th>
<th>Agent</th>
<th>Vector/Vehicle</th>
<th>Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaria</td>
<td>Man</td>
<td>Plasmodium sp.</td>
<td>Mosquito</td>
<td>Mosquito bite</td>
</tr>
<tr>
<td>Skull Fracture</td>
<td>Man</td>
<td>Mechanical energy</td>
<td>Motorcycle</td>
<td>Crash with tree</td>
</tr>
</tbody>
</table>
10 methods for limiting physical energy transfer

1. Prevent the development of energy form

2. Reduce the amount of energy

3. Prevent the energy release

4. Alter the rate of energy release from its source or its spatial distribution

5. Separate structures from the energy release by space or time
10 methods for limiting physical energy transfer

6. Place a barrier between the released energy and susceptible structures

7. Modifier surfaces that can be impacted

8. Strengthen structures susceptible to damage from energy transfer

9. Prevent the extension of existing damage

10. Carry out intermediate and long-term repair and rehabilitation
Traditional Crash Analysis

- Car approaches road junction and goes through red light which has just turned red.
- Hits motorcyclist, and then hits median.
- Motorcyclist gets thrown sideways, hits pedestrian walking on road.
- Car driver gets facial injuries, motorcyclist head injuries, and pedestrian leg fracture

Motorcycle Crash

**Cause**
- Rash and negligent driving by car driver
- Pedestrian walking on the road

**Solution**
- Driver, pedestrian education
- Strict punishment

16 December, 2016
<table>
<thead>
<tr>
<th>Time</th>
<th>Space</th>
<th>Human (Victim)</th>
<th>Products</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crash Prevention</td>
<td>Role of the human beings in preventing the event</td>
<td>Role of the product in preventing the event</td>
<td>Role of laws, policing, &amp; environment in preventing the event</td>
<td></td>
</tr>
<tr>
<td>Injury Prevention</td>
<td>Role, changes in victim in minimizing injury during crash</td>
<td>Design changes in product to minimize injury during crash</td>
<td>Changes in laws, policing, &amp; environment</td>
<td></td>
</tr>
<tr>
<td>during crash</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injury Management</td>
<td>Management of victim to minimize effect of injury</td>
<td>Design changes in product to minimize after effects</td>
<td>Societal and environmental arrangements</td>
<td></td>
</tr>
<tr>
<td>after crash</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Scientific Crash Analysis
Cell 1

Preventing the possibility of a crash: Human error based measures

- Training of drivers
- Pedestrians to walk facing traffic
- Bright clothing M/C

Reduced probability of Crash

Time
## Scientific Crash Analysis

<table>
<thead>
<tr>
<th>Time</th>
<th>Space</th>
<th>Human (Victim)</th>
<th>Products</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crash Prevention</td>
<td>Role of the human beings in preventing the event</td>
<td>Role of the product in preventing the event</td>
<td>Role of laws, policing, &amp; environment in preventing the event</td>
<td></td>
</tr>
<tr>
<td>Injury Prevention during crash</td>
<td>Role, changes in victim in minimizing injury during crash</td>
<td>Design changes in product to minimize injury during crash</td>
<td>Changes in laws, policing, &amp; environment</td>
<td></td>
</tr>
<tr>
<td>Injury Management after crash</td>
<td>Management of victim to minimize effect of injury</td>
<td>Design changes in product to minimize after effects</td>
<td>Societal and environmental arrangements</td>
<td></td>
</tr>
</tbody>
</table>
Scientific Crash Analysis
Cell 2
Preventing the possibility of a crash: Vehicle based measures

- Reduced probability of Crash

**Countermeasure**
- Disc brakes
- Headlights, daytime compulsory use
- Very visible M/C
- Speed limiters
- Training of drivers
- Pedestrians to walk facing traffic
- Bright clothing M/C
Scientific Crash Analysis

<table>
<thead>
<tr>
<th>Time</th>
<th>Space</th>
<th>Human (Victim)</th>
<th>Products</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crash Prevention</td>
<td></td>
<td>Role of the human beings in preventing the event</td>
<td>Role of the product in preventing the event</td>
<td>Role of laws, policing, &amp; environment in preventing the event</td>
</tr>
<tr>
<td>Injury Prevention during crash</td>
<td></td>
<td>Role, changes in victim in minimizing injury during crash</td>
<td>Design changes in product to minimize injury during crash</td>
<td>Changes in laws, policing, &amp; environment</td>
</tr>
<tr>
<td>Injury Management after crash</td>
<td></td>
<td>Management of victim to minimize effect of injury</td>
<td>Design changes in product to minimize after effects</td>
<td>Societal and environmental arrangements</td>
</tr>
</tbody>
</table>
Preventing the possibility of a crash: Environment based measures

- Vigilant policing
- Red light cameras
- Bright illumination of crossings
- Adequate sidewalks
- No left turn on red
- Alcohol checking
- Use of roundabouts
- Disc brakes
- Headlights, daytime compulsory use
- Very visible M/C
- Speed limiters
- Training of drivers
- Pedestrians to walk facing traffic
- Bright clothing M/C

