Safer Roads to School

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Abstract

Any and all advances made by medical science cannot solve the problem of road traffic injuries (RTIs) in school-going children, especially if the only concerned people are those of the medical fraternity. Children are a vulnerable part of the traveling population and thus have been persistent due to the callous nature of the citizens and policy makers toward road safety and injury prevention. In our multicultural and multilingual country, there is a need for multistakeholder initiative with a countrywide presence if we are to stem the rise of mortality and morbidity due to these accidents. The first question we need to ask is how to prevent road traffic accidents and improve the condition of our roads. Pediatric RTIs are eternal problem of industrial revolution with complications and effects that may affect individual and society with increase in the number of motorized communications. Dedicated capacity building is urgently need who should be able to provide the necessary care to the injured children at the road crash spot as well as should be informed where to take the injured child and whom to contact in the dedicated injury care center while transporting the victims of situations.

Keywords: Pediatric, pediatric trauma, road safety, road traffic accidents, school-aged children, traumatic brain injury

INTRODUCTION

The United Nations Children’s Fund defined children as “Every human being who is below 18 years of age.”[1] Children can be a part of the road users as pedestrians, vehicle occupants, bicyclists, and motorcyclists or as young drivers or pillion riders.[2-6] The World Health Organization (WHO 2004) recognized childhood injuries as a major public health problem, resulting in about 10 lakhs deaths each year under the age of 18 years.[7] Road crashes are recognized as one of the leading causes of road traffic injuries (RTIs) in the pediatric and adolescent age groups with significant load of morbidity, disability, and mortality in the whole world.[4,6,8,9] These injuries not only pose a great burden on financial resources but also result in loss of potential workforce expected of bulk of the future citizens of the world.[6,7] Many studies from India have reported injury patterns and related issues in road traffic crashes from India.[10-14] In addition, a number of strategies have been planned and implemented in developed and developing countries to reduce the number of road traffic-related injuries in children.[6,15,16] The aim of this study was to identify the epidemiology including innumerable risk factors and risk correlates of childhood injuries on road to find out holistic multistakeholder solutions for this totally preventable health issue.

MECHANISM OF INJURY

Globally, road crashes are also foremost causes to seek dedicated care in emergency departments of health-care delivery systems for school-aged children.[17] Almost all the studies have reported that male children were more prone to get involved in RTIs than female counterparts.[18,19] These injuries can be sustained when they use roads as motor vehicle occupants, drivers, pedestrians, cyclists, or motorcyclists, even playing on roads.[19-22] Traumatic brain injury is the most

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leading cause of morbidity and mortality among the victims of road crashes; however, high-velocity impacts can also lead to multisystem injuries including associated injuries leading to fatal and nonfatal outcomes including facial with mandibular injuries; chest and abdominal injuries including soft tissues (lung and spleen); and injuries to spine, pelvis, and extremities which are designated as polytrauma that may have further sequel for the growing anatomy and physiology of childhood and adolescence. The whole lot of injury spectrum depends on the impact and other correlates that make the situation graver including untrained primary health-care delivery system to manage the injury continuum.

**Child-related Factors**

“Children are not small adults;” they differ significantly from adults. These differences include height, relative weight of the head, head-to-body ratio, center of gravity, strength of neck and spinal muscles, and the developmental pattern of bony structures (including skull and vertebrae), fusion pattern of ossification centers, and structure of bony pelvis. As the myelination of the nerve fibers remains incomplete in this period of life, damage to major neural fiber pathways may have long-term health issues. Further, damage to vascular structures also has long-lasting effects as they are still under development till puberty is over. Because of these anatomical and functional differences, restraint devices and kinetic forces exerted during accident will result in injuries that will be grossly different in children and adolescents than those in adults. In addition, children may not be able to adapt to the safety issues regarding road environment and vehicle behavior which is not designed for them in many situations; they may not be attentive as they may be unable to protect themselves when casually roaming, walking, running, jogging, and playing on the road and, further, their inability to visualize and imagine safer and smarter decisions at the crisis moments; unintentional risk-taking behavior corresponding to their ages; poor ability to perform multitasking when engrossed in their own world; less developed sensory facilities (particularly visual and auditory) leading to their inability to anticipate clues to danger, and sensitized to respond optimally to get out of these dangers safely viz., when and where to stop. Further, awareness levels of these young individuals of the school-age groups vary depending on their ages from preschool to high school levels. Thus, we need to consider a very critical issue of safety of this heterogeneous spectrum of the school children because they are the future citizens who will carry the message of road safety in this new millennium.

