Accidents and Injuries

The problem is not as simple as it seems !!!

Really, It’s not that simple… !!!

Common Questions

- **Long Question** : Describe the various epidemiological factors causing Injuries and Accidents, and discuss the strategies for Prevention and control of RTAs.
- **Short Notes**
  - Human factors causing Accident
  - Environmental factors causing Accident
  - Primary prevention for RTAs
  - Haddon Matrix

Introduction

- Of all the systems that people have to deal with on a daily basis, **road transport** is the **most complex and the most dangerous**.
- Road traffic injuries are a **major** but **neglected** global **public health problem**
- The road traffic death toll represents only the "**tip of the iceberg**" of the total waste of human and societal resources from road injuries.
- Periods of economic prosperity tend to be associated with increasing mobility and demand for transport services

Introduction

- Represent a major epidemic of non-communicable disease
- ACCIDENTS are not ACCIDENTAL as majority of accidents are preventable
- A single error can have life or death consequences.

Why a Public Health Problem?

- For every person killed, many more are injured with different severity – a terrible loss of life together with much pain, misery, suffering, disability, expense and use of valuable medical services affecting upwards of more than a million individuals each year.
- The majority of such deaths are currently among “vulnerable road users” – pedestrians, pedal cyclists and motorcyclists.
- This catastrophic loss and injury is a public health problem demanding urgent attention.

Tragedy of RTA !!!

- The tragedy of Road Traffic Accidents is that they particularly involve the young, perhaps the "**young and adventurous**". Young males are especially involved; fatal accidents in this group represent not only tragic family losses but also a serious economic loss to the community, for their education and training have been wasted.

Why a Public Health Problem?

- Deaths due to accidents represent only a fringe of the problem of accidents, because for every death due to an accident, 10-15 sustain severe injuries, and 30-40 slight injuries (WHO, 1976).
- One more reason why accidents should be a matter of great public concern is that a person disabled or killed by an accident represent such a great loss, in WHO's phrase defining health, of "**socially and economically productive life**".

Random Event ? !!!

One reason for the historical neglect of "injury" in public health is the traditional view of accidents and injuries as "**random events"** that happen to others. Such events are looked upon as an inevitable outcome of road transport.

“Narrow Escape”

- Many more escape accidents by “**narrow escape**”, which might add to their confidence and escalate their ego, so as to make them repeat accidents, which may sometimes be fatal.


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It can’t happen to me !!!

Although the numbers of road accidents are high, one difficulty in studying them is the relative rarity of accidents in relation to the large number of vehicles and road users. This unfortunately provides some justification for the commonly held “**It can’t happen to me**” attitude, which is not conducive to safety.

Neglect !!!

- The proverbial phrase **“accidents will happen”** is an indication of a widespread, fatalistic belief that little can be done to prevent them

- Owing to the multiplicity of factors operating in the causation of Road Traffic Accidents, it is unlikely that there can be any single preventive measure adequate to produce effective minimization of accidents. The complete prevention of all Road Traffic Accidents, which result in death or serious injury, seems at the present time an impossible ideal.
- The risk of a crash is relatively low
- The sum of these small risks is considerable.

Definition

- An unexpected, unplanned occurrence which may involve injury
- Occurrence in a sequence of events which usually produces unintended injury,death or property damage
- WHO Advisory group (1956): unpremeditated event resulting in recognizable damage

Measurement of problem

MORTALITY

- Proportional Mortality Rate
- Number of death per million population
- Death Rate per thousand registered vehicle
- Number of accidents or fatalities as a ratio of the number of vehicle per kilometer or passenger per kilometer
- Death of vehicle occupants per 1000 vehicles per year etc

Measurement of problem

MORBIDITY

- Abbreviated injury scale

DISABILITY

- Impairment
- Disability
- Handicap

AIS

Score	Injury
1	Minor
2	Moderate
3	Serious
4	Severe
5	Critical
6	Unsurvivable

social and economic costs

- The cost of road crash injuries estimated at roughly 1% of gross national product
- (GNP) in low-income countries, 1.5% in middle income countries and 2% in high-income countries

Problem-World

- **Worldwide**: People **killed** in RTA each year is estimated **1.2 million**(2002) and eleventh leading cause of death (about 6 percent of all deaths and 66 percent of all injury deaths)
- **90 percent** unintentional injury deaths occurred in low-and middle income countries, accounting for around 7% of all deaths
- More than 90 percent of DALYs that were attributed to unintentional injuries occurred in these countries, accounting for about 8 percent of all DALY in these countries

Problem-World

- **People Injured in RTA-50 million**
- On current trends, by **2020**, road crash injury is likely to be the **third leading cause** of disability-adjusted life years lost and **sixth** leading cause of death
- Every day around the world, almost 16,000 people die from **all types of injuries**.
- Injuries represent 12% of the global burden of disease,

