TRAUMATIC BRAIN INJURY

NATIONAL INSTITUTE OF MENTAL HEALTH AND NEUROSCIENCES,
BANGALORE - 560 029

Traumatic Brain Injury

THE TEAM

Gururaj G[a], Kolluri S.V.R.[b] , Chandramouli B.A[b], Subbakrishna D.K[c] & Kraus JF[d]

Research Officers[a]

Suryanarayana S. P and Rajashree Narasimhan Ananda, Balachandra, H.C.S.C.R Reddy

Data Manager[a]

Vijendra S. Kargudri

Departments of Epidemiology[a], Neurosurgery[b] & Biostatistics[c]
NATIONAL INSTITUTE OF MENTAL HEALTH & NEUROSCIENCES BANGALORE, India

and

Southern California Injury Prevention Research Centre[d],
UCLA School of Public Health, Los Angeles, USA[d]

Address for Correspondence

G. Gururaj
Professor & Head
Department of Epidemiology
WHO Collaborating Centre for Injury Prevention and Safety Promotion
National Institute of Mental Health & Neuro Sciences
Bangalore-560029, India. e-mail: guru@nimhans.kar.nic.in

Suggested Citation

Gururaj G, Kolluri S.V.R, Chandramouli B.A, Subbakrishna D.K and Kraus JF, "Traumatic Brain Injury", National Institute of Mental Health & Neuro Sciences, Publication no. 61, Bangalore - 560029, India. 2005

CONTENTS ►

FOREWORD

Traumatic Brain Injuries (TBIs) are a major public health problem in India, resulting in deaths, injuries and disabilities of young and productive people of our society. The economic losses to India are phenomenal, though unmeasured. As India progresses to greater growth and development in terms of motorization, urbanization, TBIs will increase in India. The recent World Report on Road Traffic Injury Prevention and The World Report on Violence and Health by World Health Organization clearly highlight the growing enormity of the problem of injuries across the world and the urgent need for well designed and evaluated programmes in prevention, management and rehabilitation. Countries like India have not placed much greater emphasis on prevention.

Any growth, development and progress in every society has to be balanced with appropriate safety policies and programmes in all areas. The failure to implement several proven countermeasures and neglect of people's safety has only resulted in increase of TBIs. Technological advancements in recent years have clearly reduced the case fatality rates from Injuries and TBIs, especially in Urban India. However, the problem continues to be high in rural and peripheral areas due to lack of adequate trauma care. Rehabilitation services are still to reach the vast parts of the country due to lack of facilities and skilled human resources. Thus, many injured continue to live with disabilities resulting in increasing socioeconomic burden and poor quality of life. Importance should be given to all three aspects of brain injuries, namely: prevention, management and rehabilitation, integrated through well-coordinated activities in a systematic approach. As India has resource limitations in all areas, more markedly in health care, policy makers and professionals need to identify cost effective means of developing integrated programmes.

The need for good quality scientific information for policy and programme development needs no overemphasis. The lack of research and good quality data in India is often a major barrier, as we tend to undermine the importance of the problem, even though it is a major public health issue. In order to bridge this gap, the Departments of Epidemiology, Neurosurgery and Biostatistics in collaboration with The Southern California Injury Prevention Research Center undertook this project over a period of three and a half years in Bangalore. This first extensive and in-depth study has documented several epidemiological dimensions of TBIs in India, revealing the enormity of the problem. This understanding should lead to more research and influence policies across India from several other centers. The efforts of the research team will be amply rewarded if more focus is laid on strengthening research to place injuries and TBIs on the public health agenda of our governments. I hope that the coming years will witness a decline in TBIs in the Indian region.

Dr. D. Nagaraja
Director/Vice-Chancellor
National Institute of Mental Health and Neuro Sciences
Bangalore-560 029, India.

March 05, 2005

PREFACE

Comprehensive research in India in the area of Traumatic Brain Injuries (TBIs) is extremely limited. Scientific information in this area is vital and a basic prerequisite to understand the enormity of the problem and its various determinants and various dimensions to formulate, implement and evaluate programs for reduction of morbidity, mortality, disability and socioeconomic losses in every country. Earlier research in India has been extremely limited and has been from isolated settings based on personal areas of interest by individual researchers.

Injuries are a major public health problem today. Injuries and TBIs in India have been increasing significantly due to rapid motorization, industrialization, migration and changing value systems of Indian society. The consequences on health are tremendous and have been underestimated due to absence of research. Apart from instantaneous deaths, the suffering and poor quality of life among survivors is a living testimony to the impact of TBIs.

Earlier research at NIMHANS has focused on examining epidemiological burden, disabilities and causation in a limited manner through small-scale independent studies. The need for a well-designed comprehensive study was felt by the team and also expressed by professionals on several platforms. The present study was thus conceived and carried out to examine in depth all aspects of TBIs registered at NIMHANS. The study has adopted well-defined scientific methodologies for measurement and quantification in several areas. This report summarizes the salient findings from this study to track events and changes from the time of injury occurrence till 2 years after hospital discharge. The contents focus on the characteristics of the injured persons, where did it occur? How did it occur?, Why did it occur ?, nature of prehospital and emergency care, course during hospital stay and nature – impact after discharge. As hospital based follow-ups were not adequate in terms of coverage, domiciliary interviews were conducted for in-depth interviews of patients and family members. Broadly, the findings of the study cover important issues related to prevention, management and rehabilitation along with identifying new areas for research. The various recommendations placed at the end of the report needs immediate attention of political leaders, policy makers and professionals.

This publication is also intended to stimulate and encourage research in the area of TBIs in India and other developing countries. "Accidents are no more accidents"; Unraveling the factors - causes, situations, circumstances, is crucial to initiate action in a scientific way. This understanding is also crucial to move from present pessimistic attitudes to more optimistic thinking in the area of prevention and rehabilitation. We hope that our efforts will be amply rewarded if readers consider promoting and conducting research in this area along with placing injuries and TBIs on the public health agenda of their respective communities.

Study team
NIMHANS

March 05, 2005

ACKNOWLEDGMENTS

THANKS

TO

NATIONAL INSTITUTE OF MENTAL HEALTH & NEURO SCIENCES,
BANGALORE, INDIA

and

SOUTHERN CALIFORNIA INJURY PREVENTION RESEARCH CENTRE,
UNIVERSITY OF CALIFORNIA, LOS ANGELES, USA

FOR

FINANCIAL SUPPORT TOWARDS THIS PROJECT

We sincerely acknowledge the support and encouragement from Dr. D. Nagaraja, Director/ Vice-Chancellor, NIMHANS and Dr. M. Gourie-Devi (former Director/Vice-Chancellor, NIMHANS) in conducting this study. We are highly thankful to Prof. Jess F. Kraus, Director, Southern California Injury Research Centre and Professor of Epidemiology, UCLA School of Public Health, Los Angeles, USA, for facilitating this study by providing guidance and financial support for conducting this study. Our sincere thanks to all the faculty members and residents of the Neurosurgery Department, Casualty Medical Officers and nursing staff of NIMHANS for extending all cooperation towards this study. We are deeply indebted to Mr. Joseph and Ms.Maria and their team from the medical records department of NIMHANS for helping with records on a day to day basis. We also are thankful to Dr. Suryanarayana SP, Dr. Rajashree Narasimhan, Mr. Ananda, Mr. H.C.S.C.R Reddy and Mr. Balachandra, Research Officers in the project for diligent and meticulous data collection and data entry in the entire project. Our thanks go to Mr. Vijendra S. Kargudri for efficient data management in the study. Thanks to Ms. Beereshwari for contribution towards manuscript development. Thanks are also to Mr. Ravindranath for language editing of the final report. Finally, we are extremely grateful to all patients and their family members for cooperation in this study, amidst their pain and suffering.

EXECUTIVE SUMMARY

India is facing the triple burden of communicable diseases, non-communicable diseases and injuries. The number of deaths, hospitalization, disabilities due to injuries has been increasing due to socio-demographic and epidemiological transition. The unprecedented motorization, urbanization, rapid industrialization, increasing media penetration across society, changing lifestyles and values of people along with absence of safety policies and programmes has added further to this Scenario. It is estimated that nearly 4,50,000 people died due to injuries during 2001 as per official report. As per a recent report entitled "First India Injury Report: Problem – Solutions", it is estimated that during 2004 nearly 8,50,000 persons died and 16.5 million were hospitalized due to injuries in India. Among various injuries, traumatic brain injuries (TBIs) are a leading cause of morbidity, mortality, disability, socio-economic losses and poor quality of life among survivors. It is estimated that nearly 1 million persons are injured, 200,000 people die and nearly 1 million require rehabilitation services every year in India. In the city of Bangalore alone, nearly 10,000 individuals sustain brain injury and more than 1,000 die every year. The related epidemiological information required for developing programmes in prevention, management and rehabilitation are not available in India due to lack of systematic research efforts.

The present study undertaken at NIMHANS (National Institute of Mental Health & Neuro Science) during 2000-03 aimed at bridging this gap by comprehensively examining all major aspects of Neurotrauma. NIMHANS provides care for nearly 60 - 70% of brain-injured persons in Bangalore city. 7,164 persons were enrolled into a Neurotrauma Registry during the year 2000 at NIMHANS. Trained research officers undertook data collection from emergency service department of NIMHANS round the clock using standard and validated instruments. Reliable methodological measures were used for measuring socioeconomic variables, injury causes (International Classification of Diseases -10th Revision and International Classification of External Causes of Injuries), severity (Glasgow Coma Scale), outcome (Glasgow Outcome Scale), disabilities (Modified Barthel's Index and Glasgow Outcome Scale - Extended Version) and Quality of Life (WHO Quality Of Life – BREF Version). While Phase–1 study focused on identifying and measuring all epidemiological correlates in a hospital setting, phases–II and III focused on identifying disability patterns, extent of socio-economic burden and measuring quality of life. Thus, all major issues with regard to preventive, managerial, rehabilitative and economic aspects have been addressed in this study from Bangalore. The scenario is likely to be similar for other Indian cities and in some of the other developing countries.

The present descriptive summary report provides salient data from the study and future reports will discuss individual aspects in detail. On an average, 20 - 25 patients are registered every day with a head injury at NIMHANS and TBIs constituted 39% of total registration during 2000.

- Individuals in the age group of 21 - 35 years were represented to the extent of 40% with children (< 15 years) and elderly accounting for 20% and 5%, respectively with a male to female ratio of 4:1.

- The majority of those injured were with less than collegiate levels of education, employed in skilled and unskilled jobs, married and with income levels of < Rs. 3,000 per month.

- Road Traffic Injuries (RTIs) (59%), Falls (25%) and Violence (10%) were the major causes of neurotrauma.

- RTIs occurred predominantly in the age group of 15 - 40 years, among men and during evenings and nights (66%). Pedestrians (26%), two-wheeler riders (31%) and pillions (12%) and bicyclists (8%) were represented in higher numbers. The majority of the RTIs took place in midblocks of roads (70%). Not wearing helmets, driving under influence of alcohol, over speeding and overtaking, crossing in the middle of the road were the major behavioural factors. Poor visibility of vehicles and or roads and mechanical problems of vehicles were responsible for one-third of injuries, road design and structural issues were responsible for another 30% of TBIs.

- Falls were the second-leading cause (25%), with the majority occurring in children and elderly. Amongst them domestic falls (57%) were the leading cause followed by falls in public places (15%). Accidental falls at home (26%), falls from stairs/steps (22%) and fall from building (14%) were the common pattern of fall injuries.

- Violence/assault (10%) were the third-leading cause, more frequent among men and associated with use of blunt physical objects.

- Prehospital and emergency care was poor in the areas of - availability of First Aid Services (even though many had contacted a health care provider, recognition and management of brain injuries was poor), high referrals from local hospitals (even for injuries which could have been managed at peripheral levels), safer transportation (ambulances were used only in 25%) and longer interval between injury and reaching definitive hospital (only 13% within one hour and 40% in one to three hours).

- In total, 71% of TBIs were mild, 15% moderate and 13% severe in nature based on Glasgow Coma Scale. Concussions (36%), contusion (32%), skull fractures (12%) and brain haemorrhages (13%) were the injury patterns. Severe polytrauma was noticed in 22% of total injuries.

- Measurement of outcome based on GOS at hospital discharge time revealed that 5.5% died in hospital and 4% were discharged in a persistent vegetative state. Severe and moderate disabilities were observed in 15% and 37%, respectively.

- Various types of disabilities affecting activities of daily living, memory, communication, social interaction and ability to work were seen in 52% of the patients at hospital discharge time.

- Phase II and III study of the present project (community based follow-up study) focused on measuring disability patterns, socioeconomic burden and quality of life at 1 and 2 years after discharge. Nearly 35% had problems in health, social, economic dimensions of life at 1-year follow-up, while more than 50% of them continued to have problems in similar areas at second

year follow up also. The study has brought out a clear need for well planned and cost effective rehabilitation services in the city.

- The sudden occurrence of TBIs had placed a major economic burden on individuals and families to meet costs of hospitalization and rehabilitation. The affected families had to spend resources (their own or borrowed from external source) to reach definitive hospitals, to take care of injured person during hospital stay and after discharge. This however excludes expenditure met by the hospital to provide care as these costs are subsidized in public hospitals. The indirect costs due to loss of work and income are substantial and are not routinely included in costing exercises. Thus, the total costs are huge and phenomenal for developing societies.

- The quality of life was poor in nearly 30% of brain-injured persons at two years post discharge.

The study after comprehensively examining all major aspects of neurotrauma has placed several recommendations for prevention, management and rehabilitation of brain injuries. These recommendations are based on findings from study, perspectives of professionals and reactions of survivors and families. Information from project has been freely shared with policymakers, professionals and public (through press) for bringing in well-organized service and prevention programmes. The Government of Karnataka should urgently consider implementing the following major interventions through its member departments with the broader aim of reducing the burden of TBIs. These include:

i) Implementing helmet legislation by immediate notification and strict enforcement;

ii) Reducing drinking and driving by strict enforcement;

iii) Speed control mechanisms within and outside city by engineering and enforcement measures;

iv) Improving pedestrian facilities by engineering solutions;

v) Increasing visibility of vehicles and roads;

vi) Better organization of emergency and prehospital care facilities;

vii) Introducing trauma audits in hospitals;

viii) Strengthening training of doctors and allied personnel in early recognition and management of brain injured persons;

ix) Improving facilities in taluks and district hospitals (making them as integrated trauma care centres); and

x) Organization and delivery of rehabilitation services.

Description of these recommendations along with important details can be found at the end of the report. Needless to say, increasing awareness across society for various measures should be inbuilt into respective programmes. A greater level of awareness on safety on roads, homes, workplace is very much required at all levels with development and implementation of safety policies and programmes. This requires integration and better coordination along with implementation and evaluation of programmes at all levels. Undoubtedly, this man-made tragedy can be effectively controlled and needs a vision and mission to act.

1

Introduction

The demographic, epidemiological and economic transition in India has changed the health scenario in a significant way during the last two decades. This shift in health problems and priorities has brought the entire spectrum of non-communicable diseases and injuries to the forefront of health care delivery system. Among these emerging problems, man-made and behavior-linked injuries occupy a significant place. The rapid urbanization, industrialization, motorization and changing lifestyles of individuals have given rise to a plethora of problems, among which injuries top the list. A number of social factors accompanying this change like increasing migration, large-scale housing and construction activities, economic reforms, increasing import of technology without safety criteria, lack of safety measures on road at home and in work and play sites, emerging problem of alcohol and drugs, increasing violence and crime rates and the general absence and disregard to safety practices at all places has contributed to an alarming increase of injuries. The gradual decline of communicable diseases and advances in health care technology has also been one of the factors for the emergence of injuries as a major public health problem. A steep increase in vehicle and human population traversing the adverse road situations has made road traffic injuries a serious condition. Meagre prehospital care with added delay in emergency care has only added further to rising mortality and disability rates. The phenomenal increase in morbidity, mortality, disability and socio-economic impact from injuries, and brain injuries in particular, during the past decade has been a matter of increasing concern among professionals and policy makers.

At the global level, it is estimated that the annual incidence and mortality from Acquired Brain Injury (ABIs) or Traumatic Brain Injuries (TBIs) is 200 and 20 per 1,00,000 per year, respectively [1]. National level data in India is not available for traumatic brain injuries as in many developed countries. The only epidemiological study undertaken in Bangalore by the authors has revealed that the incidence, mortality and case fatality rates were 150/1,00,000, 20/1,00,000 and 10%, respectively[2, 3]. At the national level, nearly two million people sustain brain injuries, 0.2 million loose their lives and nearly a million need rehabilitation services every year. Nearly 10,000 people sustain brain injury every year in the city of Bangalore with more than 1,000 deaths. The data also showed that the majority of these individuals are males, in their early years (5 - 44 years) and often involved in road traffic injuries. The survivors of injuries had various problems in day-to-day life affecting almost every sphere of life. The study also highlighted the lack of comprehensive, integrated, preventive and rehabilitative programmes in the city of Bangalore as noticed in the rest of the country.

Epidemiological indicators of TBI in India & Bangalore (estimates for 2001).

Indicators	Rates	Population with TBI in India	Population with TBI in Karnataka	Population with TBI in Bangalore
Incidence	150/100,000/yr	2,000,000	79,100	10,000
Mortality	20/100,000/yr	200,000	10,500	1,000
Prevalence	97/100,000/yr	1,000,000	51,000	5,000
Case fatality rate	9%	-	-	-

Among all types of injury, neurotrauma — injury to the central nervous system has serious consequences and major implications. Literature from the West and limited data from India indicate that these injuries cause enormous suffering and losses not just to individuals, but also families and communities [4]. The resulting damage from an injury to an individual would range from a state of sudden shock to instantaneous death. A survivor will have brain injuries varying from superficial injuries to a permanent vegetative state. Apart from physical damage and neurological disabilities of different types, psychosocial problems like fear, anxiety and suffering will affect the individual even after discharge from the hospital. The recovery from injury will take years depending on physiological factors and pathological damage. The affected individual will go through pain and suffering of immense nature for long periods of time. Hospitalization may be needed for brief or long periods. During this period he/she will lose work and has to pay for medical expenses, often determined by type of injury and level of care along with accessibility to services.

Apart from loss of precious human resources in their productive age groups, traumatic brain injuries place significant burden on our societies. Damage to property and vehicles, loss of productive man-years, work absenteeism and compensation claims are only a few manifestations of injury. Indirectly, decreased productivity, cost of repair and maintenance of vehicles and goods, and long-term impact of scholastic and occupational loss are phenomenal and unmeasured. The burden on health care services is considerable as public funds are allocated towards acute, intermediate and long-term care. With increasing technological orientation for diagnosis and management along with privatization of health care, the economic impact on individual, family and society has increased and is bound to increase. Information on economic burden of injuries is not available for the country as a whole or for any selected cities. It is estimated that the total costs of road traffic injuries alone is about 3% of GDP in India [5].

The World Health Organization and several other leading agencies have recognized the critical need for effective ways to prevent the occurrence of these injuries, to provide

appropriate care for those injured and for rehabilitation of survivors. In order to effectively organize and implement these programmes in an acceptable, cost-effective and sustainable manner reliable information is required in every country. This is crucial to influence policymakers and public health administrators. These programmes require good information based on well-designed and scientific epidemiological studies. Information is required on the number of persons affected, persons at increased risk of injury, nature of external causes, severity of injuries, outcome and impact of traumatic brain injuries for designing and implementing interventions.