**Injury Spectrum and Emergency Response**

Children are injury prone traveling population with a high risk of sustaining a spectrum of injuries during their journey from home to school, participating in different academic and cocurricular activities and return back home. The injuries experienced by them vary from minor injuries viz., lacerations and bruises (in any parts of the body), sprains and strains, fractures and dislocations, burns and scalds, blunt soft tissue injuries to chest and abdomen, traumatic brain injury, spinal cord injuries, and in severe cases injury to the multiple organ systems. In case of emergency, transport vehicle drivers shall provide transport vehicle attendants and bystanders might include passerby, teachers and support staff, parents, as well as fellow children and other first responders whenever they are available trained for prehospital care. These responders need to spot the emergency and the level of urgency that is highly needed on the case-to-case basis. The vehicles carrying school children should have dedicated section for keeping necessary gadgets necessary for prehospital care. This is expected to include a well-planned prearranged updated first aid box (discussed latter), stethoscope and sphygmomanometer, spine and cervical stabilization equipment, oxygen and intravenous fluid administration facility, etc., with a back-up generator set if possible along with the arrangement of lights for managing emergencies during nights. There is a need to provide detailed information regarding available prehospital and emergency care services in their area viz., whom to contact or where to take the injured child or should they wait at the scene doing triage and resuscitation till the suitable vehicles for transportation arrive and which health-care center will be best equipped to take care of pediatric cases. Simultaneously, they should be able to make sure the safety of other children as well as they should be able to assure the fellow children.

**Steps to be followed for emergency mitigation**

Schools and appropriate authorities should design an appropriate crisis and emergency response protocol for the capacity building of all levels of staffs working with the schoolchildren supported by regular drill of the well-oiled first responder machinery. Accordingly, they need to be trained adequately to provide the whole range of prehospital care that includes conventional first aid in cases of minor injuries and basic life support in cases of life-threatening injuries.

**Steps to be followed during an emergency**

Involved personnel’s should be able to recognize from their competency on emergency medical services that there is a need for emergency response (i.e., maybe a road traffic accident or fall). Once an emergency is suspected the person can follow these steps:

- Make a “help” call to the co-ordinating center and/or nearby dedicated injury care center
- Assess the area of incidence and the injured persons by ABCDE protocol of basic life support
- Triage and color coding of the children and adolescent at the site of the event
- Determine the safety of himself/herself, place, and safety of others
- Identify the mechanism and type of injuries as well as associated medical care issues
- Explore the possibility of whether there are nearby people...
to support him or her or them
- Identify and examine how many persons are injured and died on spot
- Identify the extent of minor injuries who can be disposed of from the site
- Identify the life-threatening injuries and fractures who need to be carried to referral centres
- Liaison with dedicated referral injury care center regarding arrangements before transfer
- Co-ordinate at the site of emergency till all the victims are optimally managed
- Stay back at the site of emergency till all the dead bodies are disposed with due care.

Life-threatening conditions
These can be strongly suspected in case the following clinical signs are seen:
- Loss of consciousness
- Shock
- No motor or verbal response or breathing movements
- Chest pain or discomfort in breathing
- Absence of pulse
- Hypo or hyperthermia
- Exsanguination and bleeding
- Seizures
- Extensive burns and scalds involving the head, neck, feet, hands, and genital area
- Injuries due to explosives, chemicals, electricity, or high-velocity accidents.