Motor vehicles & countries

- Motorization rate rises with income. In wealthier countries, there has been dramatic growth in the numbers of cars. Around 80% of all cars are owned by 15% of the world's population, situated in North America, western Europe and Japan.
- Motor vehicle growth in low-income countries is taking place against a background of associated problems. Only a small number of people in these countries can afford cars, while the costs of roads, parking spaces, air pollution and road traffic injuries are borne by the whole society
- the greatest growth rate in the number of motor vehicles is expected in Asian countries, most of the increase likely to be in motorized two-wheeled vehicles and three-wheelers

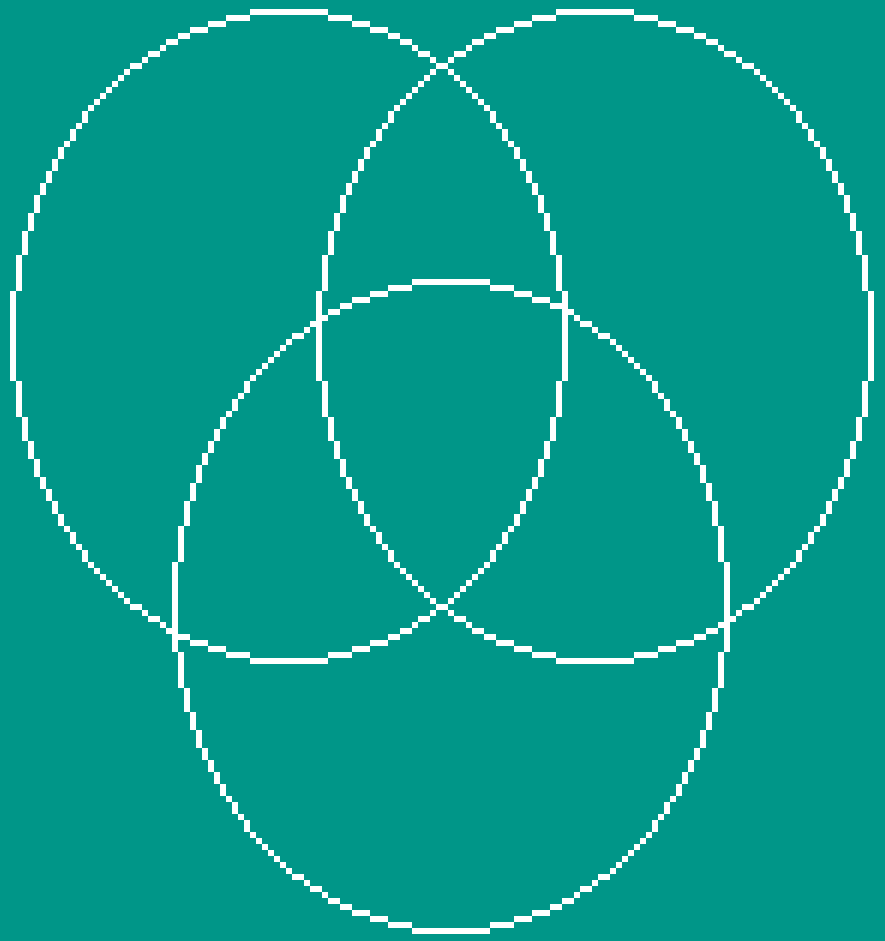
Types of Accidents

- **Road Traffic Accidents**
- **Domestic Accidents**
- **Industrial Accidents / Occupational**
- **Railways Accidents**
- **Violence**
- **Others**

Domestic Accidents

- **Drowning**
- **Burns**
- **Falls**
- **Injuries**
- **Bites**
- **Poisoning**

Injuries and the Epidemiology Triad



Human

Environment

Physical

Social

Vehicle

Causative factor ?

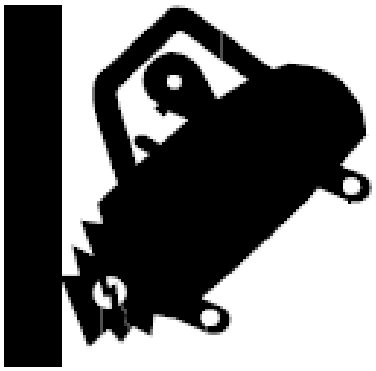
- Infectious disease – microbes are the agent
- Traumatic injury – energy is the agent which may be mechanical, electrical, chemical, and thermal
- The transfer of energy to a host (accident victim) is the necessary and sufficient cause of injury.

Haddon Matrix

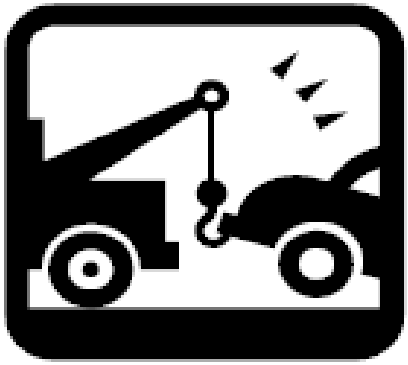
- Developed by Dr William Haddon in the 1970s.
- The Haddon Matrix identifies **three phases** in an injury event and links approaches to prevent or reduce injury in each phase.
- This matrix was developed for application to countermeasures for highway safety but continues to be a useful theoretical framework for many types of injuries.