Epidemiology, defined as "the study of distribution and determinants of health and related events in population" and the application of this information for improving health of communities. A major purpose of epidemiologic studies and surveillance is to provide information necessary for primary prevention (avoiding the occurrence of injury), secondary prevention (early diagnosis and treatment) and tertiary prevention (mitigating the sequelae of injury and reducing consequent disability). To assess the public health importance of injuries and to design and implement effective injury prevention programmes, it is necessary to describe the (1) magnitude of the problem (e.g., total number of persons with neurotrauma in terms of incidence and mortality rates and prevalence of resulting impairments), (2) population at highest risk of injury (varied subgroups in population), (3) causes (external causes and circumstances of injury) and, (4) severity and outcome (e.g., type of injury, case fatality ratio, patient disposition, resulting disability, cost of care and impact of injuries). Any interventions developed and implemented in society needs to be evaluated in a scientific way. Thus, descriptive, analytical or interventional studies help in defining the problem and bringing the issue on the public health agenda of individual societies and communities. However, careful attention has to be paid for case definition, case identification methods, inclusion and exclusion criteria, and classification methods in any type of study. Epidemiology also has to move beyond 'counting heads' to organizing affordable, cost-effective and sustainable injury prevention policies and programmes in developing countries.

Neurotrauma epidemiological research is the scientific study of distribution (problem) of traumatic brain injuries in a given population, their causes and risk factors with the purpose of identifying mechanisms and approaches to prevent (reduce) the occurrence of injuries, reduce severity and to organize need-based rehabilitation services. Establishing neurotrauma registries in different areas helps in comparing the various dimensions of the problem, developing interventional strategies and to learn success and failures for future remedial measures.

2

Neurotrauma registry: Role and purpose

The use of disease-specific registries in epidemiological research needs no special emphasis. Several registries established in different areas have shown that population based and hospital-based registries are widely accepted and have been of tremendous scope for descriptive, analytical and interventional research, thus contributing for the development of services. The hospital-based and population-based Cancer Registries in India are classic examples of registries and their contribution to cancer prevention and control are well known. To register, means: 'to set down formally in writing, to enter or record in a precise manner'. Brooke in 1974 described a registry as availability of uniform information, about individual persons, collected in a systematic manner to serve a predetermined purpose [6]. Several uses of a registry are: (1) Identification of individuals; (2) Immediate protection of an individual; (3) Surveillance purposes, (4) Treatment evaluation and (5) Service evaluation [7].

A Neurotrauma Registry provides detailed description on various components of neurotrauma. Two major issues to be kept in mind are systematic data collection activities based on uniform set of data from all registered cases, and keeping the registry sensitive (not to miss out subjects with TBI) and specific (to exclude non TBI subjects). This would ensure enrolling all TBI subjects in a given hospital. Thus, a neurotrauma register provides detailed description of all individuals sustaining a TBI during a given period (beginning with a date) in a defined population, the major demographic features of which are known and representative of the selected population.

The criteria of a neurotrauma registry are:-

1) Uniform definition
2) Inclusion of all subjects with a TBI in a defined area
3) Case identification from multiple sources
4) Case evaluation by a trained team
5) Consistency in diagnosis
6) Established classification methods.

Employing these criteria will help in strengthening data-collection procedures and bring uniformity across centres or even within one centre. These issues will be elaborated further in subsequent sections of this report. This essentially amounts to adopting objective diagnostic criteria, objective diagnostic evaluation, uniformity in information gathering by all persons involved and data pooling on a prospective basis. It is essential to note that case definition;

methods of case ascertainment and procedures of classification remain uniform throughout the operation of a registry. If changes are made, special care should be taken in documenting these changes and appropriate provisions are made in analysis and interpretation of data.

A neurotrauma registry serves different purposes. Some of the important uses are listed below:

a) If established in a defined geographical area and all subjects with TBI are included, The registry reveal vital data on morbidity, mortality and disability rates (Incidence, fatality and disability rates).

b) The registry can identify major causes, pattern and mode of injury occurrence in sub-categories of injured persons, thus identifying "Population at risk".

c) It improves diagnostic accuracy as all subjects are weighed in comparison with gold standard.

d) Registry helps in identifying and establishing association of number of health conditions associated with neurotrauma, specially in establishing cause-effect associations over a period of time (e.g.: Epilepsy and TBI's).

e) The registry is continued over a period of time, will reveal temporal changes in occurrence and pattern of neurotrauma.

f) Since much of the information will be gathered in a registry, it can serve as a basic ground tool for clinical and intervention trials. It would highlight how much change has been brought about by an intervention.

g) The registry brings out problems in diagnostic classification with every chance of improving the same in future.

h) The registry helps in developing and understanding prognosis in neurotrauma management and in anticipating future risks.

i) Information from a neurotrauma registry will ultimately reveal the socioeconomic burden and health needs of a community. Once again, this will help in creating awareness among policy makers and public to place neurotrauma prevention high on the public health agenda.

For a neurotrauma registry to be effective, "Quality Control" is the key word. Quality control process must be inbuilt and must be known and followed by all members of the team. There should also be some hidden checks to test internal validity. An "Operational Manual" must be developed at the beginning of study for uniformity of procedures. This

manual should highlight case definition, inclusion and exclusion criteria, definition of various terms, ways of collecting information, checking for information from other sources, coding procedures and other aspects. This manual should be used for training of all personnel in a registry. It should also highlight computerization process and data management along with steps in data analysis and report development. While this will ensure reliability and uniformity in data collection and computerization, it will also improve timeliness of work components, reliability of reports, smooth running of a registry and greater utilization of data; thus bringing increasing participation and satisfaction among all team members. The contents of the manual should lay down a 'step-by-step approach' of various mechanisms, variable definition coding and entry of proformas in a registry. The manual should be piloted and updated as and when changes and revisions are made in the study. Apart from adhering to the instructions in the manual, "monitoring and supervising" by other members of the team is crucial for the success of a registry. The supervisory staff should look for whether all cases of TBI and Spinal Cord Injury (SCI) have been included, whether training imparted is adequate? whether interviews in emergency services, wards, and rehabilitation units are satisfactory? whether proforma entries are correct? whether coding has been done as per specifications? Check whether any blank columns have been encountered? etc.,

A neurotrauma registry assumes that all individuals with a traumatic brain injury will be covered from a defined geographical area. But in many countries and in cities, there will be multiple caregivers. It is essential, therefore, to include all centres. Nevertheless, registries can be developed in individual institutions. As per our earlier study [2], it was established that nearly 70% of brain injured persons receive care from National Institute of Mental Health And Neuro Sciences (NIMHANS) in the city of Bangalore. Hence, it was decided to set up the registry at NIMHANS. A registry by covering a defined geographical area will be representative of the population it is covering and data must be used for all activities in that area.

3

The City of Bangalore

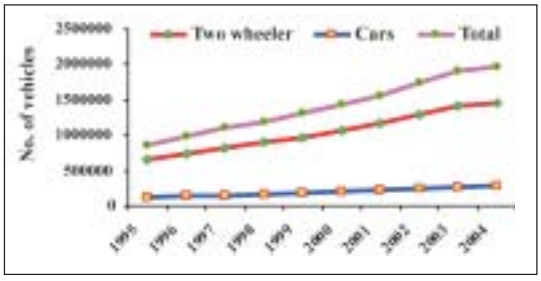
In recent years, the city of Bangalore has been acclaimed as one of the 10 new high-tech cities in the world as per many media surveys. The city of Bangalore with a population of 5.8 million, spread over 451 km^2., is an emerging hub of social, economic and technological revolution in India. The city has been recording an unprecedented increase of population, industrialization, urbanization, and migration of families from rural areas to city along with the ongoing socio-demographic and epidemiological transition. An accompanying effect of

these changes has been an increase of social, economic and health problems in the city. In this changing scenario, injuries and traumatic brain injuries have emerged as a leading public health problem in Bangalore and Karnataka. Not a single day passes in the life of people without reading or hearing about these injuries.

Bangalore urban district had a decennial growth rate of 21% during 1991-01[8]. The city has a population density of 2204/sq.km. (average for Karnataka state - 234/sq.km.). The male to female ratio as per the latest census was 960 females per 1000 males. The literacy level of the population was 66% (males 72% and females 60%).

The unabated growth of vehicle population in the city has given rise to an increase of injuries and brain injuries over a period of time. At present (during 2000), the city has 1,400,000 registered vehicles with 75% being two wheelers alone. This has increased to 1,800,000 by 2004. Every year, nearly 14,000 persons (8,000 officially reported) are injured in road accidents with a fatality rate of 6-7%. Simultaneously, other causes of injuries like falls, violence, and industrial accidents are also on the increase. In the absence of an injury or neurotrauma surveillance system, these figures are an underestimate of the situation and the need for a neurotrauma registry to understand the problem has been felt for a long period of time.

Figure 1a: Trends of motorization growth in Bangalore, 1995-2004



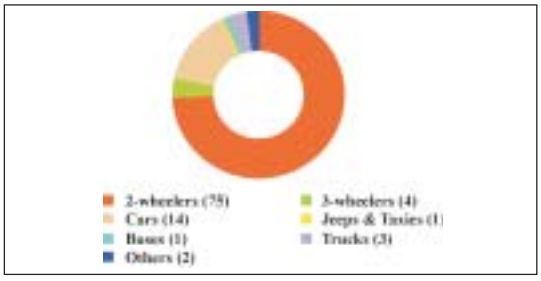
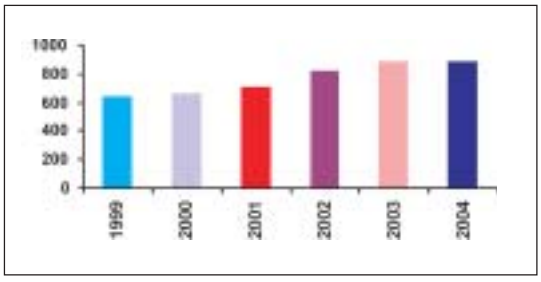
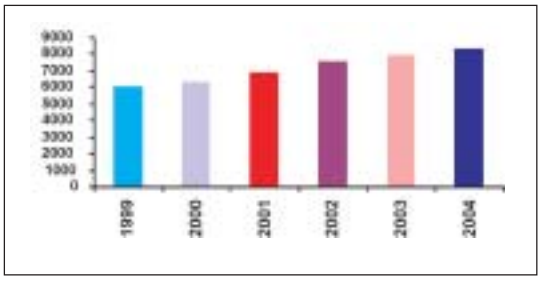


Figure 1b: Trends of road traffic deaths and injuries in Bangalore, 1999-2004.





4

The study centre: NIMHANS

NIMHANS is a premier institution in India and South East Asia, recognized for its contributions in service, training and research in the area of mental health and neuro sciences, and also traumatic brain injuries. Since 1994, the institute has been working as a deemed university even though it is 50 years old in its existence. A multidisciplinary integrated approach is the mainstay of this institute. The institute provides services for a large number of patients from within and outside the state of Karnataka. A large number of trainees also come from outside the state and India as part of the training programmes sponsored by various agencies. Research projects with support from various bodies of the Government of India, WHO, UNICEF and other agencies on a number of topics are under progress.

Services for neurotrauma patients are provided on various fronts. A well equipped and hygienic casualty department, modern radiological and laboratory facilities, state-of-the-art operating theatres, short-stay and long-stay admission facilities, regularly run outpatient services, a post-trauma clinic on every Tuesday, rehabilitation services along with committed staff are the hallmarks of patient care features. The Neurosurgical Department provides continuous care for trauma patients on a 24-hour basis with supportive inputs from casualty staff in the Emergency Service Department. Patients from Bangalore, other parts of Karnataka and India are the regular beneficiaries of these services.

Research in the area of neurotrauma has continued on focused clinical questions and also on major public health issues. The Departments of Epidemiology and Neurosurgery have undertaken various studies in focused areas of TBIs. Some of these studies have paved the way for formulation of policies and programmes, increasing public awareness, developing new action plans and for placing neurotrauma on the public health agenda. However, previous studies have been of a shorter duration and on a limited number of subjects. Hence, it was decided to establish a "Neurotrauma Registry" at NIMHANS to examine the problem of TBI in a comprehensive manner from all angles. The registry has helped in bridging the gap in our understanding of neurotrauma and to develop data required for prevention, management and rehabilitation. The findings will also be used to make inputs for various policies and programmes in the long run. Further, information generated at NIMHANS will also be a reflection of the situation in other cities of India and other developing countries as well.

4.1 Objectives of Neurotrauma Registry

The aim of developing neurotrauma registry at NIMHANS was to collect comprehensive and vital information from all subjects with TBI seeking help from NIMHANS. The specific

objectives were to identify the

1. Proportional morbidity, mortality and case fatality rates for TBIs at NIMHANS.
2. Magnitude and role of various external causes and risk factors in the occurrence of TBIs.
3. Pattern and pathways of prehospital and emergency care.
4. Nature of interventions among hospital registered and admitted subjects.
5. Various disabilities among subjects with TBI at the time of hospital discharge and at follow-up periods of one year and two years.
6. Economic impact of TBI from a sample of total patients.

5
Methodology

5.1 Phase-I Study

The current project was undertaken at NIMHANS during the period March 2000 to March 2003, over a period of three years. The research team was led by an epidemiologist, 2 Neurosurgeons and a Biostatistician. The entire Department of Neurosurgery including all clinical staff and those from the associated departments of radiology, neurology and other departments participated in the study. An operation manual was developed at the beginning of the study, which was adopted during the entire study period to maintain uniformity in data collection procedures[9] (available on request)

During the study period, a total of 7,164 head injury patients were registered at NIMHANS. The Emergency Service Division was covered round-the-clock by a team of three trained research officers. The research officers were trained at the beginning of the study on all study components in a detailed manner. The focus of training was on theoretical aspects, importance of conducting research, concept of neurotrauma registry, detailed description of variables in the proforma and scope of the study. The physiological aspects of brain functioning and its importance, various causes of brain injury in the community, mechanisms of brain injury, methods of presentation of brain-injured persons, precautions to be taken at the time of data collection, data entry, data coding and cross verification techniques were explained. A series of practical training sessions were undertaken in the beginning to familiarize the investigators in the art and science of data collection. Inter and Intra-observer variations were kept to a minimum and the entire data collection methodology was standardized at the beginning of the study. Information was collected from patients/family members/ relatives/police during

their time of hospital stay depending on the status of the patient and availability of an accompanying person.

Informed consent was obtained from patients and their families for participating in the study after explaining the nature of the study. Those unwilling to participate, uncooperative and not being able to answer were not included in the study. Preference was given to management of patients and data collection was undertaken subsequent to patient care. All information was kept confidential and not disclosed to any persons.

A case of traumatic brain injury for the purpose of this study [10] was defined as "An occurrence of injury to the head (arising from blunt or penetrating trauma or from acceleration-deceleration forces) by an external agent with at least one of the following:

a) Observed or self-reported alteration of consciousness or amnesia due to head trauma, and/or,

b) Neurological or neuropsychological changes (determined from neurologic and neuropsychological examinations) or diagnosis of skull fracture or intracranial lesions (determined from radiological examination or other neuro-diagnostic procedures) that could be attributed to head trauma and/or,

c) Occurrence of death resulting from trauma with head injury or traumatic brain injury listed on the Death Certificate, Autopsy Report, or Medical Examiner's Report in the sequence of conditions that resulted in death."

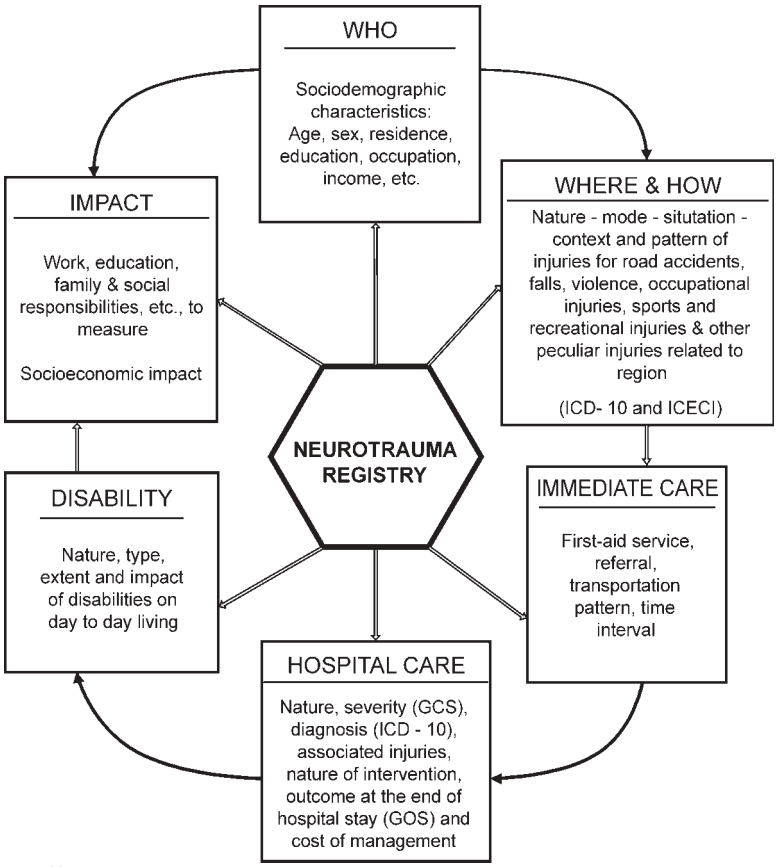
The clinical definition of TBI excludes (1) lacerations, avulsions or concussion of face, eye, ear, scalp or forehead without the other criteria listed above; 2) fractures of facial bones without the other criteria listed above; 3) birth trauma; 4) cerebral anoxia that is not a complication of brain trauma; 5) inflammatory infarction, toxic or metabolic encephalopathy that are not complications of brain trauma; 6) neoplasm; 7) brain infarction (stroke) or intra-cranial hemorrhage without associated trauma.

A case of spinal cord injury was defined as acute traumatic lesion of neural elements in the spinal canal (spinal cord and cauda equina) resulting in temporary or permanent sensory deficit, or autonomic dysfunctions. These deficits or dysfunctions may be incomplete or complete.

Specially designed, pre-tested and pre-coded proforma was developed for the study. This instrument was validated at the beginning of the study and changes were made prior to the beginning of the study. The areas of information gathering were identification and socio-demographic characteristics; risk factors specially history of alcohol consumption, cause of

injury - situation - mode and pattern; nature, pattern and pathways of pre hospital care; severity and nature of brain injuries; clinical diagnosis and ICD-10 coding; management aspects; disabilities at the time of discharge; and hospital costs for management. (Figure 2)

Figure 2: Information gathering under Neurotrauma Registry



Socio-demographic details included age, sex, education, occupation, family type and size. The information with regard to occupation was coded further by using the ICMR classification systems[11]. Information on alcohol usage was based on self-reported usage and/or accompanying medical or police information. The external causes of injury, pattern and circumstances was made as per ICD-10 classification methods[12]. The registry also examined the location and situation of injury occurrence, activity when injured, mechanism and object causing injury. The recently proposed ICECI (International Classification of External Causes of Injuries) by WHO[13] was adopted in the study in addition to ICD-10 methods.

Pre-hospital care details included availability of first-aid services, referral pathways, mode of transportation, time interval between occurrence of injury and reaching a definitive hospital and the nature of persons accompanying the injured person.

Brain injury details were collected from medical records of the hospital and also from notes of the attending consultant. The clinical diagnosis and radiological diagnosis (wherever a CT or an MRI was taken) were entered into the proformas under the guidance of the principal investigator or individual consultants. Various details with regard to loss of consciousness, presence of amnesia, type of body injuries, and the nature of brain injuries were included in

data collection systems. The clinical diagnosis was made based on ICD-10 classification systems. The severity of brain injury was assessed based on Glasgow Coma Scale [14]. Abbreviated Injury Scale [15] was used to classify all injuries. The Injury Severity Scale for each subject was developed based on the AIS.