Features suggestive of traumatic brain injury
These should be suspected in case the following signs are present:
- Loss of consciousness, disorientation, or confusion
- Headache
- Vomiting, especially if repeated and uncontrollable
- Seizures.

Other injuries
- Bruises or swelling over chest or abdomen with or without signs of blunt injury
- Swelling of arms, legs with pain
- Inability to walk
- Spinal cord injury.

First Aid Needs Assessment and Actions
School authorities should identify children-specific first aid needs and make a policy document to address the needs of the students during transportation or their stay at school. This should contain the information of people who shall be trained to provide first aid, coordinators, communication in-charges to contact parents or guardians, list of nearby hospitals, and information booklet elaborating the contents of the first aid kit and their use in local language and English so that it is understandable to all the team members. It should be clearly understood that first aid is purely to buy time in case of severe injuries and not the definitive care, which needs to be provided at a well-equipped center.

First Aid and First Aid Kit
The transportation vehicle must carry first aid material in a dust-proof removable metal box, which needs to be placed in a location that is easily noticeable and accessible. The contents of the first aid box should be checked, well-planned, and updated at regular intervals with the use-by dates inspected regularly for top-up of exhausted materials. It must contain leaflet elaborating the contents in first aid box and how to use the contents and emergency contact numbers including contact number of ambulance service and family members as well as nearby hospitals where the injured can be transported in an emergency.

At the minimum, it should include:
- Large and sterile gauze pads for dressings
- Adhesive tape of different sizes
- Roller and triangular bandages to hold dressings in place or to make an arm sling
- Adhesive bandages in assorted sizes
- Scissors
- Tweezers
- Safety pins
- Disposable gloves
- Torchlight with spare batteries
- Antiseptic wipes or soap
- Pencil and pad
- Emergency blanket
- Eye patches
- Thermometer
- Face mask or face shield.

Management Challenges
Treating a child suspected of having head injuries is a challenge in itself as often these children will not give details regarding the mechanism of injury and may not even be cooperative for physical examination for injuries and clinical tests. As for adults, the primary management starts at the site of accident and primary care and passerby and sympathizers may provide rescue. The primary objective at this level should be to identify the children with significant and or life-threatening injuries to ensure their safety at the scene followed by optimally quick and effective stabilization to prevent secondary injuries. Until proven otherwise, an often overlooked critical aspect is immobilization for spinal and associated injuries as any missed injuries and unnecessary movement can lead to irreversible and permanent disability. One can follow a clinical decision rule (NEXUS criteria) “no midline cervical tenderness, no focal neurological deficit, normal alertness, no intoxication and no painful, distracting injury” with a further evaluation with
appropriate radiographs to suspect or rule out spinal injuries.\textsuperscript{[48]} Children poses a difficult challenge as they may not be able to communicate well with the first responders and also there may have been impaired level of consciousness; a higher degree of suspicion is required to rule out any other life-threatening injuries.\textsuperscript{[49]} During the management of these groups of children and adolescents, certain social factors need to be remembered, such as age-specific patient and parent anxiety, difficulty in communication, and the relative paucity of personnel who are experienced in the management of pediatric trauma patients. All these can delay the diagnosis and management and lead to critical consequences.\textsuperscript{[50]} Children poses a difficult challenge as they may not be able to communicate and also there may be impaired level of consciousness; hence, a high degree of suspicion is required to rule any injuries.\textsuperscript{[49]} This is more important when dealing particularly with the cases of differently abled children with special needs of training to care them with more empathy.