Pre-Event

Event



Post-Event



The Haddon Matrix

use for planning, resource allocation, strategy identification

	Human	Vehicle	Environment
Pre-event			
Event			
Post-event			

The Haddon Matrix

	Human	Vehicle	Environment
Pre-event	alcohol		night, rain
Event	no seat belt	no air bag	tree too close to road
Post-event			slow emergency response

	Human	Vehicle/Equipment	Physical Environment	Social/Economic
Pre-Crash	Poor vision or reaction time, alcohol, speeding, risk taking	Failed brakes, missing lights, lack of warning systems	Narrow shoulders, ill-timed signals	Cultural norms permitting speeding, red light running, DUI
Crash	Failure to wear seat belt	Malfunctioning seat belts, poorly engineered air bags	Poorly designed guardrails	Lack of vehicle design regulation
Post-Crash	High susceptibility, alcohol	Poorly designed fuel tanks	Poor emergency communication systems	Lack of support for EMS and trauma systems

Haddon's Matrix - RTA

Phases	Factors			
	Host	**Agent/ Vehicle**	**Physical Environment**	**Social Environment**
Pre-event (*Before the crash occurs)*	• Driver vision • Alcohol impairment • Driver experience/ability	• Maintenance of brakes, tires • Speed of travel • Load characteristics	• Adequate roadway markings • Divided highways • Roadway lighting • Hazardous intersections • Road curvature • Adequate roadway shoulders	• Public attitudes on drinking and driving • Impaired driving laws • Graduated licensing laws • Speed limits • Support for injury prevention efforts
Event (*During the crash)*	• Spread out energy in time and space with seat belt and/or airbag use • Child restraint use	• Vehicle size • Crashworthiness of vehicle—"crush space", integrity of passenger compartment, overall safety rating • Padded dashboards, steering wheels, etc.	• Guard rails, median barriers • Presence of fixed objects near roadway • Roadside embankments	• Adequate seat belt and child restraint laws • Enforcement of occupant restraint laws • Motorcycle helmet laws
Post-event *(After the crash)*	• Crash victim's general health status • Age of victims	• Gas tanks designed to maintain integrity during a crash to minimize fires	• Availability of effective EMS systems • Distance to quality trauma care • Rehabilitation programs in place	• Public support for trauma care and rehabilitation • EMS training

	Pre-Crash	Crash	Post-Crash
Human Factors	Braking Licensing Education/Training Crash Avoidance Skills Attitude Toward Safety Motorist Physical Impairment Alcohol/Substance Impairment Telecommunication Distractions Rider Risk Recognition & Judgment Concurrent Exposure Data Collection	Personal Protective Equipment	Crash Research Education/Training Evaluation
Vehicle Factors	Horns Braking Intelligent Transportation Systems/ Intelligent Vehicle Initiative Conspicuity Vehicle Design Passenger/Loads Vehicle Equipment Vehicle Modifications Motorcycle Performance Vehicle Safety Equipment	Vehicle Safety Equipment Personal Protective Equipment	Automated Collison Notification (ACN) System Crash Research
Environmental Factors	Intelligent Transportation Systems Regulation Enforcement Road Hazards Natural Hazards Driver Distractions Other Vehicle Design Lane Position/Sharing Road Design and Maintenance	Road "Furniture" Other Vehicle Design	EMS Response
Social Factors	Enforcement Rider Peer Pressure Motorist Awareness Insurance Incentives Motorcycle Retail Advertising Transportation Safety Community Attitude		Transportation Safety Community Attitude Medical Community Attitude

Haddon's Matrix – Workplace injuries

Phases	Factors			
	Host (Victim)	**Agent/Vehicle/Vector** (Weapons & Assailant)	**Physical Environment** (Structures & Facilities)	**Social Environment** (Norms, policies & procedures)
Pre-Event (Pre-Assault)	Train workers to identify potentially violent clients or customers Train managers in conflict resolution and proper dismissal strategies	Make weapons less easily concealed (weapon) Provide careful oversight of potentially volatile employees (assailant) Educate patients/clients in anger management (assailant)	Modify structures to decrease ease of access by unauthorized persons (e.g. fired workers or violent partners) Install metal detectors Install bullet proof shields between workers and customers	Reduce access to weapons Prohibit solo workers in high risk establishments
Event (Assault)	Train workers methods of signaling for help during robberies and assaults Train employees to use self-protection measures when confronted with violent client	Reduce lethality of weapons (e.g. fewer firing rounds, less lethal bullets)	Install and maintain easy to operate alarm systems Reduce isolation of work spaces Ensure workers have escape route	Ensure adequate security backup for threatened workers Develop plan for responding to threats
Post-Event (Post-Assault)	Train workers in first aid Provide workers with crisis intervention counseling after assault events	Reassign workers after coworker violence Improve ability to trace firearms and apprehend suspects	Ensure access to the worksite by emergency vehicles Install cameras to facilitate identification and apprehension of assailants	Provide adequate insurance plan to workers for acute and long term medical care and counseling services