Management details with regard to emergency care, medical or surgical care was documented for each patient based on the intervention followed at NIMHANS. The duration of hospital stay was also taken from hospital records.

The economic aspects (the cost of managing a head injury patient in emergency medical services of NIMHANS) were calculated in a systematic way by including direct and indirect hospital costs.

All subjects were evaluated at hospital discharge time with Glasgow Outcome Scale[16]. The disability assessment was undertaken for all severe, moderate and mild brain injury subjects with the help of modified Barthel's Index [17].

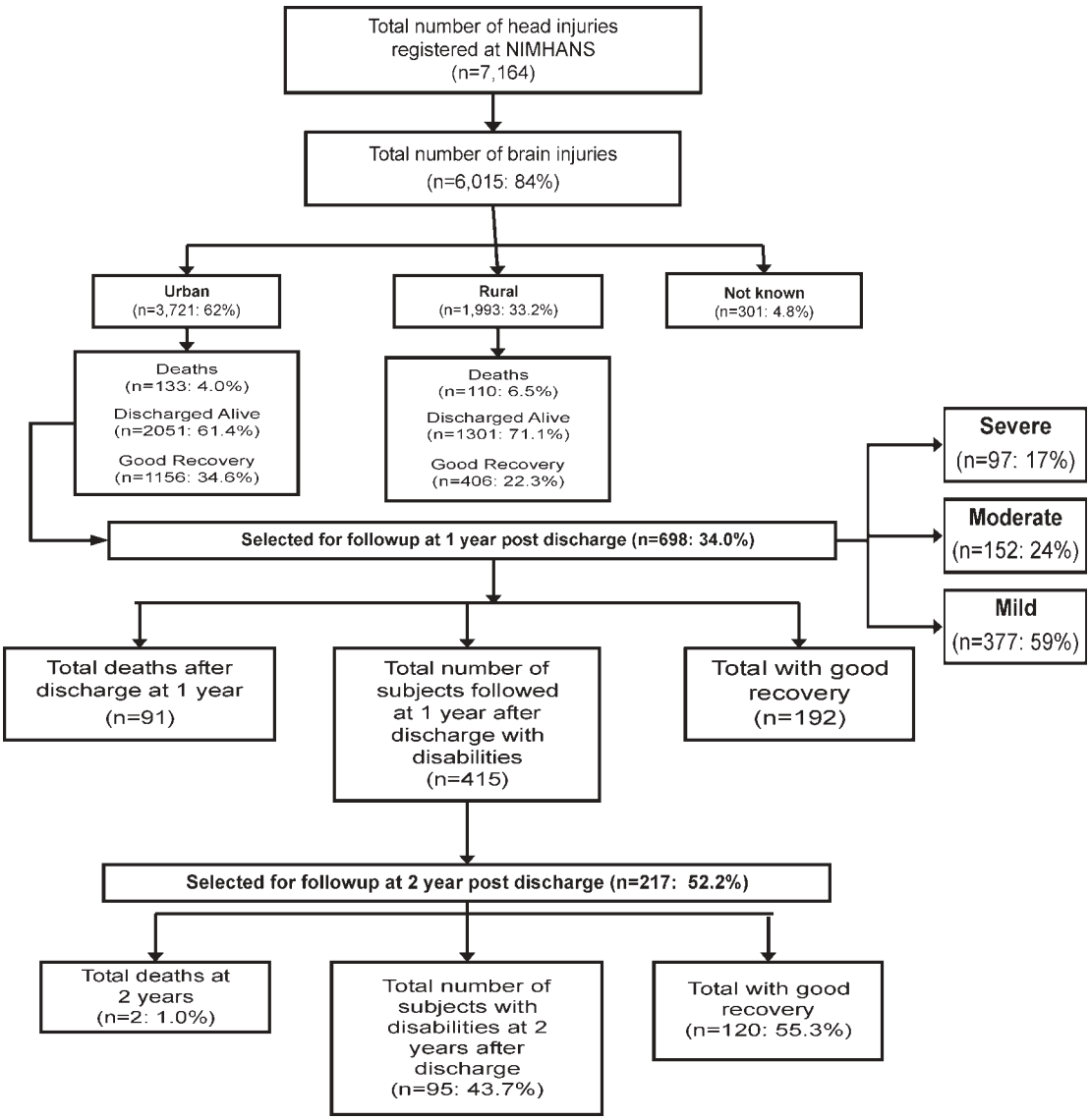
Thus during the period March 2000 - March 2001, a total of 7,164 patients were registered and were enrolled into the Neurotrauma Registry at NIMHANS.

5.2 Phase-II Study

The Phase-II Study (March 2001 - March 2002) focused on measuring disabilities, identifying socio-economic burden and specifying the quality of life among brain injured persons. The subjects were identified based on the criteria of (i) discharged alive with a diagnosis of brain injury and (ii) resident of the city of Bangalore. All subjects with a diagnosis of serious brain injury (GCS < 8), 50% of those with a moderate brain injury (GCS 9-12) and 10% of mild brain injuries (GCS > 13) were recruited for the second phase of study.

A total of 698 patients qualifying under these criteria were contacted one-year (± 10 days) post discharge. Letters were mailed and telephone contacts were established at the beginning and were requested to come to NIMHANS. Since the response was not satisfactory (only 13%), it was decided to undertake domiciliary visits by the team of trained research officers. The disability and impact of TBIs were evaluated with the modified version of GOS - extended version[18]. The socioeconomic burden was assessed with the scale developed by Pai and Kapur at NIMHANS. The impact of brain injury on the individual and family was assessed in the areas of activity in daily living, communication, social interaction, family burden, family responsibility and economic impact. World Health Organization - Quality of Life (BREF Version) was used to assess quality of life[19]. (Figure 3)

Figure 3: Methodology of Neurotrauma Registry (Phase I - III)



5.3 Phase - III Study

Phase-III of the study (March 2002 - March 2003) focused on the second year follow up of 219 brain-injured persons who were diagnosed with brain injury at discharge, had health - psychological problems at one year follow up and were on treatment at first follow-up contact. The same team contacted these people with the same instruments at one year (± 10 days) after the first follow-up contact.

The economic impact was assessed by both direct and indirect methods. The cost of managing head injury patients at NIMHANS was a comprehensive method by focusing on expenditure incurred towards manpower, equipment, basic infrastructure and maintenance costs. From the families, expenditure incurred till reaching the hospital, during the course of hospital stay and during follow-up periods after discharge from the hospital was collected systematically.

The entire data collection at different stages of the project was monitored on a day-to-day basis by the principal investigator. Mechanisms were set up for daily, weekly and monthly review of the progress of activities by the entire team. All data collected from a total of 7164 patients was checked for completeness, accuracy and coding. Data analysis was undertaken using the EPI-INFO Version 6[21].

The present report is descriptive in nature highlighting salient findings from the study on vital aspects of major importance. The available data would be analyzed in depth in a stratified manner on various aspects of traumatic brain injuries in a rapidly developing city of India in due course of time.

6
Results

NIMHANS is a tertiary referral institution for care and management of brain-injured persons in the city of Bangalore. The services of the institution are utilized by many patients from other districts of Karnataka State and from even other parts of India. Traumatic brain injuries have been increasing significantly over a period of time. At NIMHANS, the number of persons with head injuries has increased from 5,592 (34%) to 6,720 (41%) during the period 1998 to 2002 (Table 1). Apart from acute trauma care, NIMHANS also provides rehabilitation services and human resource development programmes for medical and allied personnel. Several research projects in the areas of prevention, care and management and rehabilitation are in progress.

Table 1: Distribution of TBIs & other emergency patients at NIMHANS, 1998-2002*

Year	Number of Emergencies	Number of Head Injuries	Percent of head injuries to total emergencies
1998	16454	5592	34
1999	15982	5724	36
2000	15763	6204	39
2001	16038	6060	38
2002	16229	6720	41

* As per Medical Records Department

During the study period, a total of 7,164 patients were

registered in the emergency and casualty divisions of NIMHANS. As mentioned under methodology, information was collected from all patients seen in the institution. However, in some instances, information was not available due to unconscious status of patients, attendants not being available, immediate referral of patients to other hospitals, immediate referral of patients for investigations like CT, MRI and others, patients brought by police in hit-and-run injuries and non-cooperation of the patients.

The distribution of TBIs over the period March 2000 to March 2001 is shown in Table 2. On an average, nearly 600 patients use the services of NIMHANS on a regular basis every month. During the study period there were no significant variations in the distribution of TBIs seen at NIMHANS.

Table 2: Month-wise distribution of TBIs at NIMHANS

Month	No.	%
March (2000)	505	7.0
April	599	8.4
May	642	9.0
June	603	8.4
July	611	8.5
August	578	8.1
September	592	8.3
October	630	8.8
November	585	8.2
December	604	8.4
January (2001)	658	9.2
February	557	7.8
Total	7164	100.0

6.1 Socio-demographic characteristics

The distribution of TBIs as per age and sex is of vital importance to identify high-risk groups. As per the present study, males were at a higher risk with a male to female ratio of 4:1 (Table 3). Among them, those in the age group of 16 - 45 years constituted 65% of total patients. Children < 15 years and elderly > 60 years accounted for 20% and 5%, respectively, in the study population. Among females, children < 15 years were represented to the extent of 29% (male children -17%) in the series.

Table 3: Age and Sex distribution of TBIs

Age in years	Male (%)	Female (%)	Total (%)
0-5	318 (5.5)	179 (13.0)	497 (7.0%)
6-10	330(5.7)	150(10.9)	480 (6.7)
11-15	333(5.8)	72 (5.2)	405(5.7)
16-20	509(8.8)	95 (6.9)	604(8.4)
21-25	954(16.5)	131 (9.5)	1085(15.2)
26-30	871(15.1)	132 (9.6)	1003 (14.0)
31-35	626(10.9)	109(7.9)	735(10.3)
36-40	478(8.3)	128 (9.3)	606(8.5)
41-45	395(6.8)	102 (7.4)	497(7.0)
46-50	304(5.3)	84 (6.1)	388(5.3)
51-55	181(3.0)	51 (3.7)	232(3.2)
56-60	179(3.0)	58 (4.1)	237 (3.3)
> 60	291(5.0)	88 (6.3)	379(5.2)
Not known	13 (0.2)	3 (0.2)	16(0.2)
Total	5782(80.7)	1382(19.3)	7164 (100.0)
Mean ± SD	30.8 ± 16.5	29.8 ± 19.9	30.6 ± 17.2

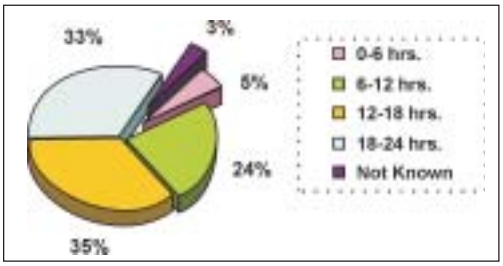
Information on socio-demographic characteristics is of importance to understand the distribution of TBIs in society. This also helps in targeting particular groups for different intervention programmes. As shown in Table 4, nearly 58% of the injured persons were from urban Bangalore and 36% were from rural areas with absence of

Table 4: Socio-economic characteristics of TBI subjects as per education, marriage, occupation & income (n = 7164)

Education	No.	(%)
Illiterate	1566	21.8
Primary	808	11.2
Secondary	766	10.7
High school	1351	18.9
Pre-university	330	4.6
Vocational	144	2.1
Graduate	424	5.9
Post-graduate	41	0.6
Professional	105	1.5
Not applicable	493	6.9
Information not known	1136	15.8
Occupation		
Professional	125	1.7
Semi-professional	1016	14.2
Skilled	1299	18.2
Semi-skilled	564	7.9
Unskilled	830	11.6
Unemployed	121	1.7
Retired	99	1.4
Housewife	466	6.5
Student	982	13.7
Not applicable	613	8.6
Others	1030	14.3
Information not available	19	0.2
Marital status		
Married	3210	44.8
Unmarried	1272	17.7
Widowed	110	1.5
Divorced	7	0.1
Separated	5	0.1
Information not Available	982	13.7
Not applicable	1578	22.1
Family Income		
< 3000	6265	87.5
3001- 6000	637	8.9
> 6000	262	3.7

information in 6% of the patients. Majority of patients were with lower levels of education constituting 30% of the series. Nearly 50% of the subjects were married and 17% were unmarried in the series. One third of the injured persons were involved in semi-professional or skilled occupational categories. Housewives and students constituted 6.5% and 13.7% in the injured groups. It was interesting to note that nearly 88% were with income levels of < Rs. 3000 per month and only 3.7% had an income of > Rs. 6000 per month.

Figure 4: Time of Occurrence of Injury



Time of occurrence of brain injury is another crucial determinant reflecting distribution patterns. Nearly one-third each of the brain injuries had occurred during 12 - 18 hours and 18 - 24 hours, respectively. As the majority of these injuries were due to road crashes, it could be related to alcohol influence, greater speeds and poor visibility factors.

6.2 Alcohol and TBIs

Alcohol consumption has been identified as a major risk factor for occurrence of traumatic brain injuries. Alcohol not only influences occurrences, but also

poses problems in diagnosis and management of injured persons. In the study population, nearly 24% of subjects agreed to regular alcohol intake in their lives. Nearly, 884 (18.4%) were found to be under the influence of alcohol at the time of injury as revealed by self-reports and medical certification by the attending physicians. Among them, nearly two-thirds sustained a road traffic injury, one-fourth sustained a fall and about 12% were injured in a violent act (Table 5).

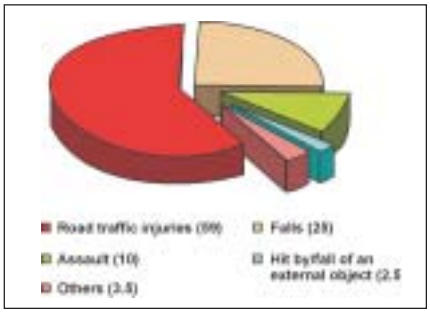
Table 5: Alcohol consumption among subjects with head injury (Males & 16+yrs) (n=4731)

	No.	%
Subjects with history of regular alcohol intake	1139	23.7
Subjects with history of alcohol consumption at the time of injury	884	18.4
RTIs	550	62.2
Falls	196	22.2
Violence	108	12.2
Others	30	3.4

6.3 Causes of TBIs

Among those injured, 59% of TBIs were due to road traffic injury, followed by falls (25.0%) and assaults (10.3%). Hit by or fall off an external object, work-related injuries and sports injuries accounted for 2.5%, 0.1%, and 0.2%, respectively. This observation indicates that road traffic injuries are the leading cause of TBIs in Bangalore (Figure 5). Some of the earlier Indian studies have shown similar distribution in various parts of the country[3].

Figure 5: Cause of Injury (%)

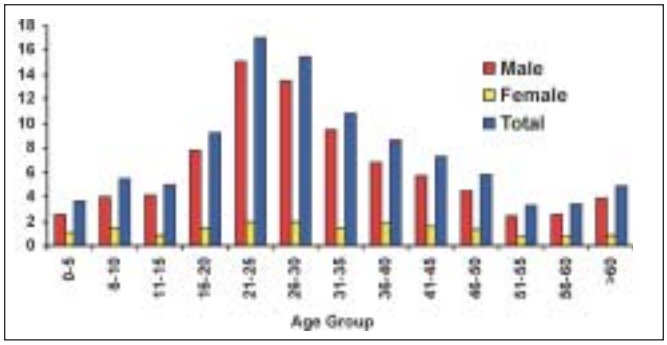


Analysis of information on place of injury occurrence revealed that 72% of TBIs had occurred on roads, 20% at homes, 3% in agricultural lands, 2% in construction places (due to fall or fall off objects), 1% in play areas and 0.6% in industrial work places.

6.4. Road Traffic Injuries and TBIs

Figure 6 depicts the age and sex distribution of individuals sustaining a brain injury in a traffic environment. Among the injured, road traffic injuries increased from 10 years, reached a peak in 21 to 30 years, gradually declined thereafter and once again increased in the elderly age groups. Highest number of TBIs with RTIs was in the age group of 21 to 35 years (43%) with a

Figure 6: Age & Sex-wise Distribution of TBIs due to RTIs (%)



Mean age for men = 31.5 ± 15.5;
Mean age for women = 32.3 ± 17.9

Table 6: Socio-demographic characteristics of RTI subjects as per occupational, educational, marital, & income status (n = 4190)

Education	**No.**	**(%)**
Illiterate	784	18.7
Primary	405	9.6
Secondary	443	10.5
High school	888	21.1
Pre-university	250	6.1
Vocational	116	2.8
Graduate	330	7.9
Post-graduate	32	0.8
Professional	86	2.2
Not applicable	154	3.7
Information not known	702	16.7
Occupation		
Professional	108	2.6
Semi-professional	666	15.9
Skilled	830	19.8
Semi-skilled	311	7.4
Unskilled	423	10.1
Unemployed	62	1.5
Retired	63	1.5
Housewife	293	7.0
Student	569	13.6
Not applicable	631	15.1
Others	234	5.6
Marital Status		
Married	1932	46.2
Unmarried	862	20.6
Widowed	58	1.4
Divorced	3	0.1
Separated	3	0.1
Not known	607	14.5
Not applicable	725	17.1
Family income		
Rs. < 3000	3319	79.3
Rs. 3001 - 6000	672	16.0
Rs. > 6000	199	4.7

male to female ratio of 4:1. Children and elderly constituted 15% and 5% of the total subjects. Surprisingly among children, there was an overrepresentation of females compared with male children (12% versus 20%). The mean age of occurrence of RTIs among men and women was 31.5 years and 32.3 years, respectively.

In similarity with the observation on time of occurrence of brain injury nearly two-thirds of road traffic injuries leading to brain injury were seen between 12 noon to 12 midnight injuries during 6 p.m. - 6 a.m. constituted % of TBIs. Once again this could be linked to alcohol consumption, greater speed and poor visibility factors. Early morning injuries were represented to the extent of 25% in the series. (Figure 7)

Educational categories of TBIs subjects involved in an RTI revealed that nearly 30% were with < 5 grades of education and only 10% were beyond graduate levels. Majority were employed in semi-professional and skilled categories. Students, housewives were represented to the extent of 14% and 7%, respectively. Nearly 50% were married and more than ¾ had a total family income of less than Rs. 3000 per month (Table 6).

Analysis of road user categories revealed that pedestrians, two-wheeler riders and two-wheeler pillions constituted 26%, 31% and 12% in the series. Bicyclists were represented to the extent of 8% and passengers to the extent of 5%. This signifies the fact that drivers, pillions of motorized two wheelers and pedestrians are at greater risk of sustaining brain injuries as in Bangalore shown in Table 7.