**Prevention**

We can say that injuries in children are not inevitable; however, at the same time, they are potentially preventable and thus prevention of road traffic-related injuries should be given a special priority in our national-level planning.\textsuperscript{[51,52]} There are proven and effective measures that can be put into place to reduce their risks to the minimum levels.\textsuperscript{[6]} Comprehensive and multifaceted approaches to injury prevention include “Education, Enforcement/legislation and Engineering (vehicle design to prevent a vehicle rollover, improved protection for vehicle occupants).”\textsuperscript{[53,54]} A number of preventive measures have been recommended, including reduced speed (30 km/h) particularly around schools, separation of two-wheelers (i.e., dedicated lane for child cyclists and exclusive motorcycle lanes), vehicle modifications, child restraint systems (i.e., booster cushions or booster seats), seat-belts (children >10 years of age), and bicycle and two-wheeler helmets.\textsuperscript{[16,55-57]} Additional measures include the promotion of road safety education to children, to drivers, and to the general public, which can be further reinforced with strong legislation and government policies.\textsuperscript{[51,52,55-58]}

**Conclusions**

Because of their unique physical and cognitive characteristics, road can be considered as a dangerous place for school-aged children. Based on the available literature, it can be supposed that a large number of school-aged children experience injury in road traffic accidents and sustain injuries with significant morbidity, disability, and mortality. We need to change the mindset from the stakeholders and policy makers to the last citizen on the urban and rural roads that this altogether preventable health issues as the outcomes of the road crashes need to handle by the active participation of all. School-aged children (or school-going children) can be a part of the road crashes as a passenger, pedestrians, bicyclist, drivers, vehicle occupants, or users of motorized or nonmotorized three- and two-wheelers. There is an urgent need to carry out research studies to better understand the need of this precious group to make them safe when traveling to and fro from home to school.

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**References**

1. UNICEF. Convention on the Rights of the Child. Available from: https://www.unicef.org/ercr. [Last accessed on 2019 Mar 19].
2. Loprinzi PD, Cardinal BJ, Loprinzi KL, Lee H. Benefits and environmental determinants of physical activity in children and adolescents. Obes Facts 2012;5:597-610.
3. Rabl A, de Nazelle A. Benefits of shift from car to active transport. Transport Policy 2012;19:121-31.
4. World Health Organization. Child Injuries and Violence. Available from: https://www.who.int/violence_injury_prevention/child/en/. [Last accessed on 2019 Mar 19].
5. Lykissas MG, Eismann EA, Parikh SN. Trends in pediatric sports-related and recreation-related Injuries in the United States in the last decade. J Pediatr Orthop 2013;33:803-10.
6. Peden M. World Report on Road Traffic Injury Prevention; 2004.
7. World Health Organization. The Global Burden of Disease. World Health Organization; 2004. Available from: https://www.who.int/healthinfo/global_burden_disease/2004_report_update/en/. [Last accessed on 2019 Mar 19].
8. Quayle KS, Powell EC, Mahajan P, Hoyle JD Jr., Nadel FM, Badawy MK, et al. Epidemiology of blunt head trauma in children in U.S. emergency departments. N Engl J Med 2014;371:1945-7.
9. Kupfermann N, Holmes DF, Dayan PS, Hoyle JD Jr., Atabaki SM, Holubkov R, et al. Identification of children at very low risk of clinically-important brain injuries after head trauma: A prospective cohort study. Lancet 2009;374:1160-70.
10. Shrivastava SR, Shrivastava PS, Ramasamy J. Scope of public health measures in ensuring road safety. J Inj Violence Res 2014;6:95-6.
11. Pal R, Ghosh A, Kumar R, Galwankar S, Paul SK, Pal S, et al. Public health crisis of road traffic accidents in India: Risk factor assessment and recommendations on prevention on the behalf of the Academy of Family Physicians of India. J Family Med Prim Care 2019;8:775-83.
12. Honavar SG. Driving blind – Should tests of visual function be mandatory for driving license? Indian J Ophthalmol 2019;67:193-4.
13. Dandonia R. Making road safety a public health concern for policy-makers in India. Natl Med J India 2006;19:126-33.
14. Raina SK. Need for a framework document on building competency in injury prevention. J Family Med Prim Care 2019;8:1814-5.
15. Mackett RL, Lucas L, Paskins J, Turbin J. A methodology for evaluating walking buses as an instrument of urban transport policy. Transport Policy 2003;10:179-86.
16. Rowland D, DiGuiseppi C, Gross M, Afolabi E, Roberts I. Randomised controlled trial of site specific advice on school travel patterns. Arch Dis Child 2003;88:8-11.
17. Adirim TA, Wright JL, Lee E, Lomax TA, Chamberlain JM. Injury surveillance in a pediatric emergency department. Am J Emerg Med 1999;17:499-503.
18. Kudal NK, Debnath PR, Sen A. Epidemiology of pediatric trauma and its pattern in Urban India: A tertiary care hospital-based experience. J Indian Assoc Pediatr Surg 2017;22:33-7.
19. Grivna M, Eid HO, Abu-Zidan FM. Pediatric and youth traffic-collision injuries in Al Ain, United Arab Emirates: A prospective study. PLoS One 2013;8:e68636.
20. Al Kilani H, Al Mosleh A, Khalid M, El Tawil M, Ibrahim T, El Madhoun I. Pediatric trauma: A hospital based study of pattern of childhood injuries in the state of Qatar. Middle East J Emerg Med 2001;1:18-22.
21. Crankson SJ. Motor vehicle injuries in childhood: A hospital-based study in Saudi Arabia. Pediatr Surg Int 2006;22:641-5.