Haddon's Matrix - Firearm

	Host *(students at school)*	**Agent/ Vehicle** *(firearm and bullets)*	**Physical Environment** *(school)*	**Social Environment** *(school and community norms, policies, rules)*
Pre-event *(before teen uses weapon)*	• Educate teens about the dangers of carrying guns to school • Educate parents about dangers of allowing teens access to guns • Teach students to recognize and report student behaviors indicative of possible violent behavior	• Modify guns so they are only operable by the owner	• Install metal detectors at entrances to schools • Eliminate storage places in schools (e.g. lockers) where guns might be kept	• Adopt school procedures/policies to notify authorities if a student is suspected of having a gun at school • Prohibit gun carrying on school grounds • Enforce restrictions on the sale or transfer of handguns to teenagers
Event *(when gun is taken out to be fired)*	• Teach students to take cover when they see guns or hear gunfire	• Reduce capacity of weapons to fire multiple rounds quickly • Modify bullets to be less lethal	• Install alarm systems to call law enforcement as soon as weapons are visible	• Have law enforcement officers on duty at school to intervene during fights • Develop safety plans to help students move to safety in event of violent episode
Post-event *(after students are shot)*	• Teach students first aid skill	• Reduce the capacity of the gun to continue firing	• Make school grounds readily accessible to ambulances	• Ensure well-trained emergency medical personnel and access to trauma facilities • Provide post-event counseling to students, staff and families

Haddon's Matrix – Fire

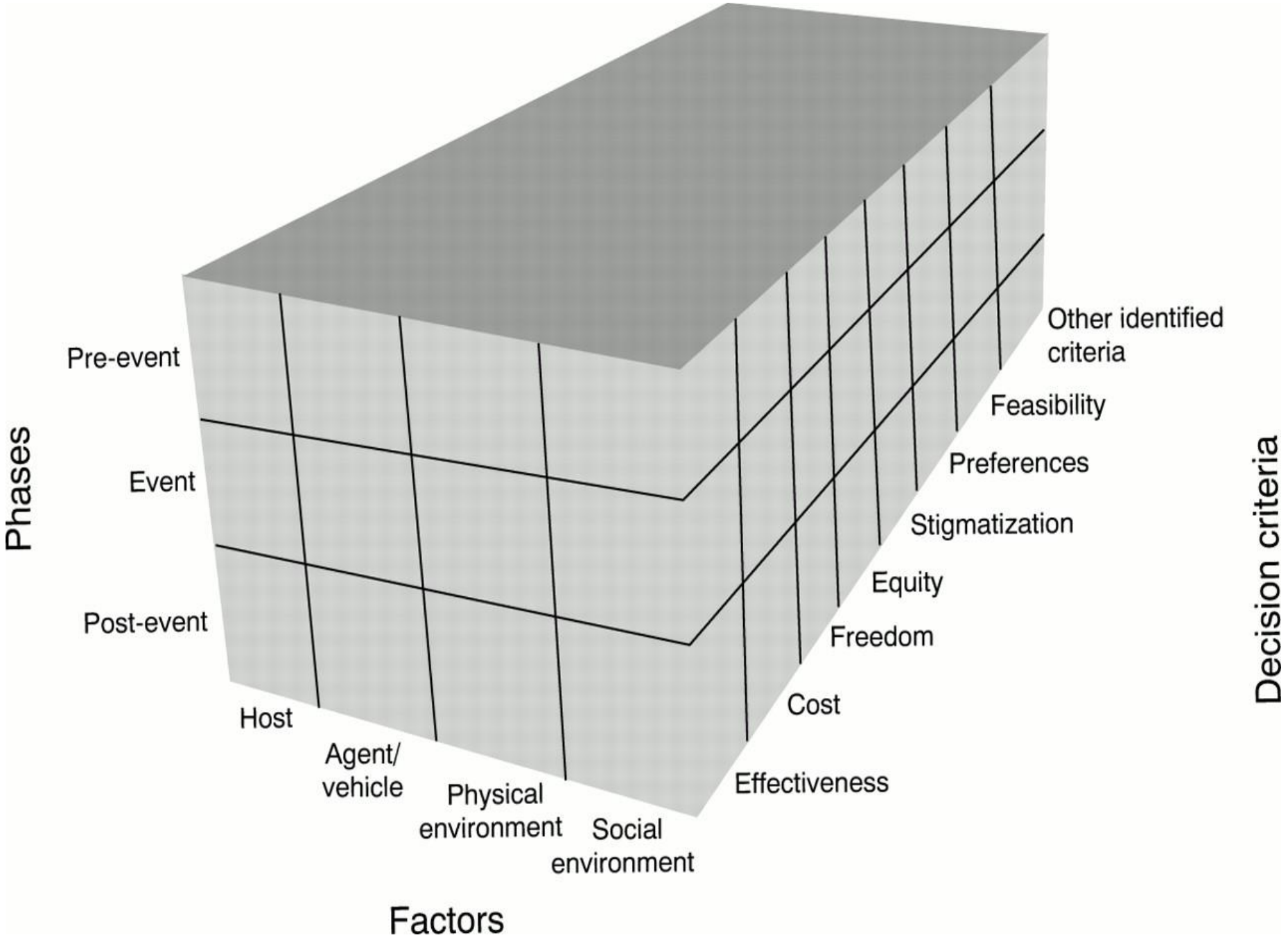
	Host *(children, elderly, adults in home)*	**Agent/ Vehicle** *(cigarette, matches, appliances, heaters, and upholstered furniture)*	**Physical Environment** *(home)*	**Social Environment** (*community norms, policies, rules*)
Pre-event *(before fire starts)*	• Teach children not to play with matches • Provide information about fire risk and cooking (loose clothing, long hair, etc., may catch on fire)	• Redesign cigarettes so they self-extinguish • Automatic shut-off for appliances such as coffee makers. • Inspect and clean chimneys, heating systems each year.	• Lower flammability of structures • Insure adequate emergency escape exits from home	• Improve efforts to curb smoking initiation • Improve smoking cessation efforts
Event *(during fire)*	• Teach children to stop, drop and roll • Plan and practice a fire escape route with children and adults • Teach children not to hide during a fire	• Design furniture with materials that are less toxic when burned • Design upholstery that is flame resistant	• Install smoke detectors • Install sprinklers • Increase number of usable exits	• Pass ordinances requiring smoke detectors and/or sprinkler systems • Fund the fire department adequately to provide enough personnel and equipment for rapid response
Post-event *(after child or person injured by fire)*	• Provide first aid and CPR to all family members	• Design heaters with quick and easy shutoff device	• Build homes with less toxic building materials	• Increase availability of burn treatment facilities