Figure 7: Time of occurrence of RTIs

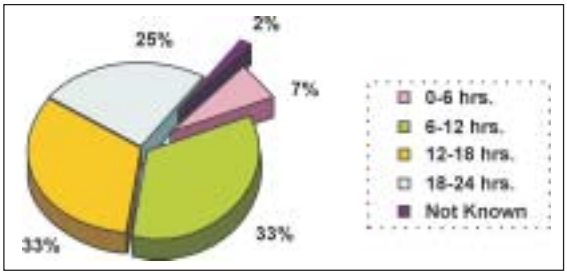


Table 7: Road user categories in TBIs due to RTIs

Status of person	No	%
Two-wheeler rider	1295	30.9
Pedestrian	1076	25.7
Two-wheeler pillion	506	12.1
Bicyclist	322	7.7
Passenger of bus	202	4.8
Passenger in matador	139	3.3
Auto rickshaw passenger	102	2.4
Car occupant	100	2.4
Passenger of lorry	80	1.9
Auto-rickshaw driver	56	1.3
Tractor occupant	44	1.1
Car driver	24	0.6
Driver of lorry	22	0.5
Rider of animal drawn vehicle	19	0.5
Driver of matador	17	0.4
Tractor driver	10	0.2
Driver of bus	7	0.2
Railway passenger	7	0.2
Stationary individual	1	0.0
Not Known	140	3.3
Others	21	0.5
Total	4190	100.0

Information on mechanism of traffic injury is vital to understand the process and pathway of crashes. Detailed investigation of even severe crashes and deaths is not an established practice in India. Information provided here should be cautiously extrapolated as it is based on hospital subjects and as reported by them.

Investigation into the mechanism of road traffic injury revealed that 62% of brain injuries were due to a collision with another vehicle and 38% due to non -collision modes. Among those colliding with other vehicles, it was observed that 16%, 14% and 25% collided with a heavy vehicle like lorry, cars and motorized two-wheelers, respectively. Collision with bus was observed to the extent of 10% in the series. In addition, nearly three-fourths of injuries had occurred in the middle of the road and only 5% at any circle, thus indicating the fact that middle-of-the-roads(mid blocks) are one of the risk situations for RTIs. Further analysis of this data will be undertaken for sub-groups of the study population. This will be of help to recommend specific strategies for the safety of individual category of the road user. Among

the injured persons, 65% also reported that the road condition was satisfactory and did not have problems. Presence of a road problem like ditches, road openings, road humps, slippery areas, lighting effects and others was a contributory factor in 15% of crashes. Nearly 1/5 of the injured persons could not clearly comment on the condition of roads at the time of injury (Table 8). Geographical analysis of RTIs has not been made as the data is only from a single institution.

Among the 1,801 two-wheeler riders and pillions who sustained a TBI, skid and fall was the commonest mode of injury in 42% of TBI's. Head-on collision with another vehicle and fall from a moving vehicle were other major injury mechanisms in 15% and 11% of injuries (Table 9).

The majority of injuries among two-wheeler riders had occurred in the middle of the road (72%). Other common places of crashes were circles (6.4%) and near the end of the roads (near turning points 3.8%). While this information is of importance to identify specific preventive strategies, in-depth analysis on a large number of all road traffic injuries is required to arrive at precision in geographical analysis.

Table 8: Characteristics of RTIs resulting in TBIs (n = 4,190)

A. Collision of injured person's vehicle with	**No**	**%**
Lorry	408	15.8
Car	357	13.8
Motorbike + scooter + moped	722	27.9
Bus	259	10.0
Matador	257	9.9
Auto rickshaw	191	7.4
Bicycle	59	2.3
Tractor	27	1.0
Others	25	1.0
Pedestrian	15	0.6
Animal drawn vehicle	9	0.3
Not Known	260	10.0
B. Location of injury		
Middle of the road	2994	71.4
Not known	750	17.8
At circle	192	4.5
End of the road	160	3.8
Other	64	1.5
Near traffic signal	30	0.7
C. Road condition at injury site		
Good	2784	66.4
Dangerous / Hazardous	883	21.1
Hole or ditch	227	5.4
Road hump	105	2.5
Lighting defect	79	1.9
Slippery Area	61	1.5
No specific condition	35	0.8
Construction work	16	0.4

* Does not include mechanism of pedestrian injuries

As there is no compulsory helmet legislation in Karnataka, the number of two-wheeler riders and pillions wearing helmets at the time of injury was less than 5%. However, two-wheeler riders and pillions constituted 43% of the total injured persons in the study.

Among the 1,076 pedestrians injured, 41% were hit by a motorized two-wheeler, 15% by a car and 11% by three-wheeled auto rickshaw. Heavy vehicles like buses, lorries and medium-sized vehicles like matadors injured a pedestrian in one-fourth of collisions (Table 10). The

location of pedestrian injuries were once again predominantly in the middle of the road (78.2% - while crossing from one side to the other side or while walking or playing), at the end of the road (4.6%), at circles (4.2%) and near traffic signals (0.4%).

Table 9: Injury mechanism among two-wheeler* injuries (n = 1801)

Mechanism	No.	%
Skid & Fall	752	41.9
Head-on collision	273	15.2
Collision pattern unspecified	213	11.9
Fall from a moving vehicle	197	11.0
Side collision	107	6.0
Nose to tail	63	3.5
Rear end hit	61	3.4
Hit fixed object	39	2.2
Hit and run	35	1.9
Angle collision	19	1.1
Hit parked vehicle	19	1.1
Others	16	0.9
Overturn	3	0.2
Fall from a stationary vehicle	4	0.2
Total	1801	100

*Includes two-wheeler rider and pillion

Table 10: Distribution of Pedestrian TBIs as per collision pattern (n = 1076)

Hit by	No.	%
Two-wheelers	438	41.4
Car	159	15.0
Auto rickshaw	118	11.2
Matador	95	9.0
Bus	80	7.6
Lorry	73	6.9
Not known	69	4.7
Bicycle	25	2.4
Others	7	0.7
Animal drawn vehicle	5	0.5
Tractor	4	0.4
Not applicable	21	1.9
Pedestrian	1	0.1
Total	1076	100.0

How and why did it happen?

I was going on my two wheeler on Bangalore - Hosur road after completing my office work. It was 8:30 pm and dark. I was in a hurry, in speed and was not wearing a helmet. There were 2 buses going in front of me at 50 km speed. I tried to overtake the second bus from left side. There was some space between the 2 buses initially. But as I approached for overtaking, the bus in front suddenly stopped. The driver of first bus was moving left and second bus could not move forward. I too suddenly applied brakes and turned left. I was ejected out of my vehicle and my head hit the ground. Luckily, there was some space between me and the bus, otherwise, I would have been killed.

I was walking with my father after completing our evening walk in a park. We were on footpath and then started crossing the road. There was movement of vehicles from both sides and no traffic lights or policeman. We waited for few minutes, but traffic never seemed to slow down. I suddenly decided to cross and had to take my ageing father who was slow in walking. We started crossing and suddenly a car came in full speed and hit us in high speed. My father fell down and hit the ground. He was unconscious immediately. By the time we took him to a hospital, he had passed away.

I was travelling in a night bus from Bangalore to Shimoga. I was asleep. The next thing I realized was that I was in a hospital bed. I learnt later that the bus while taking an acute turn in full speed went and rammed into a tree. The driver along with 17 other people were brought back to Bangalore and admitted. My family was informed 16 hours later about my state. I might have hit my head to the metallic object of my front seat. I also learnt later that the bus driver was drunk and was driving a bus which had brake problem.

To identify various human, vehicle and environmental factors responsible for causation of RTIs and to prioritize these for intervention programmes, 1508 RTI persons were interviewed in the Casualty with the help of semi-structured questionnaire after completion of treatment procedures. These interviews were partially open ended, with all information being documented in the form of a narrative as reported by the injured person/ accompanying person present at the time of the crash. The written history was undertaken for factor analysis with classifications made into human, vehicle and road-related factors alone, along with their interactions. Nearly 98% of injuries were due to a combination of more than one factor (mean 5 ± 2). The involvement of various factors varied with the type of road, user category and involvement with another vehicle or environment. The five major human factors responsible for injury were over-

speeding, overtaking another vehicle in speed, not wearing helmet, driving under the influence of alcohol and sudden road crossing without observation. The prominent five vehicle factors were: poor visibility of vehicles, loss of balance, brake failure, problem with head and taillights and overloaded vehicles. The predominant environmental/road/system factors were absence of efficient and reliable public transport, poor street-lighting conditions, obstacles on existing roads, poorly designed roads and absence of traffic systems. Immediate emergency care was not available for more than half of the patients. There were many other factors present in each of the three domains apart from the ones mentioned above (Box 1).

Box 1: Causative factors for Road Traffic Injuries based on Qualitative Analysis

(only five major factors have been provided based on ranking)

Human Factors	Vehicle Factors	Environmental/System Factors
Over speeding	Poor visibility	Absence of reliable & efficient public transport and coordinated traffic systems
Overtaking	Loss of balance	Poor street lighting conditions
Not wearing helmet	Brake failure	Poorly-designed roads, obstacles on existing roads
Driving under the influence of alcohol	Problem with head & tail lights	Absence of timely and effective trauma care
Sudden road crossing without observation	Overloaded vehicles	Absence of enforcement of safety laws

Lack of efficient trauma care has not been included in this table and has been dealt separately

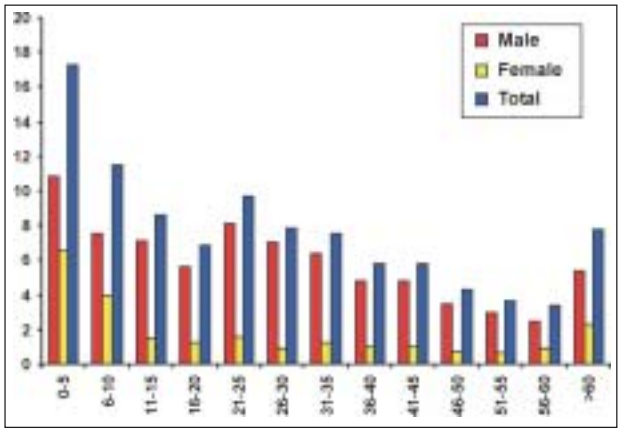
6.5. Falls and acquired brain injuries

Falls were the second leading cause of TBIs. Information on age and sex distribution of fall-related injuries is provided in Figure 8. A bimodal distribution was observed with children and elderly contributing for the highest number of falls. Falls occurred in greater numbers among female children in the age group of < 5 years (27.0%), followed by 6 to 10 years (16.5%). Elderly > 60 years were seen to the extent of 7% among men and 10% among women. The mean age of occurrence of falls among men and women was 28.2 years and 20.1 yrs, respectively. Male-to-female ratio of fall injuries was 4:1 in the series

The socio-economic characteristics of fall-related injuries revealed that nearly 52% of the injured were with educational levels of < 7 standard and were employed in skilled or unskilled jobs. Students accounted for 19% of fall injuries (Table 11). Majority of the injured were from poor families with a monthly income of < Rs.3000/- per month.

Almost an equal number of falls was observed in urban and rural areas in the study. Domestic falls were the leading pattern of falls (57%), followed by falls in public places (15%). Falls were also commonly seen in agricultural places, construction sites, industrial places, and in play areas. Investigation into the nature of falls revealed that accidental falls at home (26%), falls from stairs or steps (22%), fall on the same level (16%), fall from or out of a building (14%), fall from a tree (11%) and fall from ladder (5%) were the commonest pattern of falls. The average height of fall was < 10 feet in nearly two-thirds of injuries. The nature of landing surface was also hard areas in almost all the falls. As in the case of RTIs, most of the falls had occurred during evenings or late nights (Table 12).

Figure 8: Age and Sex distribution of TBIs due to Falls (%)



Mean age for men = 28.2 ± 29.9;
mean age for women = 20.1 ± 19.1

Table 11: Socio-demographic characteristics of falls subjects as per occupational, educational, marital, & income status (n = 1795)

Occupation	**No.**	**%**
Professional	4	0.2
Semi-professional	161	9.0
Skilled	247	13.7
Semi-skilled	135	7.4
Unskilled	229	12.7
Unemployed	38	2.1
Retired	33	1.8
Housewife	122	6.8
Student	324	18.4
Not applicable	169	9.4
Others	330	18.4
Not known	3	0.1
Education		
Illiterate	455	25.4
Primary	296	16.5
Secondary	194	10.8
High school	262	14.6
Pre-university	37	2.1
Vocational	14	0.8
Graduate	42	2.3
Post-graduate	5	0.3
Professional	12	0.7
Not applicable	302	16.9
Not known	175	9.6
Marital Status		
Married	687	38.3
Unmarried	216	12.0
Widowed	43	2.4
Divorced	2	0.1
Separated	137	7.6
Not known	2	0.1
Not applicable	708	39.5
Family Income		
< 3000	1545	86.1
3000 - 6000	209	11.6
> 6000	41	2.3

Table 12: Characteristics of falls as per place, nature, height and landing surface.

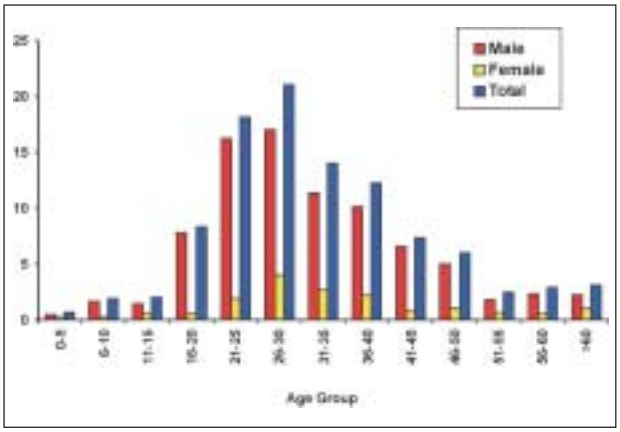
Place of Residence	**No.**	**%**
Urban	1147	63.9
Rural	598	33.3
Information not available	50	2.8
Total	1795	100.0
Place of Fall		
Domestic	1019	56.7
Public places	275	15.3
Agricultural	165	9.1
Construction site	111	6.1
Not known	67	3.7
Industrial	64	3.5
Others	47	2.6
Play site	30	1.6
School	17	0.9
Nature of Fall		
Accidental fall	464	25.9
Fall from stairs or steps	387	21.6
Fall on same level	283	15.8
Fall from or out of building	249	13.9
Fall from a tree	200	11.1
Fall from ladder	76	4.2
Fall into hole or other opening in surface	35	2.0
Fall from same level due to pushing/collision	32	1.8
Fall due to specific medical condition	27	1.5
Not known	23	1.2
Fall due to effect of drugs	19	1.1
Average Height of Fall (in feet)		
0 - 5	568	38.5
6 - 10	518	35.2
11 - 15	234	15.9
16 - 20	95	6.4
21 - 25	23	1.6
26 - 30	22	1.5
> 30	12	0.9
Nature of Landing Surface		
Hard	1581	88.2
Not known	68	3.8
Soft or mild	65	3.6
Building material	65	3.6
Others	16	0.8

It was holiday time and I had taken my son along with his friends to a fun park. They were all playing and got onto a merry go round. I was scared and he was scared too. But, his friends pulled him into the merry go round. I told the operator not to operate it fast and to stop after two rounds. After they got in and wheel started moving in full speed and they were all screaming. After 7-8 rounds, suddenly there was a loud noise and the wheel chain had snapped. All children fell down and some were thrown in the air. My son and all others got injured and luckily no one died. I got him admitted to a hospital and we were referred to 2 other hospitals due to lack of doctors and facilities. He survived, but has difficulties in learning and memory.

6.6. Violence and Neurotrauma

Violence of various types is known to be a causative factor in the etiology of TBIs by several studies. Nearly 10% of TBIs in the present study were due to an assault. As shown in Figure 9, the majority of assault injuries occurred in the age group of 21 to 40 years and was more among men compared with women. The mean age of occurrence of TBI due to an assault among men and women was 32.7 yrs and 35.3 years, respectively. Nearly 52% of assaults were reported from urban Bangalore and 45% from rural areas. Majority of the injured persons were semiskilled, unskilled or skilled category of workers (46%), with lower levels of education (50%) and were married (57%). Nearly 89% of assault victims were from lower socio-economic strata of society. Commonly available blunt physical objects were responsible for almost all brain injuries. TBI due to gunshot injuries was recorded in only one patient during the study period (Figure 9 and 10; Table 13).

Figure 9: Age and Sex distribution of subject due to Assault (%)



Mean age for men = 32.7 ± 12.6; mean age for women = 35.3 ± 14.0

Figure 10: Distribution of Patients involved in violence as per place of residence.

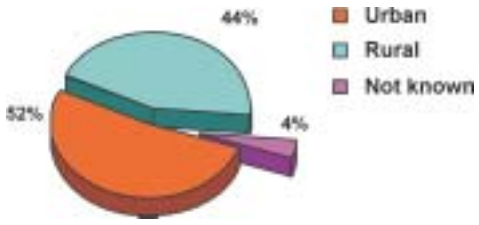


Table 13: Socio-demographic characteristics of TBIs due to Assault as per occupational, educational, marital, & income status (n = 736)

Occupation	**No.**	**%**
Professional	4	1.2
Semi-professional	151	20.5
Skilled	152	20.7
Semi-skilled	83	11.3
Unskilled	108	14.7
Unemployed	11	1.5
Retired	2	0.3
Housewife	36	4.9
Student	39	5.3
Not applicable	136	18.5
Others	8	1.1
Not known	3	0.1
Education		
Illiterate	237	32.2
Primary	60	8.2
Secondary	80	10.4
High school	138	18.8
Pre-university	30	4.1
Vocational	8	1.1
Graduate	38	5.2
Post-graduate	3	0.4
Professional	5	0.7
Not applicable	136	18.5
Marital Status		
Married	420	57.1
Unmarried	132	18.0
Widowed	7	1.0
Divorced	1	0.1
Separated	1	0. 1
Not known	119	16.2
Not applicable	55	7.5
Family Income		
< 3000	651	88.6
3000 - 6000	70	9.5
> 6000	14	1.9

We were 4 brothers and we always used to argue, quarrel, fight over property matters. On many previous occasions our fight had become bitter and harsh. On this day it was same once again. Two of them were drunk and could not even talk clearly. The arguments turned very fierce. My 3rd brother in a fit of rage, took an iron rod that was in a corner and hit my second brother on the head. The force was so much that he started bleeding profusely. We took him to hospital and doctors informed that he had a skull fracture and his eyes are damaged beyond repair.

6.7. Prehospital and emergency care

The availability, accessibility, affordability and utilization of prehospital and emergency care are major determinants for survival and outcome in TBIs. An investigation into the pattern, nature and utilization revealed that nearly 85% contacted a health care provider soon after the injury. However, the quality of first-aid services was far from satisfactory. It was limited only to control of bleeding and treatment of wounds (Table 14).

Table 14: Status of pre-hospital & emergency care (%)

	RTIs n = 4190	Falls n = 1795	Assault n = 734	Others n = 445	Total n = 7142
First-aid services					
Received	84.9	79.8	89.5	81.1	84.1
Not received	13.1	17.8	8	15.1	13.7
Not known	2	2.4	2.5	3.8	2.2
Source of referral					
General practitioners	6.1	12.5	3.3	7.6	7.5
Government hospital	43.1	29.6	69.8	39.7	42.4
Private teaching hospital	3.4	3.2	1.8	4.3	3.1
Sanjay Gandhi Accident Relief Center	1.4	0.8	1.3	0.9	1.3
Private non-teaching hospitals	15.5	16.9	5.8	15.1	14.8
Direct	13	17.2	7.9	15.1	13.5
Primary health centre	1.7	0.6	1.2	0.7	1.4
Others	0.9	1.2	0.6	2.6	0.9
Not known	1.2	1.6	1.5	1.7	1.4
No. of Medical contacts					
0	12.9	17.3	8.6	15.6	13.6
1	75.1	69.8	70.2	71.6	74.0
2	9.3	9.7	10.9	8.5	9.6
> 3	2.7	3.1	2.2	4.2	2.7

The source of referral revealed that neighbouring government hospitals were the major source of referral in 42% of injuries. The private non -teaching hospitals and private teaching hospitals within the city had referred 18% of the cases. Only 14% of injured persons had reached the hospital directly on their own. There were no significant differences with regard to various injury causes in the source of referral. In three-fourths of the injuries, the patients had made at least one medical contact with another hospital before reaching NIMHANS (Table 14). In all, 10% of the brain-injured persons had contacted more than two hospitals before reaching NIMHANS.