Reduced probability of Crash
Scientific Crash Analysis

<table>
<thead>
<tr>
<th>Time</th>
<th>Space</th>
<th>Human (Victim)</th>
<th>Products</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crash Prevention</td>
<td>Role of the human</td>
<td>Role of the product in preventing the event</td>
<td>Role of laws, policing, &amp; environment in</td>
<td></td>
</tr>
<tr>
<td></td>
<td>beings in preventing</td>
<td></td>
<td>preventing the event</td>
<td></td>
</tr>
<tr>
<td></td>
<td>the event</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injury Prevention during crash</td>
<td>Role, changes in victim in minimizing injury during crash</td>
<td>Design changes in product to minimize injury during crash</td>
<td>Changes in laws, policing, &amp; environment</td>
<td></td>
</tr>
<tr>
<td>Injury Management after crash</td>
<td>Management of victim to minimize effect of injury</td>
<td>Design changes in product to minimize after effects</td>
<td>Societal and environmental arrangements</td>
<td></td>
</tr>
</tbody>
</table>

16 December, 2016
Scientific Crash Analysis
Cell 4

Preventing injuries during the crash:
Human victim based measures

- Vigilant policing
- Red light cameras
- Bright illumination of crossings
- Adequate sidewalks
- No left turn on red
- Alcohol checking
- Use of roundabouts
- Disc brakes
- Strong headlights
- Very visible M/C
- Speed limiters
- Training of drivers
- Pedestrians to walk facing traffic
- Bright clothing M/C

Counter-measures
- Protective clothing
- Helmets

Duration of Crash
Less or no injury

Time
# Scientific Crash Analysis

<table>
<thead>
<tr>
<th>Time</th>
<th>Space</th>
<th>Human (Victim)</th>
<th>Products</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crash</td>
<td></td>
<td>Role of the human beings in preventing the event</td>
<td>Role of the product in preventing the event</td>
<td>Role of laws, policing, &amp; environment in preventing the event</td>
</tr>
<tr>
<td>Prevention</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injury</td>
<td></td>
<td>Role, changes in victim in minimizing injury during crash</td>
<td>Design changes in product to minimize injury</td>
<td>Changes in laws, policing, &amp; environment</td>
</tr>
<tr>
<td>Prevention</td>
<td></td>
<td></td>
<td>during crash</td>
<td></td>
</tr>
<tr>
<td>during crash</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injury</td>
<td></td>
<td>Management of victim to minimize effect of injury</td>
<td>Design changes in product to minimize after</td>
<td>Societal and environmental arrangements</td>
</tr>
<tr>
<td>Management</td>
<td></td>
<td></td>
<td>effects</td>
<td></td>
</tr>
<tr>
<td>after crash</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Scientific Crash Analysis
Cell 5

Preventing injuries during the crash: Vehicle based measures

- Vigilant policing
- Red light cameras
- Bright illumination of crossings
- Adequate sidewalks
- No left turn on red
- Alcohol checking
- Use of roundabouts
- Disc brakes
- Strong headlights
- Very visible M/C
- Speed limiters
- Training of drivers
- Pedestrians to walk facing traffic
- Bright clothing M/C

Counter-measures
- Airbags, Seat belts
- Safer fronts

Counter-measures
- Protective clothing
- Helmets

Duration of Crash

Time

Less or no injury

16 December, 2016
# Scientific Crash Analysis

<table>
<thead>
<tr>
<th>Time</th>
<th>Space</th>
<th>Human (Victim)</th>
<th>Products</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crash Prevention</td>
<td>Role of the human beings in preventing the event</td>
<td>Role of the product in preventing the event</td>
<td>Role of laws, policing, &amp; environment in preventing the event</td>
<td></td>
</tr>
<tr>
<td>Injury Prevention during crash</td>
<td>Role, changes in victim in minimizing injury during crash</td>
<td>Design changes in product to minimize injury during crash</td>
<td>Changes in laws, policing, &amp; environment</td>
<td></td>
</tr>
<tr>
<td>Injury Management after crash</td>
<td>Management of victim to minimize effect of injury</td>
<td>Design changes in product to minimize after effects</td>
<td>Societal and environmental arrangements</td>
<td></td>
</tr>
</tbody>
</table>
Scientific Crash Analysis
Cell 6

Preventing injuries during the crash: Environment based measures

- Vigilant policing
- Red light cameras
- Bright illumination of crossings
- Adequate sidewalks
- No left turn on red
- Alcohol checking
- Use of roundabouts
- Disc brakes
- Strong headlights
- Very visible M/C
- Speed limiters
- Training of drivers
- Pedestrians to walk facing traffic
- Bright clothing M/C