Haddon's Matrix – Dog Bite

	Host/Human	Agent/(Dog)	Physical Environment	Social Environment
Pre-event (*Before the dog attack occurs)*	• Teach kids about dogs: don't go near food, strange dogs, yards, mother with new puppies, etc. • Teach parents, elderly,	• Teach dogs not to bite—socialization training. • Spay and neutering of dogs.	• Dogs in fenced yards/enclosures • Dogs chained up • Install electronic "invisible" fencing	• Community awareness of the problem • Leash laws passed • Stray dog ordinances
Event (*During the dog attack)*	• Teach kids not to run from dogs • Yell for help • If knocked to the ground, protect head, neck and face. • Fight back if attacked	• Dangerous dogs are muzzled	• Alarm system sounds if dog escapes from fence or gate is opened	• Passage of dangerous dog laws ordinances • Enforcement of such laws
Post-event *(After the attack)*	• Provide first aid/trauma care • Victim's general health status • Age of victims	• Destroy violent dogs	• Availability of effective EMS systems • Distance to quality trauma care • Rehabilitation programs in place • Quarantine, Impoundment of violent dogs	• Laws requiring impoundment of violent dogs, and/or laws requiring violent dogs are destroyed. • Animal control programs in place to pick up violent dogs

	Host	Agent	Physical Env't	Social Env't
Pre-Event				
Event				
Post-Event				

Haddon's Matrix


Phases
Pre-event
Event
Post-event
Factors
Host
Agent/
vehicle
Physical
environment
Social
environment
Decision criteria
Other identified
criteria
Feasibility
Preferences
Stigmatization
Equity
Freedom
Cost
Effectiveness

Important Factors

- Large numbers of pedestrians
- Large numbers of old and poorly maintained vehicles
- Large numbers of two wheelers
- Low driving standards
- Large numbers of buses often overloaded
- Widespread disregard for traffic rules
- Defective roads, poor lighting ,Speed breakers.
- Unusual behavior of man, and animals.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Environmental factors

- Relating to road
- Relating to Vehicles (agent?)
- Bad weather
- Mixed traffic

Psychosocial factors

- Lack of experience
- Risk taking
- Impulsiveness
- Defective judgment
- Delay in decision
- Aggressiveness
- Poor perception
- Family dysfunction

Human factors

- Age
- Sex
- Education
- Medical conditions-sudden illness, heart attacks.
- Fatigue
- Psychosocial factors

Demographic factors

- Increased need for travel
- Choice of less safe forms of travel
- Young drivers and riders
- Alcohol Medicinal and recreational drugs
- Driver fatigue
- Hand-held mobile telephones
- Inadequate visibility
- Pre-hospital factors
- Hospital care factors

Lack of body protection

- Helmets
- Safety Belts


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Precipitating Factors

- Heightened emotional tension
- Alcohol and drugs
- Social pressures
- Use of stolen vehicles

Factors influencing exposure to risk

- **Rapid motorization**
- **Demographic factors**
- **Transport and land use**
- **Increase need for travel**
- **Choice of less safe forms of travel**

Risk factors influencing crash involvement

- **Speed**
- **Alcohol, medicinal or recreational drugs**
- **Fatigue**
- **Hand held mobile telephone**

  Increase in reaction time by 0.5-1.5 seconds. risk of a crash is four times higher.
- **Inadequate visibility**
- **Road related factors**
- **Vehicle related risk factors**