Table 15: Transportation pattern and time interval among subjects with TBI (%)

Mode of transportation					
	RTIs	**Falls**	**Assault**	**Others**	**Total**
Auto rickshaw	26.6	40.6	28.9	23.4	30.6
Private vehicle	24.2	23.3	18.5	26.0	23.3
Ambulance	25.5	14.5	20.0	16.1	22.0
Public vehicle	2.3	5.5	6.8	5.9	3.7
Own vehicle	0.5	1.1	0.4	0.5	0.7
Hoysala/Police	5.7	1.4	9.4	9.7	5.0
Others	0.7	1.1	0.5	1.2	0.8
Not known	14.4	12.4	15.4	17.3	14.0
Time interval between injury & reaching a definitive hospital					
< 1 hr	13.2	11.7	5.9	12.1	12.0
1 - 3	32.6	26.9	24.4	22.2	29.7
3 - 6	23.2	19.7	22.5	24.1	22.3
6 - 12	13.4	10.9	17.7	13.2	13.2
12 - 18	4.1	5.3	6.4	3.8	4.6
18 - 24	2.6	5.1	4.1	3.1	3.4
> 24	7.6	16.5	14.3	11.3	10.8
Not known	3.2	3.9	4.8	10.2	3.9

The mode of transportation was predominantly private vehicles and locally available three-wheeled auto rickshaws in 23% and 31%, respectively. An ambulance was used for transportation in 22% of the injured patients. In more than half of the injuries, a family member or a different person had accompanied the injured person to NIMHANS. This was slightly high among fall-related injuries as compared to other injury causes.

Availability of early and appropriate care after an injury is a major determinant in avoiding secondary injuries and death. Even though, the majority had received some first-aid soon

after injury, all of them were referred from different places. In the study, it was observed that only 12% reached a definitive hospital in less than an hour and 30% in 1 - 3 hours. In half of the injured, the interval between injury and reaching a hospital exceeded 6 hours, with 10% reaching beyond 24 hours.

There were significant differences in prehospital and emergency care between urban and rural patients. First-aid services were not received by nearly 80% of the injured in rural areas. Many of the injured patients had contacted private (teaching or non-teaching) hospitals as the first contact and were subsequently referred to NIMHANS and (rural/urban ratio being 57%: 35%) this was higher among rural patients. Most noticeably, more than 75% of the rural subjects had reached NIMHANS beyond three hours, as compared with 45% of the urban patients. The ambulance usage was significantly higher in rural areas (29% vs. 17%) compared with urban areas. Transportation by private vehicles was also higher in rural areas (35% vs. 17%). On the contrary, many of the urban patients reached a hospital by a local three wheeler (42%) or a police/Hoysala vehicle (6%). These findings reflect that availability and quality of prehospital and emergency care services are extremely poor and deficient in rural areas (Table 16).

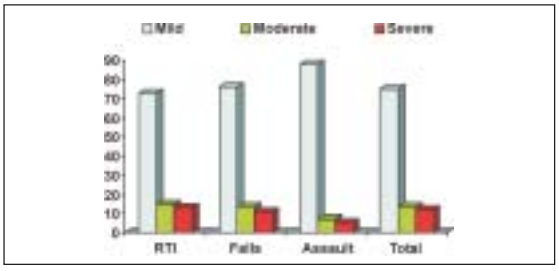
Table 16: Status of pre-hospital & emergency care in urban and rural areas (%)

	Urban	Rural
First-aid services		
Received	80.3	22.1
Not received	19.7	79.9
Source of referral		
General practitioners	8.6	6.5
Government hospital	18.7	15.8
Private teaching hospital	35.7	57.1
Direct	17.6	11.2
Primary health centre	17.8	6.7
Others	0.5	2.7
Not known	0.1	1.1
No. of Medical contacts		
0 (directly)	17.6	6.9
1	74.3	77.2
2	7.3	14.5
> 3	0.3	1.2
Mode of transportation		
Auto rickshaw	42.3	13.0
Private vehicle	17.5	34.9
Ambulance	17.5	28.8
Public vehicle	2.0	6.9
Own vehicle	0.7	0.6
Hoysala/Police	6.0	1.8
Others	14.0	13.8
Time interval between injury & reaching a definitive hospital		
< 1 hr	17.3	4.0
1 - 2	21.0	8.5
2 - 3	19.7	9.9
3 - 6	20.1	28.5
> 6	24.9	49.1

6.8. Severity and nature of brain injuries

Based on Glasgow Coma Scale, it was observed that nearly 71% of the injuries were mild, 15% were moderate and 13% severe brain injuries. This varied significantly across different injury causes. Moderate and severe brain injuries were higher in RTIs and falls

Figure 11: Severity of TBIs based on GCS



(Figure 11), compared with those injured in violent acts.

Table 17: Nature of brain injuries (based on ICD -10)

	ICD - 1		ICD - 2		Total	
	No.	%	No.	%	No.	%
Cerebral concussion	1870	36.1	527	33.6	2397	35.5
Cerebral contusion	1839	35.5	343	21.8	2182	32.3
Skull fractures	571	11.0	216	13.8	787	11.7
Brain Haemorrhage	561	10.8	321	20.4	882	13.1
Unspecified	72	1.4	110	7.0	182	2.7
Crush Injury	4	0.1	1	0.1	5	0.1
Spinal cord injury	258	5.0	52	3.3	310	4.6
Total	5175	100	1570	100	6745	100

Information on nature of brain injuries is provided in Table 17. Those with superficial injuries to head and scalp have been excluded from the analysis. Since it is common for multiple brain injuries to be seen only first two diagnoses have been included in the analysis. The nature of brain injuries was decided based on diagnosis of neurosurgical staff after complete examination and investigation of the patient. It was noticed that 55.6% had single lesion, 15.3% had two lesions and 29.1% had three and more injuries to the brain. As can be seen from Table 17, concussion, contusion, and skull fractures constituted 35.5%, 32.3% and 11.7%, respectively. 13% were diagnosed to have brain haemorrhages. Spinal cord injuries in association with other injuries were documented in 4.6% of the subjects.

Table 18: Associated injuries along with TBIs (n = 4570)

Nature of injury	No.	%
Face	3305	48.8
Neck	132	2.0
Chest	192	2.8
Abdominal	52	0.8
Pelvic bone	27	0.4
Upper limb bones	362	5.3
Lower limb bones	328	4.8
Crush injury	14	0.2

Table 19: Duration of Hospital stay of TBI subjects at NIMHANS (n = 5554)

Hospital stay in hours and days	No.	%
< 3 hrs	2547	45.9
3 - 6 hrs	1418	25.6
6 - 9 hrs	580	10.5
9 - 12 hrs	194	3.5
12 - 18 hrs	122	2.2
18 - 24 hrs	39	0.7
1 - 3 days	269	4.9
3 - 6 days	201	3.6
7 - 14 days	90	1.6
15 - 21 days	39	0.7
22 - 28 days	24	0.4
> 28 days	18	0.3

In addition to TBIs, nearly 4,412 (2/3rd or 65% of the patients) had injuries to various parts of the body. These included facial injuries (49%), chest injuries (2.0%), abdominal injuries (1.0%), injuries to upper and lower limb bones - mainly fractures (5.3% and 4.8% each) and pelvic injury (0.4%) as shown in Table 18.

6.9. Management details

The mode of management revealed that either nearly 45% were provided treatment in the emergency room and referred to other hospitals, 48% were admitted for short- or long-term observation for investigations and medical management. Surgical intervention was undertaken in 6% of the total brain injured persons.

Information on duration of hospital stay was available for 5554 (82%) of the subjects. Duration of hospital stay revealed that nearly 45% of the patients stayed in the hospital for approximately three hours. Among the remaining patients, 26%, 14% and 3% stayed for three to six hours, six to 12 hours and 12 to 24 hours, respectively. Nearly 641 (11%) patients stayed in the hospital for more than a day. The mean duration of stay for short-term and long-term stay patients was approximately four hours and seven days, respectively (Table 19).

The outcome of traumatic brain injuries based on Glasgow Outcome Scale revealed that 6% died in the course of hospital stay, 4% were in a persistent vegetative state, 15% were severely disabled, 47% were moderately disabled and 29% had recovered at the end of the hospital stay (Table 20).

Table 20: Outcome of TBI based on Glasgow Outcome Sscale

Outcome based on GCS	No.	%
Death	308	5.5
Persistent vegetative state	206	3.7
Severe disability	850	15.3
Moderate disability	2597	46.8
Good recovery	1593	28.7
Total	5554	100

Table 21: Pattern of disabilities among TBI cases at hospital discharge (n = 2994)

Disability assessment	Severe - GCS < = 8 (n = 417)			Moderate - GCS = 9 to12 (n = 500)			Mild - GCS > 13 (n = 2077)		
	Not possible	Yes but needs help	Yes, can do without help	Not possible	Yes but needs help	Yes, can do without help	Not possible	Yes but needs help	Yes, can do without help
Bathing by self	61.4	31.7	7.0	35.0	53.8	11.2	8.3	37.1	54.6
Dressing by self	60.4	31.2	8.4	34.2	51.0	14.8	8.2	32.1	59.7
Grooming by self	60.9	27.6	11.5	33.4	46.4	20.2	8.0	27.0	65.0
Eating by self	59.7	28.5	11.8	32.6	46.4	21.0	7.1	27.4	65.5
Sitting/standing by self	59.7	30.9	9.4	32.8	48.0	19.2	8.0	30.3	61.6
Walking about 15 meters by self	64.0	29.5	6.5	39.2	50.2	10.6	10.3	37.1	52.6
Having control over bladder/bowel	59.0	24.5	16.5	33.2	41.4	25.4	7.4	25.0	67.7
Hearing abilities	47.2	16.3	36.5	19.6	27.4	53.0	1.9	6.5	91.7
Normal memory/ thinking ability	52.0	25.4	22.5	26.4	39.4	34.2	3.3	15.1	81.6
Communicating needs	56.6	27.3	16.1	34.0	41.4	24.6	5.9	21.8	72.4
Social interaction	64.7	25.7	9.6	44.0	45.0	11.0	12.5	30.5	57.0
Family responsibilities	81.8	15.6	2.6	69.8	26.8	3.4	33.4	40.1	26.5
Able to work as before	87.1	10.3	2.6	78.3	19.3	2.4	42.3	37.7	20.0

Table 21 provides detailed description of disability pattern and status after a brain injury among hospital-registered subjects at the time of hospital discharge. Disability assessment was done using Modified Barthel's Index Among severely brain injured, nearly all subjects could not perform any activities of daily living like bathing, dressing, grooming, eating, sitting-standing and others, either on their own or even with support. Even hearing abilities were disrupted significantly in two-third of the subjects. Memory and thinking abilities were altered in approximately three-fourth of the patients. Social interactions, undertaking family responsibilities and ability to work at pre-injury levels were totally lost among all severely brain-injured persons. In the group with moderate brain injuries nearly one-third had total loss of regular activities of daily living with another 40 - 50% requiring support to perform the same. Once again the three domains of social interaction, carrying out family responsibilities and work ability were significantly affected in 90% of the injured persons. Even among those with mild brain injury, around 10% had difficulties and one-third required external help for performing daily living activities. The data will be analyzed in greater detail for different age groups, sexes, associated injuries and other confounders in our subsequent reports.

6.10. Economic aspects of TBIs

One of the objectives of the study was to identify the economic cost of managing a brain injury patient at NIMHANS. Considerable difficulties were experienced in arriving at these figures, and complete attempts were made to obtain data from all sources. It can be seen from Table 22 that the cost of managing one patient per day (in the EMS Department only) is estimated at Rs. 2,152. This is the lowest possible estimate and in actual values could be much higher (detailed report available separately). Also, this does not include medical/surgical/ICU costs of inpatients, which constitute nearly one-third of the head injury patients.

Table 22: Apportioned costs of managing TBIs in the EMS Department of NIMHANS (in Indian rupees).

Particular	INR per month
Apportioned human resources costs	315400.00
Apportioned infrastructure costs (building)	34000.00
Apportioned furniture costs and related	6773.00
Apportioned costs for supportive services, essential services and related	339509.00
Apportioned costs for radiological services	224415.00
Apportioned costs for ambulance services	34333.00
Total apportioned cost for care to head injury patients per month	954431.00
Total costs for care for head injury patients per month including miscellaneous costs @ 15% = Rs.1,43,164.59	1097595.00
Total apportioned costs for care for head injury patients per day	36587.00
Total apportioned costs for care of one head injury patient per day	2152.00

Apart from hospital expenses being influenced by severity, duration of stay and intervention procedures, the majority of the families of injured persons had incurred an average expenditure of Rs. 5000/- (sometimes reaching up to Rs.100,000) during the time of hospital stay. However, this includes only direct medical expenditure and does not include indirect expenses (loss of work, loss of income and others).

6.11. Disabilities and Quality of Life (Phase - II study)

The study aimed at setting up an initial database of all brain-injured patients reaching NIMHANS over a period of one calendar year. From this data pool, the selection of study subjects for follow up was based on a two-step process. In the first step - those patients with a diagnosis of brain injury, residents of the city of Bangalore and alive at hospital discharge were included for follow-up to identify the disability patterns (using GOS Extended Version), socio-economic burden (using Pai and Kapur Scale) and quality of life (using WHOQOL - BREF Version). In the second step and from within this database - all severely injured, 50% of moderately injured and 10% of mildly brain injured were identified for the second phase of study. Thus, 698 patients qualifying these criteria were selected for follow up in the first year. These patients were contacted initially by letters or over telephone and requested to come for follow up. However, since the response was very poor, they were contacted at their doorsteps by the trained team of investigators.

Following discharge from hospital, 91 (13%) persons had died and 607 (87%) were alive. Enquiry into cause of death by the Verbal Autopsy Method revealed that brain injuries and its complications were primarily responsible for death. During this one-year follow-up period, nearly 415 (67%) patients were still continuing treatment in different centres for various health problems and disabilities. Among them 147 (35.4%) were even seeking care from local healers and non-medical practitioners within the city. The primary reason cited was their inability to meet expenses of hospital care in public and private hospitals. The majority were not on any other treatment due to affordability factors. The various interventions that were ongoing included continued medical management, psychological services, physiotherapy, speech therapy, occupational therapy and nursing care. The treatment was being continued in various public and private hospitals within the city of Bangalore (Table 23). Some of those who actually required care were not utilizing any services due to financial limitations.

Table 23: Various interventions for TBIs following hospital discharge at one year (n = 415)

Type of services received	No.	%
On regular medication and physician care	396	95.4
Nursing care	246	59.3
Local healers/doctors	147	35.4
Physiotherapy	46	11.1
Occupation therapy	16	3.9
Speech therapy	9	2.17
Psychological services	3	0.7

The specific health problems faced by surviving injured persons were difficulty in locomotor activities among 87 subjects, post traumatic headache (n = 79), decreased power and strength in limbs (n = 57), memory and information processing deficits (n = 44), visual difficulties(n = 31), speech and communication problems (n = 25), generalized pains and aches (n = 48), anxiety features(n = 30), giddiness and loss of balance (n = 32), hearing problems (n = 14), and phobias (n = 22). Behavior problems of getting angry, depressive features like worry and sadness, becoming violent, inability to concentrate were noticed among 74 subjects at one year follow-up. Post traumatic epilepsy was clearly documented in 38 subjects and all of them were on anti epileptic medication. Majority of the times , injured persons suffered from multiple health problems interfering in all their day to day activities.

Table 24: Impact of Brain Injury at one year follow-up period (n = 415)

Activity Profile	Before Injury		After Injury	
	No.	%	No.	%
Health-related problems present	Nil	-	219	34.6
Able to follow commands/instructions	541	100.0	535	98.1
Help required for routine day-to-day activities	11	2.0	43	8.0
Not able to carry out routine activities	13	2.4	35	6.7
Not able to travel locally without help	12	2.2	37	6.9
Work pattern				
Full-time	369	65.4	295	55.1
Part-time	6	1.1	23	4.3
Reduced work capacity	NA	NA	192	60.3
Able to work in protected environment	NA	NA	126	39.7
Unemployed	49	8.7	43	8.0
Not working at present (with a job before injury)	4	0.7	43	8.0
Social & leisure-time activities	29	5.3	87	16.1
Family disruption	25	4.6	74	13.6

With regard to various disabilities, the pre- and post-injury assessment revealed that the burden of disabilities in various areas had increased following the injury as shown in Table 24. Day-to-day help was required for 8% of the patients and the number of people not able to carry out routine activities had increased from pre-injury levels of 2.4% to 7.0%. Nearly 93% were able to travel locally without help and 7% could not travel without help. The occupational pattern revealed that while 65% were able to work full-time before injury, the same had decreased to 55% following injury. People employed on part-time jobs had increased from 1.1% to 4.3%. Among those working, nearly 60% had reduced work capacity, 40% could only work in protected/sheltered jobs. 8% of those injured could not do any work compared with their pre-injury levels. Nearly 10% were unable to work after the occurrence

of injury. Disruption of social and leisure-time activities had increased from 5.3% to 16% following brain injury. Family disruption was noticed in 13% of the households, an increase from 5% of pre-injury levels. Only 1% of the injured persons had received some compensation either from local government or from their current employers and in 15% of the cases, the legal process was still continuing at the end of one year.

As shown in Table 25, nearly 50% each of patients and their family members had lost income during the 1st year after brain injury. Up to 75% had incurred heavy expenditure due to injury, even though the exact amount was difficult to quantify and was rated as moderate to severe in nature. Among the moderately and severely injured households, 50% and 22% each had taken substantial loans from outside sources to manage life after injury. Here again, nearly 22% had experienced serious impact of injury as they experienced severe hardships.

Table 25: Financial Burden of specified nature in the 1st year after injury (n = 607)

Financial Burden	Nil	Moderate	Severe
Loss of patient's income	52.9	28.8	18.3
Loss of income of other family members	53.9	30.6	15.5
Expenditure incurred due to head injury	25.7	51.4	22.9
Expenditure incurred due to extra arrangements	53.3	29.8	16.9
Loans taken/savings spent	27.9	50.4	21.7
Postponing investment/expenditure oriented activities	79.5	13.2	7.3

An attempt was made to assess the overall economic impact of brain injury during the first year after injury (Table 26). It was noticed that nearly 25% had incurred expenditure of more than Rs. 10,000/- (US $1200) with half of them spending more than Rs.25,000/- as out-of-pocket expenses for health care alone. It should be interpreted with caution as this is merely 'out-of-pocket expenses' and does not include much of health care (subsidized care) and other indirect costs resulting in loss of work and pay. Also, this does not include the expenditure incurred by public or private hospitals towards rehabilitation of injured persons. Several factors like age, working status, nature of injury, type of care and

Table 26: Economic burden due to TBIs

Hospital Expenditure (Rs.)	Freq	%
Up to 10000	408	72.4
10001 - 25000	64	11.5
25001 - 50000	36	6.5
50001 - 100000	36	6.5
> 100000	12	2.2
Total	556	100.0

Table 27: Quality of Life as reported by respondent at one-year follow-up time (n = 249)

Quality of life score	No.	%
Very poor	7	2.8
Poor	11	4.4
Neither poor nor good	54	21.7
Good	152	61
Very good	25	10

services utilized along with many other factors determine the total economic impact of brain injuries.