22. Kapapa T, Kapapa M, Posovszky C, Gülke J, König R, Woischenck D, et al. Pediatric Head Injury: The Incidence of Multiple Injuries. J Behav Brain Sci 2016;6:254-67.

23. Rouse TM, Eichelberger MR. Trends in pediatric trauma management. Surg Clin North Am 1992;72:1347-64.

24. Eid HO, Abu-Zidan FM. Biomechanics of road traffic collision injuries: A clinician’s perspective. Singapore Med J 2007;48:693-700.

25. Akbarnia BA. Pediatric spine fractures. Orthop Clin North Am 1999;30:521-36, x.

26. Hadley MN, Zabramski JM, Browner CM, Rekate H, Sonntag VK. Pediatric spinal trauma. Review of 122 cases of spinal cord and vertebral column injuries. J Neurosurg 1988;68:18-24.

27. Babu RA, Arimappamagan A, Pruthi N, Bhat DI, Arvinda HR, Devi BI, et al. Pediatric thoracolumbar spinal injuries: The etiology and clinical spectrum of an uncommon entity in childhood. Neurol India 2017;65:546-50.

28. Gorrie C, Duflou J, Brown J, Gibson T, Waite PM. Extent and distribution of vascular brain injury in pediatric road fatalities. J Neurotrauma 2001;18:849-60.

29. Brody BA, Kinney HC, Kloman AS, Gilles FH. Sequence of central nervous system myelination in human infancy. I. An autopsy study of myelination. J Neuropathol Exp Neurol 1987;46:283-301.

30. Paus T, Zijdenbos A, Worsley K, Giedd JN, et al. Structural maturation of neural pathways in children and adolescents: In vivo study. Science 1999;283:1908-11.

31. Muizelaar JP, Marmarou A, DeSalles AA, Ward JD, Zimmerman RS, et al. Cerebral blood flow and metabolism in severely head-injured children. Part 1: Relationship with GCS score, outcome, ICP, and PVI. J Neurosurg 1989;71:63-71.

32. Marin JR, Weaver MD, Yealy DM, Mannix RC. Trends in visits for traumatic brain injury to emergency departments in the United States. JAMA 2014;311:1917-9.

33. Nuckley DJ, Ching RP. Developmental biomechanics of the cervical spine: Tension and compression. J Biomech 2006;39:3045-54.

34. Embree TE, Romanow NT, Djerboua MS, Morgunov NJ, Bourdeaux JJ, Hagel BE. Risk factors for bicycling injuries in children and adolescents: A systematic review. Pediatrics 2016;138. pii: E20160282.

35. Davison C. Injury among young Canadians: A National Study of Contextual Determinants: CHPR Team in Child and Youth Injury Prevention; 2014.