Risk factors influencing severity of post-crash injuries

- **Delay in detecting crash**
- **Presence of fire resulting from collision**
- **Leakage of hazardous materials**
- **Presence of alcohol and other drugs**
- **Difficulty rescuing and extracting people from vehicles**
- **Difficulty evacuating people from buses and coaches involved in crash**
- **Lack of appropriate pre-hospital care**
- **Lack of appropriate care in the hospital emergency rooms**


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Prevention and Control

Injuries and the Public Health Approach

- A cycle of surveillance
- Risk factor identification
- Intervention implementation
- Evaluation

Prevention of Accidents

- Data Collection
- Safety Education
- Promotion of Safety Measures
- Alcohol
- Primary Care
- Elimination of causative factors
- Enforcements of laws
- Rehabilitation services
- Accident research

Data Collection

- Special surveys
- In-depth studies
- Detailed environmental data
- Police records as starting point

Prevention

- Very short ‘latent’ periods
- Primary Prevention
- Secondary Prevention
- Tertiary Prevention

Modes of intervention

- ***Passive intervention*** requires no input or action by the host and is usually accomplished by modifying the agent, vehicle, vector, or environment. Modifications in car design to improve brakes or increase energy absorption by the vehicle frame are two examples.
- ***Active intervention*** requires that the host take some type of action for the intervention to work. Seat belts and helmets are examples of active intervention.

4E approach for injury prevention

- Education
- Environmental modification
- Enforcement
- Engineering measures

Elimination of causative factors

- Improvement of roads
- Imposition of speed limits
- Marking of danger points
- Reduction of electric voltage
- Provision of fire guards
- Use of safety equipments in occupations
- Safe storage of drugs poisons and weapons.

The motto is

Safer Roads, Safer Vehicles, and Safer Systems

- **Providing visible, crash-protective, “smart” vehicles**
  - **Improving the visibility of vehicles**
  - **Crash-protective vehicle design**
  - **Intelligent vehicle**

Improving the visibility of vehicles

- Daytime running lights for cars
- High-mounted stop lamps in cars
- Daytime running lights for motorized two wheelers
- Improving the visibility of non-motorized vehicles

Crash-protective vehicle design

- ***Safer car fronts***
- ***Safer bus and truck fronts***
- ***Car occupant protection***
- ***Frontal and side impact protection.***
- ***Occupant restraints.***
- ***Protection against roadside objects.***
- ***Vehicle-to-vehicle compatibility***
- ***Front, rear and side under-run guards on trucks***
- ***Design of non-motorized vehicles***

“Intelligent” vehicles

- *“Smart”, audible seat-belt reminders*
- *Speed adaptation*
- *Alcohol interlocks*
- *On-board electronic stability programmes*

Reducing motor vehicle traffic

- Efficient land use
- Safety impact assessments of transport and land-use plans
- shorter, safer routes
- Trip reduction measures
- Providing better public transport facilities
- Pooling of vehicles
- Providing no private vehicle zones

Safer modes of travel ?

- Promotion of public transport
- Walking and cycling
- ‘PARK & RIDE’ facilities
- Higher fuel taxes to discourage private car use
- Financial incentives.

Encouraging use of safer modes of travel ?

- **“Unstable vehicles”**
- **Person capacity of vehicle**
- **Load limits**
- **Safety vs. time of travel**
- Buses and trucks are a major mode of travel in low-income and middle-income countries. High volumes of passengers being transported have an impact on the safety, not only of the passengers themselves, but also on other vulnerable road users

Minimizing exposure to high-risk scenarios

- Restricting access to different parts of the road network
- Priority in the road network to higher occupancy vehicles
- Restrictions on speed and engine performance of motorized two-wheelers
- Legal age for use of motorized two-wheelers
- Improving driver licensing systems


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Shaping the road network

1. **Safety-awareness in planning road networks**
   - ***Classifying roads and setting speed limits***
2. **Incorporating safety features into road design**
   - ***Higher-speed roads***
   - ***Single-lane carriageways***
   - ***Residential access roads***
   - ***Area-wide urban safety management***
   - ***Safer routes for pedestrians and cyclists.***
   - ***Traffic-calming measures.***
   - ***Safety audits***
   - ***Crash-protective roadsides***
   - ***Crash cushions***
3. **Remedial action at high-risk crash sites**

Enforcements of laws

- Enforcements of laws by state
- Factory and industrial laws


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Legislations

The important legislations on the subject in India are as under:

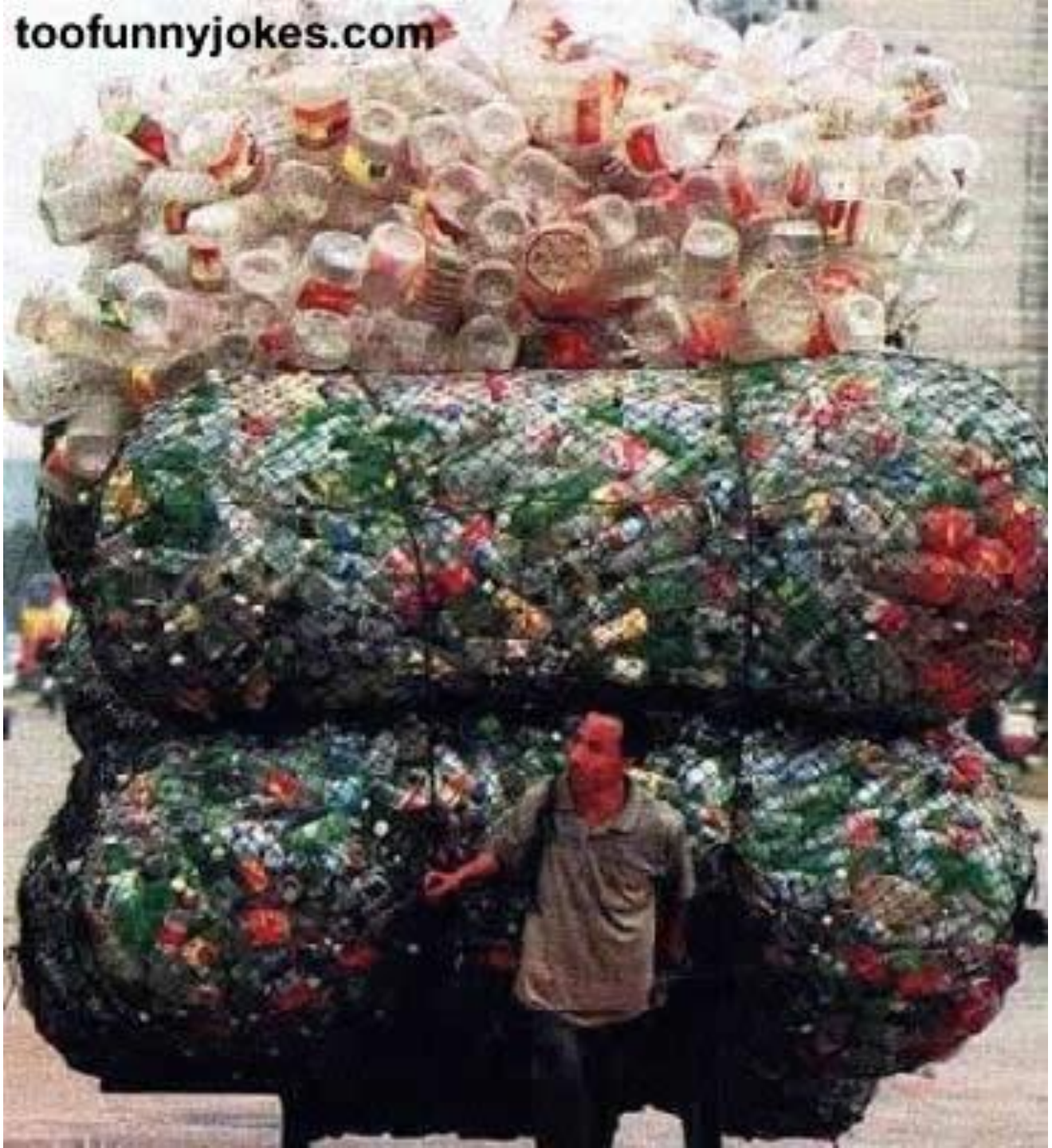
- Motor Vehicles Act, 1988
- Central Motor Vehicles Rules, 1989
- The Carriers Act,1865