The quality of life as measured by WHO Quality of Life (BREF Version) was administered for 249 patients directly. This revealed that the quality of life was very poor and poor in the areas of physical and psychological domains in nearly 3% and 10%, respectively. The quality of life in social and environmental areas was more affected in nearly 15 - 20% of the subjects following brain injury (Table 27 & 28). The scores in various domains of physical, psychological, social and environmental areas revealed that greater disabilities were experienced by nearly 20% of the patients following injury. The quality of life as reported by the respondents revealed that nearly 30% of the patients had not improved significantly following the injury.

Table 28: Quality of Life scores for various domains at one year follow-up time (n = 249)

Physical Domain		
Score	**No.**	**%**
1 - 2	7	2.8
2 - 3	22	8.8
3 - 4	66	26.5
4 - 5	154	61.8

Psychological Domain		
Score	**No.**	**%**
1 - 2	6	2.4
2 - 3	21	8.4
3 - 4	75	30.1
4 - 5	147	59.0

Social Domain		
Score	**No.**	**%**
1 - 2	6	2.4
2 - 3	51	20.5
3 - 4	69	27.7
4 - 5	123	2

Environmental Domain		
Score	**No.**	**%**
1 - 2	5	2.0
2 - 3	42	16.9
3 - 4	131	52.6
4 - 5	71	28.5

6.12. Disabilities and Quality of Life (Phase - III Study)

Following the assessment at one year, 219 patients were contacted in the second year with similar objectives and methodology of Phase - II Study. Two patients had died and 217 were evaluated at this time. These patients were identified based on the criteria of presence of health-related problems and disabilities at one year follow up and also those receiving care in various hospitals at first contact follow up. The quality of life assessment could be undertaken in 139 patients.

Table 29 reveals that 91 out of 215 (42%) who had health problems, were still continuing on regular medication and on follow up in various hospitals. Only a very small proportion of 1 - 6% were still receiving supportive services like psychotherapy, physiotherapy, occupant-ional therapy and domiciliary nursing care (related to affordability issues).

Table 29: Various interventions for TBIs following hospital discharge at 2nd year contact

Type of services received	**No.**	**%**
On regular medication and physician care	61	28.4
Psychological services	5	2.3
Physiotherapy	14	6.5
Occupation therapy	3	1.4
Nursing care	8	3.7

Table 30: Impact of Brain Injury at 2nd year follow-up time (n = 206)

Health problems and activity profile	After Injury at 1st yr follow up (n = 541)		After Injury at 2nd yr follow up (n = 206)	
	No.	%	No.	%
Health-related problems present	187	34.6	95	50.8
Able to follow commands/instructions	535	98.1	206	38.5
Help required for routine day-to-day activities	43	8.0	18	41.8
Not able to carry out routine activities	35	6.7	18	51.4
Not able to travel locally without help	37	6.9	20	54.1
Work pattern				
Full-time	295	55.1	109	36.9
Part- time	23	4.3	13	56.5
Reduced work capacity	192	60.3	38	19.9
Able to work in protected environment	126	39.7	23	18.2
Unemployed	43	8.0	19	44.2
Not working at present (with a job)	43	8.0	29	67.4
Social & leisure-time activities	87	16.1	46	52.8
Family disruption	74	13.6	41	55.4

The continued impact of brain injury is shown in Table 30. It was observed that among those having health problem - disability and social problems at one year follow up, nearly 50% continued to have significant problems and the other 50% had recovered. In all, 95 subjects (51%) had health problems at 2nd year follow up and 38% required help in day-to-day activities. Thus, at the end of two years after hospital discharge 18% of individuals continued to have various health problems related to TBIs and had not recovered in an optimal way. Nearly 42% could not carry out routine activities and 51% required help for traveling locally. One-third and two-third of the subjects were working full-time and part-time, respectively and 20% had reduced work capacity. Disruption of social and leisure-time activities and family disruption continued to occur in the life of more than 50% of the individuals with brain injury.

Table 31: Financial Burden of specified nature in the 2nd year after injury (n = 215)

Financial Burden	Nil	Moderate	Severe
Loss of patient's income	72.9	10.6	16.6
Loss of income of other family members	73.9	17.1	9.0
Expenditure incurred due to head injury	75.4	15.1	9.5
Expenditure incurred due to extra arrangements	79.4	12.1	8.5
Loans taken/savings spent	76.4	13.6	10.1
Postponing planned activities	84.4	7.5	8.0

The financial burden at the second year follow-up time revealed that 10 - 15% and 8 - 15% had financial burden of a moderate and very severe nature, respectively. The financial burden included loss of income of injured person and his or her family members (26% each), making extra loans from outside agencies (24%), increasing expenditure to meet rehabilitation costs (25%) and unanticipated financial loss due to postponement of planned activities (Table 31).

Table 32 reflects the quality of life among 139 patients evaluated on WHO Quality of Life Instrument. The physical, psychological, social and environmental areas were highly affected in 1 - 3% of the patients and moderately affected in 10% of the patients. Poor ratings in social and environmental domains were observed in 25% and 14%, respectively.

Table 32: Quality of Life scores for various domains at second year follow-up time (n = 139)

Physical Domain		
Score	**No.**	**%**
1 - 2	2	1.4
2 - 3	15	10.8
3 - 4	51	36.7
4 - 5	71	51.1

Psychological Domain		
Score	**No.**	**%**
1 - 2	2	1.4
2 - 3	10	7.2
3 - 4	54	38.8
4 - 5	73	52.5

Social Domain		
Score	**No.**	**%**
1 - 2	1	0.7
2 - 3	34	24.5
3 - 4	38	27.3
4 - 5	66	47.5

Environmental Domain		
Score	**No.**	**%**
1 - 2	5	3.6
2 - 3	19	13.7
3 - 4	73	52.5
4 - 5	42	

As reported by patients themselves, nearly 8% informed that their quality of life encompassing all areas was poor. Up to 31% reported that brain injury had affected their life and their quality was neither poor nor good.

During the second year, nearly 28% of the individuals and households incurred an expenditure of > Rs. 10,000 towards management of illness related to brain injury. Only 4% (an increase from 1% at first year follow up) had received limited compensation by this time.

7

Implications and emerging Issues

1. **Traumatic brain injuries** are a leading cause of morbidity, mortality, disability and socio-economic losses in India. Earlier epidemiological studies have shown that the incidence and mortality of traumatic brain injuries was150 and 20/100,000 population, respectively. Translated to real numbers this means that every year in the city of Bangalore nearly 10400 people sustain brain injury, 2,000 people are hospitalized and about 1,000 people die from brain injuries. Several people live with various types

of disabilities affecting physical, social and occupational areas of their life following a brain injury. With improving technology and new high tech hospitals emerging, the case fatality rates are on the decline.

2. The present study is an epidemiological study undertaken from one of the leading hospitals in the city of Bangalore. The earlier study has revealed that nearly **70% of brain injuries are provided care at NIMHANS** on a regular basis. With the emergence of many private healthcare institutions offering care for brain-injured persons, this might have undergone slight variations. However, with the increase in brain injuries over a period of time, not much of a difference would have occurred in this pattern as NIMHANS still receives a large number of patients every day (even from private hospitals).

3. The increasing motorization in the city of Bangalore at the current levels of **nearly 1.8 million vehicles** has been a matter of increasing concern. The increase in two wheelers has been significant during the last decade. Apart from various transportation problems, citizens also feel greater risk of exposure to brain injury. This increasing motorization combined with absence of safety practices with regard to environmental, vehicle and personal protective factors has increased the problem of brain injuries in a significant way.

4. In the present study, it has been observed that **young men in the age group of 15 to 44 years** are at an increased risk of brain injury. Among the various causes, road traffic injuries and falls were the leading causes of brain injuries. In addition, majority of the affected persons were with low levels of education, employed in skilled and unskilled jobs and earning low levels of income. The sudden occurrence of brain injury places phenomenal burden on day-to-day activities, affecting survival and income. In addition, the majority had not received any compensation from their local governments or from their employers following the brain injury.

5. **Alcohol consumption** has been found to be a major risk factor in the city with nearly one-fourth of the patients being under the influence of alcohol at the time of injury. In the absence of preventive programmes towards control of alcohol-related issues, this problem is likely to increase further over a period of time. Regular, random, visible and uniform enforcement of drinking-and-driving programmes by the local police department will go a long way in reducing alcohol-related problems. Larger programmes aimed at a rational alcohol policy should be considered in all places.

6. Majority of the **road traffic injuries** were noticed in younger age groups and predominantly in men. The major categories of injured and killed road users were

motorized two wheeler occupants, pedestrians and bicyclists. Collision of heavy vehicles with these categories of road users resulted in greater number of deaths and serious injuries. Undoubtedly, safety of these Vulnerable road users should be of importance to save lives and prevent disabilities.

7. With nearly 1.8 million vehicles and 75% of them being two wheelers alone, safety and protection of two-wheeler occupants should occupy an important place. It was observed that **only less than 5% of the injured were wearing a helmet at the time of injury**. Despite the enormous scientific evidence on protective nature of helmets, the government has still not introduced mandatory helmet legislation. Compulsory helmet legislation, speed control and better traffic management will go a long way in reducing two-wheeler injuries. Safer pedestrian crossing places will be of importance to reduce pedestrian exposure to the occurrence of brain injuries.

8. **Falls were the second leading cause** of traumatic brain injuries in the study with majority being children or elderly people and predominantly women. The majority of the **falls had occurred in homes or** in public places and the nature of the falls was primarily accidental or fall from stairs or steps. Further, the majority of the falls had occurred at an average height of less than 15 feet and on a hard surface. This emphasizes the importance of domestic safety, play safety and work safety towards prevention of brain injuries.

9. **Violence was the third leading cause** of traumatic brain injuries in the study with nearly 10% of the brain injuries due to violence. Much of the violence was due to usage of commonly available blunt physical objects due to interpersonal rivalry, property disputes, communal riots, disharmony between the family and other reasons. The perpetrator was always a known person to the injured person.

10. **Prehospital and emergency care was found to be totally inadequate** and unscientific. In the given scenario, many of the brain injuries being mild injuries, local doctors could have provided care in local hospitals. However, referring such patients to a tertiary apex central institution added only to time delays and increasing brain injury severity. In addition, many of the patients were transported in private vehicles and ambulances were used in one-fourth of the brain injuries. Appropriate organization of emergency and prehospital care is the need of the hour.

11. The majority of the brain injuries were mild brain injuries and concussive head injuries. **Contusions, haemorrhages and skull fractures accounted for one-third of brain injuries**. Nearly 25% of the registered patients were admitted in the hospital and provided medical and surgical care. The duration of hospital stay varied from a few hours to a

few days with nearly 10% staying for longer periods. The case fatality rate of brain injuries has been on the decline for the last few years at NIMHANS due to improved facilities, greater manpower and early interventions.

12. Nearly **one-third of the patients continued to experience various disabilities** having an impact on their day-to-day activities. Nearly 10% could not continue in their previous work and had reported restricted work abilities. In all, 8% reported themselves to be unfit for any work following a brain injury. Injury had also affected their social and leisure-time activities causing family disruption at various levels. This indicates the need for reorganizing and strengthening brain-injury rehabilitation within the city. The study could not identify disability patterns and the burden among rural people where rehabilitation services are far from satisfactory. To use rehabilitation services, these people need to travel longer distances to nearby district headquarters or to the cities.

13. **Less than 1% of patients had received some compensation** following the injury within 1 year. This indicates the absence of supportive mechanisms for maintenance and rehabilitation of brain-injured persons in the city. Absence of income from their previous jobs combined with lack of compensation places additional burden on individuals and their families. This had necessitated people to sell their existing property, make additional debts at higher rates of interest and had forced other family members to take up employment to compensate for loss of income of the injured person.

14. Interestingly, nearly 25% of patients had incurred a **total expenditure of more than Rs.20,000** towards injury care. This included only the expenditure incurred by individual households and their family members as out-of-pocket expenses. Since much of the health care in public institutions is subsidized, the cost incurred by institutions has not been taken into account. From a collateral study in this project it was identified that Rs.2,152 is incurred towards management of one patient for a day's stay at NIMHANS casually. If the subsidized expenditure and the family expenditure are combined together, it indicates the phenomenal economical losses by brain injuries in a rapidly developing city.

15. From a state of normal life to a state of disabled life, **the quality of life of the injured person is a gradual decline over a period of time**. In the study, it was noticed that nearly one-third of brain-injured persons have long-term disabilities affecting various spheres of life, thus bringing a decline in their quality of life at 1 year with half of them having disabilities at 2nd year. This resulted in the emergence of new psychosocial problems likely to be present for the rest of an individual's life.

8

Epilogue

Traumatic brain injuries are a leading cause of injuries, deaths and disabilities in India. Due to lack of research, the various dimensions of TBIs are underreported and underestimated. The present study undertaken over a three-year period (2000-2003) at NIMHANS has unraveled the socio-demographic characteristics, causative patterns, risk factors, status of pre-hospital and emergency care, injury patterns in terms of severity and nature and outcome in a series of 7164 head injury - 5630 brain-injured persons. The first and second year follow up revealed that one-third of the patients will have health problems, disabilities, socio-economic burden and a poor quality of life at the end of hospital stay. These people who were normal before injury pass through a phase of hospitalization due to an injury like RTI, falls, violence and others with a significant burden and a poor quality of life affecting all dimensions of their life. Hospital and families incur huge expenditure due to an injury after forcing individuals to generate resources by other methods. In all, 409 persons died with a case fatality rate of 7.1% (308 in hospital and 93 after discharge). At one-year and two-year follow-up time it was observed that one-third (35%) and one-fifth (20%), with half of them seen at one year follow up, respectively, confirmed to have problems, disabilities and increased burden after injury.

Unless systematic efforts are made in India towards prevention, management and rehabilitation, many more individuals, children and middle-aged adults will continue to die and this will be an unbearable loss to Indian society.

9

Recommendations

The following recommendations are placed herewith for reducing morbidity, mortality and disability from traumatic brain injury. The recommendations have been developed based on study results, opinion of medical professionals, views expressed by participating subjects and their families. The recommendations are also based on the current understanding of interventions ongoing in the field of traumatic brain injury prevention, management and rehabilitation. We sincerely hope that these recommendations will be considered seriously by policymakers, programme managers, professionals and the media for bringing in safety mechanisms and consciousness among the citizens of Bangalore and in other parts of country. Undoubtedly, similar efforts are required across several states and cities of the country to

reduce the growing burden of traumatic brain injuries. The suggested recommendations include both short-term and long-term measures.

1. Scientific understanding of the problem of traumatic brain injuries in its various dimensions is very crucial to organize services in the areas of acute care, rehabilitation and towards prevention. Information on the precise magnitude of the problem, risk factors, causes, mechanism, clinical manifestations and outcome from traumatic brain injury is very crucial in understanding the problem to identify remedial measures. The present study has been conducted in one major hospital in the city of Bangalore, with a focus on pre-injury to post-injury status over a period of three years. The study has brought a wealth of information with regard to various issues of acquired traumatic brain injuries.

    - It is important that a long-term surveillance system focusing on the problem and its determinants and consequences is developed for the city of Bangalore by inclusion of information from all major hospitals in the city on a uniform basis based on standardized methodologies. Record linkage system with police data will be highly useful. This would help in tracking the epidemic, identifying changes in causation and also the various risk factors. In addition, it would also help in measuring the impact of interventions over a period of time.

2. Since a large number of people, predominantly men in the younger age groups, are injured, killed and disabled in brain injuries, it is appropriate to focus on several preventive strategies. Experience of developed countries has revealed that traumatic brain injuries are predictable and preventable. Several interventions, combined with one another and implemented on a scientific basis have resulted in a gradual decline of brain injuries in many high-income countries. Areas of road safety, home safety, work safety and play safety have to be given major importance and interventions have to be developed on a scientific basis for implementation. It is important that we move from pessimistic approaches to a more optimistic vision with a commitment to reduce injuries and traumatic brain injuries with increased focus on safety at all levels.

    - Awareness and sensitization programmes should be undertaken by health professionals in collaboration with media personnel to increase safety consciousness in society among political leaders, policymakers, product/vehicle manufacturers, professionals and the community.

3. At present, there are no systematic programs that are developed, implemented and evaluated based on scientific policies and programmes. There is an immediate need to formulate a national injury prevention policy and programme based on analysis of available data with inputs from different sectors.

- A national injury prevention policy with defined programmes in the areas of road safety, home safety and work safety should be formulated with clearly- defined goals and objectives. A time-bound action plan with short-term and long-term activities should be clearly specified in this process. The National Road safety Policy is currently under development .

- At the city and state level, programmes aimed at prevention of road traffic injuries should receive highest importance as nearly 60 percent of traumatic brain injuries are due to road traffic injuries. Activities that can be implemented with minimal or less additional resources - and those demonstrated to have scientific evidence should be taken up on a priority basis for prevention programmes.

- To effectively implement these activities, a coordinating body with sufficient funds, status and authority to formulate, guide, and supervise activities at the state level needs to be formed. This body could be independent of any ministries with a responsible senior nodal officer to coordinate all activities.

4. Considering the importance of pedestrians, motorized two-wheeler occupants and bicyclists being involved in greater numbers in traumatic brain injuries, preventive efforts should be focused on making these groups safer in the longer run. Known and scientifically proven interventions should be considered on a priority basis in Bangalore and other places. In this direction, the following activities should be undertaken on a priority basis:

   - Mandatory helmet legislation should be introduced in Karnataka and should be totally enforced by the Department of Police. Sufficient global and national evidence exists in this regard and a large number of brain injuries among two-wheeler occupants can be reduced with this measure. The enforcement should be visible, uniform and random with stiff penalties. Community awareness programmes should be combined with enforcement strategies for better compliance with the law. No confusion should be created amongst public and once the law is introduced, it should not be repealed for any simple reasons.

   - The existing laws with regard to seatbelt usage by car occupants should be widely publicized and enforced by the police. It should also be ensured that all cars are fitted with seatbelts and necessary awareness among vehicle manufacturers and public should be promoted.

   - The existing laws and enforcement with regard to reduction of drinking-and-driving should be strengthened and enforced in a visible, uniform, random manner with stiff penalties by the police. To achieve this, dedicated enforcement teams should be constituted and supplied with breathalyzers and other requirements of transport and

supply items. The required training should be provided to all involved police personnel in this regard. In addition, all hospitals in the city must introduce breath alcohol testing with the help of breathalyzers.

- The city council needs to formulate effective speed-control laws with clearly- defined speed limits within the city, on highways and in arterial roads. The formulation of speed control laws should be based on scientific studies and must be clearly communicated to the public on a regular basis. Necessary enforcement should be undertaken by the police and the transport departments in all places, both within and outside the city with new technologies that are currently available. In addition, low cost engineering scientific solutions of traffic calming, speed breakers and road design features should be systematically introduced all over the city and state. Highway road design should consider regulation of speed at safer levels on scientific methods.

- The existing traffic regulations need to be efficiently communicated to the public and traffic violators should be fined appropriately to control violation of traffic laws. The existing sections of the Indian Motor Vehicles Act must be clearly enforced in this regard.

- Safer pedestrian crossing and walking places must be provided on all possible routes in the city of Bangalore. Wherever possible, pedestrians mixing with traffic should be avoided and engineering solutions for safe travel of pedestrians should be promoted.

- Bicycle travel is an important mode of non-motorized transport within the city. Wherever possible, bicycle routes must be earmarked for travel of bicyclists within the city. The visibility of bicycles should be improved with use of bright-reflectorized colors. Community awareness programmes towards safe travel by bicycles should also be promoted through media channels.