Duration of Crash

Counter-measures
- Airbags, Seat belts
- Safer fronts

Counter-measures
- Protective clothing
- Helmets

- Smooth railings
- No sharp edges

Time

16 December, 2016
## Scientific Crash Analysis

<table>
<thead>
<tr>
<th>Time</th>
<th>Space</th>
<th>Human (Victim)</th>
<th>Products</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crash Prevention</td>
<td>Role of the human beings in preventing the event</td>
<td>Role of the product in preventing the event</td>
<td>Role of laws, policing, &amp; environment in preventing the event</td>
<td></td>
</tr>
<tr>
<td>Injury Prevention during crash</td>
<td>Role, changes in victim in minimizing injury during crash</td>
<td>Design changes in product to minimize injury during crash</td>
<td>Changes in laws, policing, &amp; environment</td>
<td></td>
</tr>
<tr>
<td>Injury Management after crash</td>
<td>Management of victim to minimize effect of injury</td>
<td>Design changes in product to minimize after effects</td>
<td>Societal and environmental arrangements</td>
<td></td>
</tr>
</tbody>
</table>
Scientific Crash Analysis
Cell 7
Managing injuries after the crash: Victim based measures

- Vigilant policing
- Red light cameras
- Bright illumination of crossings
- Adequate sidewalks
- No left turn on red
- Alcohol checking
- Use of roundabouts
- Disc brakes
- Strong headlights
- Very visible M/C
- Speed limiters
- Training of drivers
- Pedestrians to walk facing traffic
- Bright clothing M/C

- Airbags, Seat belts
- Safer fronts
- Smooth railings
- No sharp edges

Duration of Crash

Less or no injury

Counter-measures
- Protective clothing
- Helmets

Counter-measures
- First Aid
- Treatment
- Rehabilitation

Time

16 December, 2016
# Scientific Crash Analysis

<table>
<thead>
<tr>
<th>Time</th>
<th>Space</th>
<th>Human (Victim)</th>
<th>Products</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crash Prevention</td>
<td>Roles of the human beings in preventing the event</td>
<td>Role of the product in preventing the event</td>
<td>Role of laws, policing, &amp; environment in preventing the event</td>
<td></td>
</tr>
<tr>
<td>Injury Prevention</td>
<td>Role, changes in victim in minimizing injury during crash</td>
<td>Design changes in product to minimize injury during crash</td>
<td>Changes in laws, policing, &amp; environment</td>
<td></td>
</tr>
<tr>
<td>during crash</td>
<td>Management of victim to minimize effect of injury</td>
<td>Design changes in product to minimize after effects</td>
<td>Societal and environmental arrangements</td>
<td></td>
</tr>
<tr>
<td>Injury Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>after crash</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Scientific Crash Analysis
Cell 8
Managing injuries after the crash: Vehicle based measures

- Vigilant policing
- Red light cameras
- Bright illumination of crossings
- Adequate sidewalks
- No left turn on red
- Alcohol checking
- Use of roundabouts
- Disc brakes
- Strong headlights
- Very visible M/C
- Speed limiters
- Training of drivers
- Pedestrians to walk facing traffic
- Bright clothing M/C

Countermeasures
- Airbags, Seat belts
- Safer fronts
- Protective clothing
- Helmets

Countermeasures
- Automatic s/o
- No fuel leakage
- First Aid
- Treatment
- Rehabilitation

Duration of Crash
Less or no injury

Time
16 December, 2016
## Scientific Crash Analysis

<table>
<thead>
<tr>
<th>Time</th>
<th>Space</th>
<th>Human (Victim)</th>
<th>Products</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crash Prevention</td>
<td>Role of the human beings in preventing the event</td>
<td>Role of the product in preventing the event</td>
<td>Role of laws, policing, &amp; environment in preventing the event</td>
<td></td>
</tr>
<tr>
<td>Injury Prevention during crash</td>
<td>Role, changes in victim in minimizing injury during crash</td>
<td>Design changes in product to minimize injury during crash</td>
<td>Changes in laws, policing, &amp; environment</td>
<td></td>
</tr>
<tr>
<td>Injury Management after crash</td>
<td>Management of victim to minimize effect of injury</td>
<td>Design changes in product to minimize after effects</td>
<td>Societal and environmental arrangements</td>
<td></td>
</tr>
</tbody>
</table>
Scientific Crash Analysis
Cell 9

Managing injuries after the crash: Environment based measures

- Vigilant policing
- Red light cameras
- Bright illumination of crossings
- Adequate sidewalks
- No left turn on red
- Alcohol checking
- Use of roundabouts
- Disc brakes
- Strong headlights
- Very visible M/C
- Speed limiters
- Training of drivers
- Pedestrians to walk facing traffic
- Bright clothing M/C

- Airbags, Seat belts
- Safer fronts
- Protective clothing
- Helmets

- Smooth railings
- No sharp edges
- Automatic s/o
- No fuel leakage
- First Aid
- Treatment
- Rehabilitation

Duration of Crash
Less or no injury

Time

Counter-measures
- Clear the scene
- Police system
- Hospital, Rehab Ctrs
Epidemiology: need

- Rapid evaluation techniques
- Methodologies for short focused surveys
- Data collection systems related to possibility of determining countermeasures
- Guidelines for extrapolation/generalisation