36. Dunbar G, Hill R, Lewis V. Children’s attentional skills and road behavior. J Exp Psychol Appl 2001;7:227-34.

37. Arnett JJ. Developmental sources of crash risk in young drivers. Inj Prev 2002;8 Suppl 2:i17-21.

38. Allen JP, Brown BB. Adolescents, peers, and motor vehicles: The perfect storm? Am J Prev Med 2008;35:S289-93.

39. Pitcairn TK, Edlmann T. Individual differences in road crossing ability in young children and adults. Br J Psychol 2000;91(Pt 3):391-410.

40. Whitemode D, Neilson K. The contribution of visual search strategies to the development of pedestrian skills by 4-11 year-old children. Br J Educ Psychol 2000;70(Pt 4):539-57.

41. Zeedyk MS, Wallace L, Spry L. Stop, look, listen, and think? What young children really do when crossing the road. Accid Anal Prev 2002;34:43-50.

42. NHS. What should I keep in my First aid Kit? Available from: https://www.nhs.uk/common-health-questions/accidents-first-aid-and-treatments/what-should-i-keep-in-my-first-aid-kit/. [Last accessed on 2019 Apr 03].

43. Alexiou GA, Sfakianos G, Prodromou N. Pediatric head trauma. J Emerg Trauma Shock 2011;4:403-8.

44. Wing R, James C. Pediatric head injury and concussion. Emerg Med Clin North Am 2013;31:653-75.

45. Murphy S, Duhaime AC. Update in pediatric neurotrauma. Curr Trauma Rep 2016;2:222-31.

46. ATLS Subcommittee, American College of Surgeons’ Committee on Trauma, International ATLS working group. Advanced trauma life support (ATLS®): The ninth edition. J Trauma Acute Care Surg 2013;74:1363-6.

47. Martin BW, Dykes E, Lecky FE. Patterns and risks in spinal trauma. Arch Dis Child 2004;89:860-5.

48. Slack SE, Clancy MJ. Clearing the cervical spine of paediatric trauma patients. Emerg Med J 2004;21:189-93.

49. Lally KP, Senac M, Hardin WD Jr, Hafel A, Kaehler M, Mahour GH. Utility of the cervical spine radiograph in pediatric trauma. Am J Surg 1989;158:540-1.

50. Zogg CK, Haring RS, Xu L, Canner JK, AlSulaim HA, Hashmi ZG, et al. The Epidemiology of Pediatric Head Injury Treated Outside of Hospital Emergency Departments. Epidemiology 2018;29:269-79.

51. Bener A, el-Rufaie OE, al-Soweidi NE. Pediatric injuries in an Arabian Gulf country. Int J Emerg Med 2007;3:224-6.

52. Osifo OD, Osagie TO, Iribhogbe PE. Pediatric road traffic accident deaths presenting to a Nigerian referral center. Prehosp Disaster Med 2012;27:136-41.

53. Rasouli MR, Rahimi-Movaghar V, Maheronnaghsh R, Youssefian A, Vaccaro AR. Preventing motor vehicle crashes related spine injuries in children. World J Pediatr 2011;7:311-7.

54. Razzaq JA, Sasser SM, Kellermann AL. Injury prevention and other international public health initiatives. Emerg Med Clin North Am 2005;23:85-98.

55. Dinh-Zarr TB, Sleet DA, Shults RA, Zaza S, Elder RW, Richards JL, et al. Reviews of evidence regarding interventions to increase the use of safety belts. Am J Prev Med 2001;21:48-65.

56. Macpherson A, Spinks A. Bicycle helmet legislation for the uptake of helmet use and prevention of head injuries. Cochrane Database Syst Rev 2008;CD005401.

57. Zaza S, Sleet DA, Thompson RS, Sosin DM, Bolen JC; Task Force on Community Preventive Services. Reviews of evidence regarding interventions to increase use of child safety seats. Am J Prev Med 2001;21:31-47.

58. Rivara FP, Grossman DC, Cummings P. Injury prevention. First of two parts. N Engl J Med 1997;337:543-8.