- Implementing safe, reliable and efficient public transportation systems is undoubtedly the need for the whole city and also across many other places. This would increase mobility in a safe mode while decreasing individual risk of exposure associated with personal and unsafe modes of transport. An investment in this policy will reduce injuries, deaths and disabilities and also address associated problems of traffic congestion, air pollution and other hazards.

5. Road design, development, expansion and maintenance should be given top importance in the city of Bangalore and other places. The design of the roads should be scientific keeping in view the increasing motorization and transportation within the city. Road-

related issues should be considered in local area planning, and appropriate strategies for urban travel should be based on local area networks.

- Roads should be cleared from ditches, potholes, openings, manholes and other obstacles. This has to be taken on a war footing on all roads in the city, throughout the total geographical area.
- Based on scientific analysis of information, more use of engineering principles in safer design and operation of roads with traffic-calming techniques, separation of heavy vehicle - fast moving traffic from pedestrians and slow-moving heavy vehicles should be developed.
- All hard, rigid and immobile objects should be removed from the roads. Wherever required soft and non-rigid flexible materials should be used on the roads.
- Since 30 to 40 percent of road crashes occur on national and state highways, these roads should be designed and developed on a scientific basis keeping in view the local travel and transportation patterns. Some prominent interventions related to promoting helmet usage, reducing drinking and driving, reducing and regulating speed, strict prohibition of overtaking from wrong side, increasing visibility, separation of traffic, and strengthening prehospital and hospital care require immediate attention. Road design features should be incorporated in road construction and maintenance and vehicle crashworthiness and stability to be significantly improved for reduction of severe crashes.

6. Poor visibility of human beings, vehicles and risk situations and dangers on the road has been found to be a major contributing factor for occurrence of road traffic injuries and traumatic brain injuries. In this regard, it is important

- That vehicle manufacturers use brighter and reflective colours;
- Reflectorisation of vehicles, specially heavy vehicles, two-wheelers and bicycles should be strongly encouraged;
- All roads with ongoing maintenance and repair works should display signboards cautioning drivers to be careful at these places;
- All edges of the roads should be marked in clear and reflective paints indicating the width of the road;
- All pedestrian and bicycle movement places should be clearly demarcated and prominently shown in bright reflective colors;

- Street lighting has to be improved with better use of technologies (solar lighting options could be considered) in all possible places;
- Daytime usage of headlights by vehicle drivers should be increased slowly and gradually as scientific research has clearly demonstrated reduction of crashes with the use of this method.

7. The present study and several other studies in the Indian region have revealed that nearly one-fourth of the injuries occur at home and domestic falls are one of the major causes for traumatic brain injuries. The mechanism of injury reveals that falls, especially among children and the elderly and in women, are significantly high. More research is required to identify specific details where interventions are likely to succeed. However, some strategies likely to yield positive results are: -
   - Avoidance of slippery floors and encouraging more use of antiskid floor materials;
   - Usage of soft and energy-absorbing materials in homes;
   - Education of parents and family members to increase supervision of children;
   - Better illumination of the interior of homes to increase visibility of the surroundings.
8. Violence with blunt objects is a common mechanism for occurrence of acquired brain injuries. Once again, more research is required to identify the precise mechanism and to develop intervention mechanisms. Some promising interventions in this area are:
   - Promotion of life skills education in colleges and workplaces for better conflict resolution management;
   - Limiting accessibility to weapons specially among youth;
   - Mechanisms to restrict alcohol consumption;
   - Supportive and counseling services for individuals suffering from alcohol, drugs and other personality problems.
9. Prehospital and emergency care should be given top most importance to save lives even after the occurrence of injury.
   - First responders training for police, drivers, teachers and for all categories of the personnel on basic life-saving measures should be undertaken by institutions based on uniform and consensus-driven methodology on fundamental interventions that can be effectively undertaken. These programs should be continuous with periodic refresher courses.

- Ambulance systems within the city need to be reorganized to see that immediate transportation of the injured persons is undertaken in an effective manner.
- Several emergency care systems are already working within the city. The systems need to be effectively organized and coordinated based on geographical mapping systems with common access numbers.
- All hospitals in the city irrespective of the levels and facilities must mandatorily provide basic and essential care towards stabilization of the patients' condition, irrespective of the ability of the injured persons to pay. The existing legal provisions should be widely communicated to society and to the health care institutions by all media channels.
- Early transportation of patients to definitive hospitals is very vital for immediate interventions to prevent deaths and subsequent disabilities. It is vital that information on the availability of definitive services in various hospitals is widely communicated to the public and treatment is provided on arrival of patients.
- Even though it is clearly mentioned that the public would not be subjected to unnecessary legal procedures for accompanying patients to hospitals after injury, it is still substantially unclear in the minds of the public. The legal provisions in this regard must be widely communicated to the public through various media channels.
- All doctors, nurses and other paramedical personnel in different (public and private) health care institutions must be trained in basic life-support systems through training programmes. These personnel should be specially trained in the recognition of brain injury at the early stage and to refer cases depending on the extent of severity based on triage principles to avoid unnecessary referrals.
- The emergency care services in the casualty departments of various hospitals needs to be studied in great detail to identify various lacunae that exists in coordination and delivery of emergency care. The physical and human resources with basic facilities for investigation and management should be upgraded in all hospitals for provision of care.

10. All hospitals on national highways and at district headquarters should be upgraded as integrated trauma care centers to manage mild and moderate brain injury and those with a lesser degree of polytrauma. The required investigating and management support systems in terms of physical resources should be strengthened in all these hospitals with training and operation of facilities.

11. Training of medical officers in taluk and district hospitals and local government hospitals must be undertaken for early recognition and better management of persons with a brain injury. These programmes should highlight recognition of brain injury, management at local level and referral-based triage.

12. Trauma audits must be introduced in every hospital to identify critical lapses in management of patients. This would help in a systematic way to identify critical areas of improvement for reducing mortality and disability rates.

13. Compensation systems for injured persons must be strengthened to provide timely support for individuals and families. In the study it was noticed that less than 5% of the patients received some support and in nearly one-fourth of the instances, the legal process was still continuing even after two years after the occurrence of injury. This places enormous burden on individuals and families and forces them to generate resources for management of the injured person. The legal hurdles must be removed to provide timely compensation for injured persons and their families.

14. The rehabilitation process is an important component to restore the optimal functioning capacity of the injured person. However problems have been experienced with regard to availability of services in urban and rural areas. It is important that patients are educated at the end of hospital stay towards appropriate rehabilitation services that need to be availed of in due course of time to restore functioning of the individual. In addition, services should be made available by both the public and the private sectors in urban as well as rural areas, towards timely rehabilitation of the brain-injured persons. In this direction, services should be strengthened in government district hospitals with manpower and additional facilities for rural patients. In urban Bangalore, patient and family education at the end of hospital stay towards the type of rehabilitation services that need to be continued should be informed to the patients during their course of hospital stay.

15. Any program, not driven by evidence and science is unlikely to yield positive results. A systematic injury surveillance program should be established in Bangalore and other cities/states to track the evolving change and trends, identify causation and to measure the impact of interventions. A simple and effective reporting system within police and health sectors should be developed with a focus on capturing information on those factors which can be potentially modified. Implementation of these interventions should lead to reduction of RTIs and other injuries. This data should be analyzed in a continuous manner by technical teams (police, health and engineering)and should be used for intervention programs. Technical teams should undertake multidisciplinary crash investigations. There is also need to establish trauma registries at medical college levels across the state. Thus, there is need for creating these mechanisms in Bangalore and all other places for

scientific understanding and developing interventions.

16. National Neurotrauma Prevention Programme under a broader national injury prevention policy with all components of education, engineering, enforcement and emergency care must be developed for the Indian region by involved ministries in partnership with various professional bodies with involvement of all related governmental and non-governmental organizations.

10

Inputs from project into policies and programmes

The information from the project has been of extreme value in the comprehensive understanding of neurotrauma issues in prevention, management, rehabilitation, socio-economic burden and current initiatives. The data has helped in reorganizing and augmenting services within NIMHANS by redistribution of resources. Simultaneously, the data has been provided to concerned departments in the city of Bangalore and the state of Karnataka for developing safety measures. Inputs for reintroduction of helmet legislation, reducing drinking-and-driving, strengthening emergency services and pedestrian safety issues has been significant. Media professionals have quoted the information on several occasions to increase awareness among the public on road and home safety issues. Rehabilitation of the brain-injured persons has also received a major boost within the institute and resources/facilities have been strengthened during the last three years.

11

Presentation in National and International meetings
(till September 2004)

Information developed from the project has been shared with professionals and policy makers on several occasions in the past three years.

11.1 Gururaj G, Sastry Kolluri VR, Chandramouli BA and Subbakrishna DK. Neurotrauma Registry in NIMHANS. First National Neuroscience Conference, Bangalore, September 10 - 12, 2004.

11.2 Gururaj G: Human Resource Development for injury prevention and control in

developing countries. Seventh World Conference on Injury Prevention and Control, Vienna, June 6 - 9, 2004.

11.3 Gururaj G and Kraus JF: Epidemiological determinants of road traffic injuries in India. Seventh World Conference on Injury Prevention and Control, Vienna, June 6 - 9, 2004.

11.4 Gururaj G: Challenges in measuring intentional injuries. TASC and UNICEF Regional Conference on Childhood Injuries, Bangkok April 19 - 21, 2004.

11.5 Gururaj G: Methodological issues in violence and injury prevention research in developing countries. Forum Seven Meeting, Geneva, December 2 - 5, 2003

11.6 Gururaj G: Current status of prehospital care in India. WHO Inter-country Consultative Meeting on Strategies for Prehospital and Emergency Care in South East Asia, Ahmedabad, June 2 - 5, 2003.

11.7 Gururaj G. Road traffic injuries in India and South East Asia. An Epidemiological Perspective: Forum 6 meeting of Global Forum for Health Research, Arusha, Tanzania, November 12 - 15, 2002.

11.8 Gururaj G, Sastry KVR, Chandramouli BA and Subbakrishna DK. Disabilities & impact after Traumatic Brain Injury. Results of one year outcome study from Bangalore, India. Seventh European Multidisciplinary Neurotraumatologica, New Castle, Upon Tyne, June 27 - 29, 2002.

11.9 Gururaj G, Sastry KVR, Chandramouli BA and Subbakrishna DK. Alcohol consumption, road accidents and acquired brain injuries. Sixth World Conference on "Injury Prevention and Control", Montreal, 12 - 15 May, 2002.

11.10 Gururaj G, Sastry KVR, Chandramouli BA and Subbakrishna DK. The pattern and impact of prehospital care on traumatic brain injury. Seventh European Multidisciplinary Neurotraumatologica, New Castle, Upon Tyne, June 27 - 29, 2002.

References

1. Romer CJ, Zitnay G, Gururaj G et al: Prevention, critical care and rehabilitation of Neurotrauma, WHO Collaborating Centre for Neurotrauma, 1995.

2. Gururaj G: An Epidemiological approach to Prevention, Prehospital care and Rehabilitation in Neurotrauma, Neurology, India, 43(3), 1995, 95 106.

3. Gururaj G. Epidemiology of Traumatic Brain Injuries: Indian Scenario, Neurological Research, 24, 1 - 5, 2002.

4. Gururaj G and Sastry KVR. Problem and determinants of traumatic brain injuries in India. NIMHANS Journal, 17(4), 1999, 407 - 422.

5. Planning Commission Report of the working group on prevention of road accidents and injuries, Government of India, 2002.

6. Brooke E.M: The Current and future use of Registers in Health Information Systems. World Health Organization, 1974.

7. Goldberg J, Gelfand M and Levy PS; Registry evaluation methods: A review and case study. Epidemiologic reviews, 232 - 241, 1980.

8. Directorate of Census Operation, Karnataka Census of India, 2001.

9. Gururaj G, Sastry KVR, Chandramouli BA and Subbakrishna DK. Training Manual for Neurotrauma Registry in NIMHANS, 2000.

10. Centre for Disease Control and World Health Organization. Standards for Surveillance in Neurotrauma, 2000 (unpublished document).

11. Gourie-Devi M, Gururaj G and Satishchandra P: Neuroepidemiology in developing countries - A manual for descriptive studies. Second edition, Prism Books Pvt. Ltd., 1997.

12. World Health Organization. International classification of diseases 10th revision, 1996.

13. World Health Organization. International Classification for External Causes of Injuries (ICECI). Guidelines for counting and classifying external causes of injuries for prevention and control, 1998.

14. Teasdale G and Jennet B. Assessment of coma and Impaired Consciousness. Lancet, 2, 1974, 81 - 4.

15. Association for Advancement of Automotive Medicine. Abbreviated Injury Scale.

16. Anderson SI, Housley AM, Jones PA, Slattery J, and Miller JD (1993). Glasgow Outcome Scale: an inter-rater reliability study. Brain Injury, 7, 309 - 317.

17. Dobkin BH. Neurologic Rehabilitation. FA Davis Philadelphia 1996: 107.

18. Wilson JTL, Pettigrew LE and Teasdale GM. Structured interviews for the Glasgow Outcome Scale and the Extended Glasgow Scale: Guidelines for their use. Journal of Neurotrauma, 15(8), 1998, 573 - 85.

19. World Health Organization. WHOQOL - BREF. Introduction, Administration, Scaling and Generic version of the assessment.

20. Epi-Info version 6.04d, Epidemiology Program Office, Division of Public Health Surveillance and Informatics, Centers for Disease Control and Prevention, 1600 Clifton Rd, Atlanta, GA 30333, U.S.A

NEUROTRAUMA REGISTRY – Phase - I

Study by the Department of Epidemiology and Neurosurgery,
National Institute of Mental Health & Neuro Sciences, Bangalore, India
and
Southern California Injury Prevention Research Centre, Los Angeles, USA.

A. IDENTIFICATION INFORMATION

1. Sl. No. _____ 2. Neuro No. _____

3. ECR No. _____ 4. Date & Time of Interview: _____

B. SOCIODEMOGRAPHIC DETAILS

5. Name: _____

6. Age: ☐☐ 7. Sex: ☐ 8. Place of residence: ☐

9. Address: _____

_____

_____

_____

Landmarks for house identification: _____

Telephone No.: _____

10. Education: _____ 11. Marital Status: _____ 12. Occupation: _____

13. Approximate family income *(per month):* _____

C. RISK FACTOR INFORMATION

14. H/O alcohol consumption
    14.1 Time interval *(hr : mm)* ☐☐ : ☐☐ 14.2 H/o regular alcohol intake: ☐

15. Past history of epilepsy ☐
    15.1 Duration *(years/months)* ☐☐ / ☐☐ 15.2 Treatment status: ☐

D. INJURY DETAILS

16. Date & Time of occurrence of brain injury _____

17. Place of injury occurrence: ☐

If others, specify: _____

18. Location of injury occurrence: _____
(*code as per A - Z map)*

19. Cause of brain injury: ☐
(*skip to appropriate sections*)

20. Road Traffic Accidents:
a. Road condition: _____ b. Status of person: _____ c. Hit by: _____

d. Location: _____ e. Nature of Collision: _____

f. Pedestrian maneuver: _____ g. Any protection equipment: _____

h. Wearing of helmet: _____ If yes, name of helmet: _____

Strapping: _____ i. Wearing of seat belt: _____

21. Falls: ☐
a. Nature of falls: _____ b. Height of fall (*in feet*): _____

c. Nature of landing surface: _____

22. Assault: ☐
a. Injury Intentional/Unintentional/Unknown

b. Reason for injury _____

_____

c. Assault by *(person)* _____

d. Assault by *(nature of instrument)* _____

23. Nature of falling object: ☐

Others, specify: _____

24. Industrial accident: ☐

Specify _____

25. Sports Injuries ☐

Nature of sports (*Name*) _____
Protective equipment to head

26. Other type of injuries, specify _____

E. PREHOSPITALISATION CARE DETAILS

27. First-aid services ☐
(Describe the type of interventions)

If yes, where: _____

28. Source of referral: ☐
If others, specify: _____

29. No. of medical contact till reaching NIMHANS. ☐

30. Brought by: _____

31. Pathways of care

						Time interval			
Place of injury occurrence	-	1st Medical contact	( ).						
1st Medical contact	( )	-	2nd Medical contact	( ).					
2nd Medical contact	( )	-	3rd Medical contact	( ).					
3rd Medical contact	( )	-	4th Medical contact	( ).					
4th Medical contact	( )	-	5th Medical contact	( ).					
Total time interval									

32. Mode of transportation: ☐

If others, specify: _____

F. CLINICAL DETAILS

33. Status on arrival: ☐

34. a. Presence of amnesia ☐ b. Type: _____

35. Glasgow Coma Scale on admission:

a. Visual response (E): ___ b. Motor Response (M): ___ c. Verbal Response (V): ___

Total Coma Score (E + M + V) = 3 to 15 ☐☐

36. Glasgow Coma Scale after 3 hours:

a. Visual response (E): ___ b. Motor Response (M): ___ c. Verbal Response (V): ___

Total Coma Score (E + M + V) = 3 to 15 ☐☐

37. Associated injuries: (1-Present, 2-Absent)

a. Neck injury: _____ b. Chest injury: _____ c. Abdominal injury: _____

e. Injury to pelvic bones: _____ f. Injury to long bones UL: _____

g. Injury to long bones LL: _____ h. Crush injury: _____

38. Details of injuries

Details of injuries	AIS						

39. Diagnosis:

a. Diagnosis on arrival:
b. Diagnosis by neurosurgical staff:
c. Diagnosis by CT Scan/MRI/X-ray:
d. Postoperative diagnosis:
e. Discharge diagnosis:
f. Autopsy diagnosis:

ICD Code: ☐☐☐☐☐☐☐

ICD Code: ☐☐☐☐☐☐☐

G. MANAGEMENT DETAILS

40. Mode of management: ________________________________

41. Details of specific interventions

_____

_____

_____

_____

42. Medical management

42.1 ICP monitoring: _____

42.2 ICU management: _____

42.3 Ventilator usage: _____

43. If operated, time interval between admission and surgical intervention: _____

44. Reason for any delay in surgical intervention:

_____

_____

45. Course during hospital stay:

46. Duration of hospital stay:

a. In days: ☐☐☐ b. In hours: ☐☐ : ☐☐

47. Discharge disposition: _____

48. Outcome (based on Glasgow Outcome Scale): ☐

49. a. Hospital costs (in Rupees) ☐☐☐☐☐

b. Expenditure incurred by patients/family members till hospital discharge time ☐☐☐☐☐

c. **Total Cost** ☐☐☐☐☐

50. Advised to follow up at NIMHANS/Other Hospitals

50.1 Advised date and time of follow up _____

H. DISABILITY ASSESSMENT

51. TOTAL DISABILITY SCORE : ☐☐

a. Is the patient able to bathe by self : ☐
(1) No (2) Yes but needs help (3) Yes

b. Is the patient able to dress by self : ☐
(1) No (2) Partially and needs help (3) Yes

c. Is the patient able to groom by self : ☐
(1) No (2) Needs help (3) Yes

d. Is the patient able to eat by self : ☐
(1) No (2) Needs help (3) Yes

e. Is the patient able to sit/stand by self : ☐
(1) No (2) Needs help (3) Yes

f. Is the patient able to walk about 15 metres by self : ☐
(1) No (2) Needs help (3) Yes

g. Is the patient having control over bladder/bowel : ☐
(1) No (2) Partial help (3) Yes

h. Is the patient able to see well (with glasses if required) : ☐
(1) No (2) Yes

i. Is the patient able to hear well : ☐
(1) No (2) Yes but needs aids (3) Yes

j. Is the patient having normal memory/thinking ability : ☐
(1) No (2) Impaired (3) Yes

k. Is the patient able to communicate needs : ☐
(1) No (2) Partially (3) Yes

l. How is the patient's social interaction compared prior to illness : ☐
(1) Nil (2) Less than before (3) Normal

m. Is the patient able to undertake family responsibilities as earlier : ☐
(1) No (2) Yes but less than before (3) Yes

n. Is the patient able to go for work as before : ☐
(1) No (2) Less than before (3) Yes