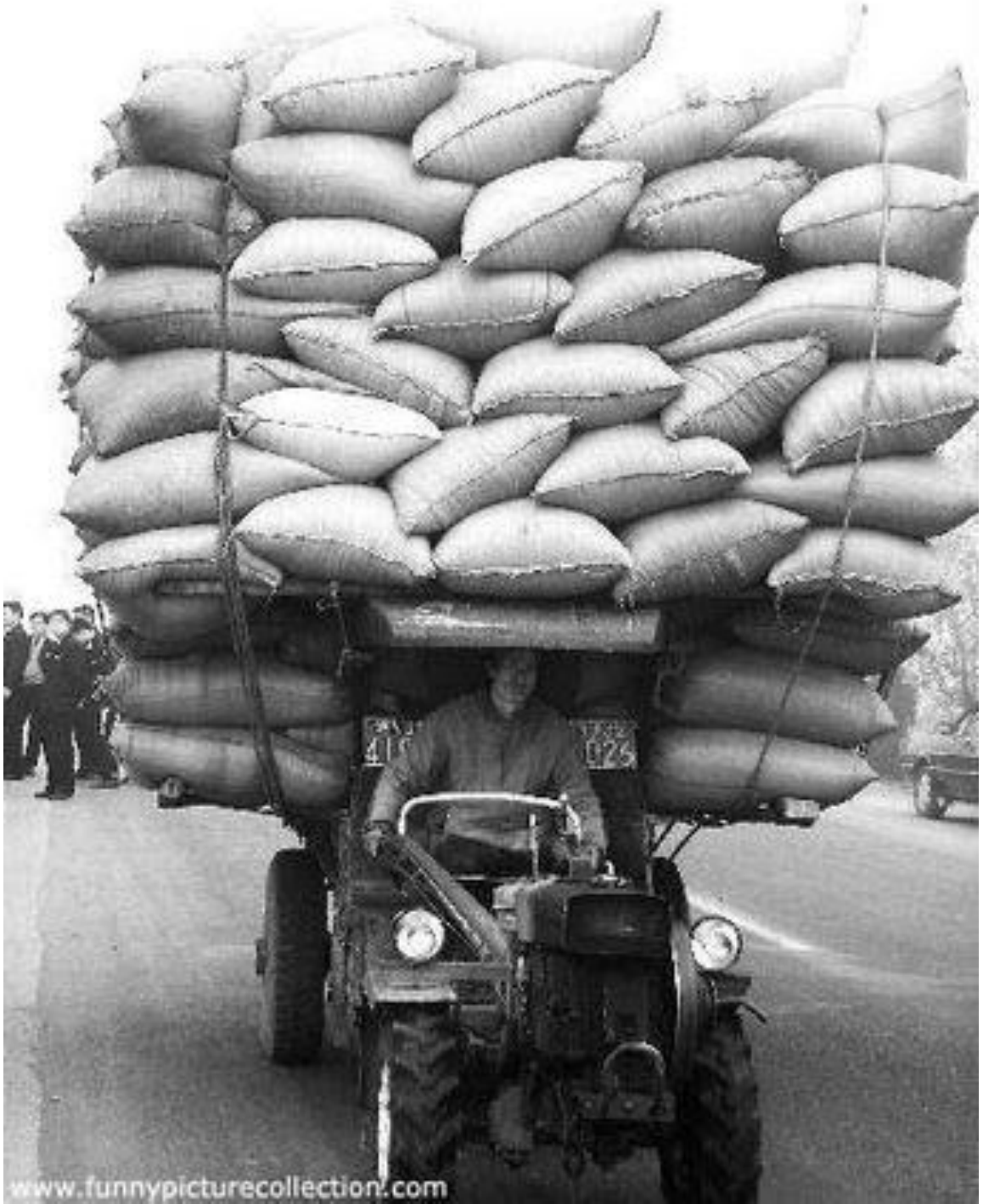
Road Safety Rules

Speed limits

- ***Speed enforcement on rural roads***
- ***Speed cameras***
- ***Speed limiters in heavy goods and public transport vehicles***
- ***Cameras at traffic lights***

Commercial and public Transport Drivers' hours of work

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SPEED ? !!!

Excess speed is when a vehicle exceeds-the relevant speed limit set for a road.

Inappropriate speed is when a vehicle travels at a speed unsuitable for the prevailing road and traffic conditions.

While speed limits only declare higher speeds to be illegal it remains for each driver and rider to decide the appropriate speed within the limit.

Alcohol

- Setting, Adhering & improving the legal limit of Alcohol with strict implementation.
- 80 mgs/100 ml of blood doubles the risk
- Other drugs & habit forming substances can also increase the risk.

Alcohol impairment laws

- *Blood alcohol concentration limits*
- *BAC limits for the general driving population*
- *BAC limits for young or inexperienced drivers*
- *Minimum drinking-age laws*
- *Deterring excess alcohol offenders*
- *Random breath testing and sobriety checkpoints*
- *Mass media campaigns*
- *Penalties for excess alcohol offenders*
- *Interventions for high-risk offenders*

Seat-belt and child restraint use

- Seat-belts
- Mandatory seat-belt use laws
- Enforcement and publicity
- Incentive programmes
- Child restraints
- Mandatory child restraint laws
- Child restraint loan programmes

Mandatory crash helmet use

- *Bicycle helmets*
- *Motorcycle helmets*
- *Mandatory laws on helmet wearing*
- Standardizing *quality of helmets used*

The role of IEC and publicity

- Rules
- Safer vehicle
- Skill
- Attitude and concern

Safety Education

- School children
- Drivers
- Young people

If accident is disease then education is the vaccine.

Primary Care

- Emergency care
- Accident service organization
- Specialized trauma care unit

Delivering post-crash care

- **Chain of help for patients injured in road crashes:**
- **Aim**
- **“Golden hour”:**
  - **50% death within minutes**
  - **15% in first 4 hour**
  - **35% after 4 hour**

Factors – post crash

Prehospital

- ***Role of lay bystanders***
- ***Access to the emergency medical system***
- ***Emergency rescue services***

Hospital

- ***Human resources***
- ***Physical resources***
- ***Organization of trauma care***


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AMBULANCE

Rehabilitation services

- Medical rehabilitation
- Social rehabilitation
- Vocational rehabilitation

Rehabilitation

- **For every person who dies in RTA many more are left with permanent disabilities**
- **Non-dependence and good quality of life**

Accident research

- Gathering precise information on extent, type and other characteristics of Accidents and correlating it with personal and environmental information.

Research

- **Mainly high income countries**
- **Independent national organizations**

World Health Day 1961

- Accidents and their Prevention

World Health Day

2004

ROAD SAFETY
IS NO ACCIDENT

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- Speed: slow down!
- Alcohol: don't drink alcohol and drive
- Seat-belts and child restraints: strap in!
- Wear helmets!
- Visibility: see and be seen

Thank you…