I. AUTOPSY DETAILS

51. Cause of death:

i) Immediate cause of death _____

ii) Antecedent causes of death _____

iii) Other associated conditions _____

52. Autopsy diagnosis _____

_____

NEUROTRAUMA REGISTRY – Phase - II

Study supported by NIMHANS, Bangalore, India & SCIPRC (WHO Collaborating Centre, Los Angeles, USA)

1. Sl. No.: _____ **2.** ECR No.: _____ **3.** Neuro No.:_____

4.1 Name: _____

4.2 Date of interview at NIMHANS

5.1 Follow-up status: Regular follow up - 1/ Telephone - 2/Letter - 3/House visit - 4.

5.2 Date of interview for Phase - II:

6. Post-Injury Interval

7. Respondent

8. Who is taking care of you now (in months): *Parents - 1/Spouse - 2/In-laws - 3/Relatives - 4/ Friends - 5/Others - 6, specify.*

9. Who was taking care of you before injury: *Parents -1/Spouse - 2/In-laws - 3/ Relatives - 4/Friends - 5/Others - 6, specify.*

9.1 Disability score at hospital discharge .....

9.2 Disability pattern

a. Is the patient able to bathe by self : ☐
(1) No (2) Yes but needs help (3) Yes

b. Is the patient able to dress by self : ☐
(1) No (2) Partially and needs help (3) Yes

c. Is the patient able to groom by self : ☐
(1) No (2) Needs help (3) Yes

d. Is the patient able to eat by self : ☐
(1) No (2) Needs help (3) Yes

e. Is the patient able to sit/stand by self : ☐
(1) No (2) Needs help (3) Yes

f. Is the patient able to walk about 15 metres by self : ☐
(1) No (2) Needs help (3) Yes

g. Is the patient having control over bladder/bowel : ☐
(1) No (2) Partial help (3) Yes

h. Is the patient able to see well (with glasses if required) : ☐
(1) No (2) Yes

i. Is the patient able to hear well : ☐
(1) No (2) Yes but needs aids (3) Yes

j. Is the patient having normal memory/thinking ability : ☐
(1) No (2) Impaired (3) Yes

k. Is the patient able to communicate needs : ☐
(1) No (2) Partially (3) Yes

l. How is the patient's social interaction compared prior to illness : ☐
(1) Nil (2) Less than before (3) Normal

m. Is the patient able to undertake family responsibilities as earlier :
(1) No (2) Yes but less than before (3) Yes

n. Does the patient go for work as before : ☐
(1) No (2) Less than before (3) Yes or has changed job

9.3 Follow-up Diagnosis _____

10. How do you feel you are coping with changes in your life style since having head injury?

No problem - 1/some, able to handle on my own - 2/some, could use help frequently – 3/ bad, need help always - 4.

11. Post injury Rehabilitation measures:

A. During the last one year, after your hospital contact with NIMHANS, have you been receiving care at NIMHANS or in any other place? *Yes/No*

B. If yes, were you hospitalised in other hospitals?

Specify name/duration _____

C. If yes, what type of services have you been receiving/received?

1. On regular medication & physician care *Yes/No*
2. Psychological services *Yes/No*
3. Physiotherapy *Yes/No*
4. Speech therapy *Yes/No*
5. Occupational therapy *Yes/No*
6. Nursing care *Yes/No*
7. Local healers/doctors *Yes/No*

D. For how long, did you/are you receiving these Services? *Duration (in months /days).* ____ / ____

Section - I. Post-Injury Disability Assessment : (1 - No; 2 - Yes)

1. Ability to follow commands, words, instructions or respond to instructions *No - 1/Yes - 2*

2.1 Assistance required at home every day for some activities of day-to-day living *No - 1/Yes - 2*

2.2 Frequent help or someone to be around for most of the time *No - 1/Yes - 2*

2.3 Assistance prior to injury *No - 1/Yes - 2*

3.1 Able to carry out routine activities (e.g., local shopping) outside home without assistance *No - 1/Yes - 2*

3.2 Ability to carry out activities without assistance prior to injury *No - 1/Yes - 2*

4.1 Able to travel locally without assistance *No - 1/Yes - 2*

4.2 Able to travel locally without assistance prior to injury *No - 1/Yes – 2*

5. Work-related details.

A. Occupation prior to injury.....

B. Before injury, what was your pattern of work?

1 - Full-time/2 - Part-time/
3 - House wife/4 - Student/
5 - Retired/6 - Unemployed/
7 - Unfit for work/not working then

C. After injury, what is your pattern of work?

1 - Full-time/2 - Part-time/
3 - House wife/4 - Student/
5 - Retired/6 - Unemployed/
7 - Unfit for work/not working now

D. How do you rate your future job prospects after this injury?

1 - Not going to be affected/
2 - Affected, but slightly/
3 - Affected, very severely/
4 - Will be worse/bad

E. Did you receive any compensation/in the process of receiving after the injury?

No - 1/Yes - 2/Under investigation - 3

If yes, how much?: _____

5.1 Ability to work to previous capacity *No - 1/Yes - 2*

5.2 Restriction in work *Reduced work capacity* - 1/ *Able to work in a protected/supervised environment or currently unable to work - 2*

5.3 Work status prior to injury *No - 1/Yes - 2*

6.1 Resumption of regular social & leisure activities outside home *No - 1/Yes - 2*

6.2 Extent of restriction of social and leisure activities *Participating slightly less than before - 1/ Much less - 2/Unable to participate - 3*

6.3 Social & leisure activity prior to injury *No - 1/Yes - 2*

7.1 Psychological problems resulting in family disruption or disruption in friendships *No - 1/Yes -2*

7.2 Extent of disruption — *Occasional -1/frequent - 2/constant - 3*

7.3 Family disruption prior to injury — *No - 1/Yes - 2*

8.1. Current problems affecting daily life — *No - 1/Yes - 2*

8.2. Problems prior to injury — *No - 1/Yes - 2*

9. Epilepsy — *No - 1/Yes - 2*

Has the person had any epileptic fits? — *No - 1/Yes - 2*

Has the person been informed that he is at risk of developing epilepsy? — *No - 1/Yes - 2*

10. Vital factor in outcome — *Effects of head injury alone – 1/ Injury to other parts of the body – 2/ Combination of both – 3.*

Total Scoring:

11. Disability from spinal injury:

11.1 Bladder management — *No problem-1/Need help sometimes-2/Need help always- 3/NA - 4.*

11.2 Bowel management — *No problem-1/Need help sometimes-2/Need help always- 3/NA - 4.*

11.3 Mobility status — *No problem-1/Need help sometimes-2/Need help always- 3/NA - 4.*

11.4 ADL status — *No problem-1/Need help sometimes-2/Need help always- 3/NA - 4.*

11.5 Medical complications — *No problem-1/Need help sometimes-2/Need help always- 3/NA - 4.*

Section 2 Specific Burden and Impact on family
(Score 0-2 for each general and specific items)

12.1 Financial burden:

1. Loss of Patient's income — *Nil - 0/Moderate - 1/Severe - 2*
2. Loss of income of other family members — *Nil - 0/Moderate - 1/Severe - 2*
3. Expenditure incurred due to head injury — *Nil - 0/Moderate - 1/Severe - 2*
4. Expenditure incurred due to extra arrangement — *Nil - 0/Moderate - 1/Severe - 2*
5. Loans taken/savings spent — *Nil - 0/Moderate - 1/Severe - 2*
6. Postponing planned activities — *Nil - 0/Moderate - 1/Severe - 2*

12.2 Disruption of family routine activities:

1. Absence from paid work/school/household activities — *Nil - 0/Moderate - 1/Severe - 2*
2. Inability to participate in household work — *Nil - 0/Moderate - 1/Severe - 2*
3. Disruption of activity of other members — *Nil - 0/Moderate - 1/Severe - 2*
4. Person's behavior disrupting activities — *Nil - 0/Moderate - 1/Severe - 2*
5. Neglect of family due to person's illness — *Nil - 0/Moderate - 1/Severe - 2*

12.3 Disruption of family leisure activities:

1. Stopping of normal recreational activities — *Nil - 0/Moderate - 1/Severe - 2*
2. Person's illness occupying other person's time — *Nil - 0/Moderate - 1/Severe - 2*
3. Lack of attention to other family members — *Nil - 0/Moderate - 1/Severe - 2*
4. Postponing leisure activities — *Nil - 0/Moderate - 1/Severe - 2*

12.4 Family Interaction:

1. General atmosphere in the house — *Nil - 0/Moderate - 1/Severe - 2*
2. Increasing arguments over illness — *Nil - 0/Moderate - 1/Severe - 2*
3. Relatives/friends stopping visiting family — *Nil - 0/Moderate - 1/Severe - 2*
4. Seclusion of the family — *Nil - 0/Moderate - 1/Severe - 2*
5. Other untoward/hostile affects — *Nil - 0/Moderate - 1/Severe - 2*

12.5 Physical health of others:

1. Health of other family members — *Nil - 0/Moderate - 1/Severe - 2*
2. Other adverse affects — *Nil - 0/Moderate - 1/Severe - 2*

12.6 Mental health of others:

1. Mental health of other family members — *Nil - 0/Moderate - 1/Severe - 2*
2. Other adverse affects — *Nil - 0/Moderate - 1/Severe - 2*

12.7 Any other burden? How much would you say you have suffered owing to the patient's illness? *Nil - 1/Moderate - 2/Severe - 3/ NA - 4*

13. Social support networks:

13.1 Who is providing you all the help after your injury? *Family - 1/Friends – 2 /Neighbours - 3/ Others – 4, (specify)*

13.2 What support have you received from these people?

1) Sharing my problems and talking to me.
2) Helping me in day-to-day activities.
3) Financial help.
4) Helping me by visiting hospital
5) Others (specify)

13.3 What support have you received from government agencies?_____

13.4 What support have you received from NGOs? _____

14. Economic burden on family:

14.1 What are the areas in which you have been incurring expenditure due to the injury in the last one month/year?

	One month	**For the whole duration since injury**
Medicines		
Doctor's/hospital fees		
Other service-related expenditure		
Transport expenses		
Legal expenses		
Loss of other member's income		
Religious/spiritual activities		
Damage to vehicles/property		
Others		

14.2 What has been your expenditure since the time of injury?

1) Pre-hospital expenditure
2) Hospital expenditure
3) Post-hospital expenditure

Total in the past one year: _____

Section 3: Status of information: Quality of life:

15.1 (G1)	**:**	How would you rate your quality of life?	*Very poor - 1/Poor - 2/Neither poor nor good - 3/Good - 4/Very good - 5.*
15.2 (G4)	**:**	How satisfied are you with your health?	*Very dissatisfied - 1/Dissatisfied – 2/ Neither satisfied nor dissatisfied – 3/ Satisfied – 4/Very satisfied – 5.*
15.3 (F1.4)	**:**	To what extent do you feel that (physical) pain prevents you from doing what you need to do?	*Not at all – 1/A little – 2/A moderate amount – 3/Very much – 4/ An extreme amount – 5.*
15.4 (F11.3)	**:**	How much do you need any medical treatment to function in your daily life?	*Not at all – 1/A little – 2/A moderate amount – 3/Very much – 4/ An extreme amount – 5.*
15.5 (F4.1)	**:**	How much do you enjoy life?	*Not at all – 1/A little – 2/A moderate amount – 3/Very much – 4/ An extreme amount – 5.*
15.6 (F24.2)	**:**	To what extent do you feel your life to be meaningful?	*Not at all – 1/A little – 2/A moderate amount – 3/Very much – 4/ An extreme amount – 5.*
15.7 (F5.3)	**:**	How well are you able to concentrate?	*Not at all – 1/A little – 2/A moderate amount – 3/Very much – 4/ Extremely – 5.*
15.8 (F16.1)	**:**	How safe do you feel in your daily life?	*Not at all – 1/A little – 2/A moderate amount – 3/Very much – 4/ Extremely – 5.*
15.9 (F22.1)	**:**	How healthy is your physical environment?	*Not at all – 1/A little – 2/A moderate amount – 3/Very much – 4/ Extremely – 5.*
15.10 (F2.1)	**:**	Do you have enough energy for every- day life?	*Not at all – 1/A little – 2/ A moderately – 3/ Mostly – 4/ Completely – 5.*
15.11 (F7.1)	**:**	Are you able to accept your bodily appearance?	*Not at all – 1/A little – 2/A moderate amount – 3/Very much – 4/ Extremely – 5.*
15.12 (F18.1)	**:**	Have you enough money to meet your needs?	*Not at all – 1/A little – 2/Moderately – 3/Very much – 4/Extremely – 5.*
15.13 (F20.1)	**:**	How available to you is the information that you need in your day-to-day life?	*Not at all – 1/A little – 2/ Moderately – 3/Very much – 4/ Extremely – 5.*

15.14 (F21.1):	To what extent do you have the opportunity for leisure activities?	*Not at all – 1/A little – 2/Moderately – 3/Very much – 4/ Extremely – 5.*
15.15 (F9.1) :	How well are you able to get around?	*Very poor - 1/Poor - 2/Neither poor nor good - 3/Good - 4/Very good - 5.*
15.16 (F3.3) :	How satisfied are you with your sleep?	*Very dissatisfied - 1/Dissatisfied – 2/ Neither satisfied nor dissatisfied – 3/ Satisfied – 4/Very satisfied – 5.*
15.17 (F10.3) :	How satisfied are you with your ability to perform your daily living activities?	*Very dissatisfied - 1/Dissatisfied – 2/ Neither satisfied nor dissatisfied – 3/ Satisfied – 4/Very satisfied – 5.*
15.18 (F12.4) :	How satisfied are you with your capacity for work?	*Very dissatisfied - 1/Dissatisfied – 2/ Neither satisfied nor dissatisfied – 3/ Satisfied – 4/Very satisfied – 5.*
15.19 (F6.3) :	How satisfied are you with yourself?	*Very dissatisfied - 1/Dissatisfied – 2/ Neither satisfied nor dissatisfied – 3/ Satisfied – 4/Very satisfied – 5.*
15.20(F13.3) :	How satisfied are you with your personal relationships?	*Very dissatisfied - 1/Dissatisfied – 2/ Neither satisfied nor dissatisfied – 3/ Satisfied – 4/Very satisfied – 5.*
15.21 (F15.3) :	How satisfied are you with your sex life?	*Very dissatisfied - 1/Dissatisfied – 2/ Neither satisfied nor dissatisfied – 3/ Satisfied – 4/Very satisfied – 5.*
15.22 (F14.4) :	How satisfied are you with the support you get from your friends?	*Very dissatisfied - 1/Dissatisfied – 2/ Neither satisfied nor dissatisfied – 3/ Satisfied – 4/Very satisfied – 5.*
15.23 (F17.3) :	How satisfied are your with the conditions of your living place?	*Very dissatisfied - 1/Dissatisfied – 2/ Neither satisfied nor dissatisfied – 3/ Satisfied – 4/Very satisfied – 5.*
15.24 (F19.3) :	How satisfied are you with your access to health services?	*Very dissatisfied - 1/Dissatisfied – 2/ Neither satisfied nor dissatisfied – 3/ Satisfied – 4/Very satisfied – 5.*
15.25 (F23.3) :	How satisfied are you with your transport?	*Very dissatisfied - 1/Dissatisfied – 2/ Neither satisfied nor dissatisfied – 3/ Satisfied – 4/Very satisfied – 5.*

15.26 (F8.1) : How often do you have negative feelings such as blue mood, despair, anxiety, depression? *Never-1/Seldom-2/Quite often-3/ Very often - 4/AIways - 5.*

16. Status of information: *Directly from patient or family members - 1/ from friends - incomplete information - 2 / Not possible to collect any information - 3.*

Specify, reasons _____

Investigator's Code & Signature

Srilatha, 32 years ....

It was a Sunday morning. Since it was a holiday for my husband and children, everything was going in a relaxed manner since morning. Being a free day, my husband decided that we will have breakfast in a restaurant as I was in no mood to do any cooking. Nitesh (my husband), Rajiv and Rachita (my children aged 7 and 3 years) and myself decided to go out. Since, my husband did not want to drive his car, we decided to go on my brother's motorbike . It was so difficult to accommodate 4 people in one bike, but still we managed. A special Sunday breakfast has to be in a special hotel. As we were going, children were generally talking to me and my husband. My husband was not wearing his helmet also. Since the roads were free on a Sunday morning, Nitesh was driving in high speed. As we approached a circle, my husband did not slow down. Adding to this, was the absence of traffic policeman in circle. As we were taking a right turn, a car from our right side tried to overtake us. My husband moved fast and turned right. At that point, he lost control and had a skid. Since he was in speed, all of us were thrown helter – swelter and went everywhere. I was the one to get up first and could not speak. I had some bruises everywhere and was in searing pain. My daughter was lying a few feet away and was screaming. Both my son and husband were lying nearby without any movement. My husband was in a pool of blood. All roadside people had gathered immediately and somebody stopped 2 auto rickshaws. One person wanted to call an ambulance, but we thought we would move on our own as we thought it is not good to wait. Two other people came along with us in the auto and reached a nursing home. The doctors started treatment. They informed that my son and husband have to be shifted to a bigger hospital for investigations. They also said that both would require surgery. Both my daughter and me were treated

Contd.....

and X-ray was done for me. Luckily, there were no fractures. My daughter escaped with minor injuries with no damage to life. After about 2 hours, we shifted my husband and son to another hospital. The hospital authorities asked us to deposit Rs. 20,000. By that time, my brother and other relatives had joined and they took care of these issues. After tests, we were informed that both my husband and son should undergo surgery and we agreed. My husband was taken in for surgery and was operated over 6 hours and later shifted to Intensive care unit. My son also underwent surgery for 3 hours & was shifted to post operative ward. We were all in pain, shock and unexplainable misery. Whatever, we want to call it, my husband did not recover after surgery and started deteriorating. This caused such a major shock to everyone. By Monday evening, my husband was slipping and we were in panic. At 7.30 pm, doctors expressed their inability to do anything further and he was declared dead. My son was still recovering and could not understand what was going on.The sudden turn of events in my life is something I am not able to understand, think and comprehend. The death of my husband has thrown my family out of gear and I am still living with my brother's family. All unexpected things have started happening. Financial problems, social problems, fear of future, children's future, where will I live?, how do I survive ? have all started coming up and I don't have any answers. My son after 2 months of discharge becomes angry and has difficulty in talking. Every time, I talk to him, he struggles for words. I don't know what he will do when he goes to school. I am taking him to doctor regularly. Doctors say, we will train him and bring him back. I am not sure what we will do from now on.....

Injury prevention and safety promotion is the responsibility of many sectors in the society. Each sector has specified roles, responsibilities and activities that need to be performed with the unified goal of making people safe on roads, at homes, in schools, in work places, play sites and in other places. Activities across and within each of these agencies needs to be coordinated and integrated for the delivery of services. A national injury prevention and control programme needs to be developed with a common goal, mission and vision to save lives.

Prevent Brain Injury