

Musculoskeletal Trauma Services in China

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Published online: 16 July 2008
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Abstract China is a developing country with a population over 1.3 billion with the second largest group of people in poverty next to India. There are about 159 million motor vehicles, with 163,887,372 drivers. From 2001 to 2004 over 100,000 people died each year in traffic accidents. With law enforcement and public education, traffic accidents have decreased, and the death rate is now less than 100,000 each year.

Introduction

China, with the world's largest population and the fourth largest geographic area, second only to India in the number of people living in rural areas, has not entirely solved the problem of adequate food, clothing, and shelter for its population. With a rapidly growing economy, it is heavily burdened with musculoskeletal trauma.

Based on the data collected from government reports and published papers, a profile of musculoskeletal trauma

care service in China is briefly outlined and recommendations made.

Overview of China

China is a large country with considerable geographic and ethnic diversity. From a geographical perspective, China has the world's largest (and highest) plateau, two of the longest rivers (Yangtze and Yellow), and a variety of environments such as polar, deserts, grasslands, tropical rainforests, lakes, and oceans. Natural disasters are common in China. In 2006 there were 7775 forest fires (3767 less than in 2005) and 93 red tides. Natural disasters resulted in 663 deaths. Among them, 14 earthquakes were over grade 5 and 10 disastrous earthquakes impacted the lives of 667,000 people. There were 112,822 deaths due to occupational injuries, an 11.2% decrease in comparison with 2005 [19, 20].

On May 12, 2008, an earthquake measuring 8.0 on the Richter scale jolted China [1, 4, 6, 7, 24, 27, 28]. The epicenter was in Wenchuan county, Sichuan province, but most of China felt the quake. Deaths and injuries occurred in Gansu, Shaanxi, Chongqing, Henan, Yunnan, Hubei, Guizhou, and Hunan provinces. By June 26, 2008, the death toll from the earthquake increased to 69,130, while another 374,031 people were injured and 17,824 others were still listed as missing. More than 46.16 million people throughout China were affected by the deadly quake [6]. Hospitals treated an estimated 94,774 injured people as of June 6, 2008, of whom 75,722 had been discharged and 16,463 were still being treated [6]. As of this writing, 10,650 aftershocks were detected in the quake-hit areas since May 12 [6]. The effects from the earthquake have not ended, and the numbers will continue to climb with the passage of time.

One author (Li-Ze Xiong) has received funding from a grant of China's Army (06G086).

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By the end of 2006, the population of China was more than 1.3 billion, approximately 20% of the world's population, of which males comprised 51.5% and females 48.5% [19]. The urban population was 577,060,000 (43.9%), and the rural population was 737,420,000 (56.1%) [19].

The birth rate in 2006 was 12.1 per 1000, while the death rate was 6.8% [19]. The population growth rate was 5.3% per year [19]. (The population data do not include that of the Hong Kong Special Administrative Region, Macao Special Administrative Region, and Taiwan Province.) Based on the standards of the World Bank, one's income or spending per day is equivalent to or above to US\$1 purchasing power, and by the end of 2006 an estimated 0.135 billion people fell under this standard, of which 0.126 billion were in rural areas [12]. This constitutes the world's second largest population in poverty, following that of India.

China is also becoming more urban. From 1952 to 2003, while its total population "merely" doubled, the proportionate urban population tripled from 13% to 39% [11]. By the end of 2004, the urban population was 542,830,000 (41.8% of the total population) and the rural population was 757,050,000 (58.2% of the total population) [22]. By the end of 2007, the urban population was 593,790,000 (44.9% of the total population), and the rural population was 727,500,000 (55.1% of the total population) [21]. From 2004 to 2007, the urban population increased from 41.8% to 44.9% of the total population, while the rural population decreased from 58.2% to 55.1%. In 2004, there were over 0.14 billion people floating between rural and urban areas, and it is estimated there will be 0.3 billion shifting from rural to urban areas by 2020 [22].

In manual labor jobs, light, medium, and heavy physical labor account for approximately even portions. More than half of laborers mainly sit and stand but do not walk much in their work. Women still do most of the housework. Fifty-three percent of men do housework while 85% of women do [23].

China's economy is large and growing rapidly, ranking third in total gross domestic product (GDP) and first in GDP growth rate (roughly three times the world average [11]). It is the world's largest producer of steel, cement, aquacultured food, and television sets, and is the second largest producer of electricity and chemical textiles. With increasing affluence, China's per capita consumption of meat, milk, and eggs has increased four-, four-, and eight-fold, respectively, between 1978 and 2002 [11]. In 2007, motor vehicle production was over 8,800,000, making China the world's third-largest vehicle manufacturer, after the United States and Japan. By 2009, China is predicted to be the largest vehicle manufacturer, and by 2015 to be the largest vehicle consumer market [30, 32]. Despite China's large total GDP and outputs of various products, its per

capita GDP and outputs are still much lower than those of many other countries.

China is subdivided into provinces, autonomous regions, and municipalities, and they all have provincial-level administrative structures. Smaller divisions have about five administrative levels: province level, prefecture level, county level, township level, and village level. By the end of 2003, there were 23 provinces, five provincial-level autonomous municipalities for minor nationalities, and four municipalities directly under the central government, and two special administrative regions. In mainland China, provinces theoretically are subservient to the PRC central government, but in practice, provincial officials have a large amount of discretion with regard to economic policy. There are 2016 counties and county-level municipalities [29].

Role of the Central Government in Health Care

Administration of healthcare services is under the direction of the Ministry of Health and its subdivisions, at each of the levels mentioned above. Roles for the ministry include the following: research and establish laws and policies related to healthcare, define healthcare development strategies, establish technical criteria and standards for practice, supervise implementation of these policies and standards, research healthcare service layout and programming, make overall plans and coordination of national healthcare resources and distributions, and organize/maintain the development and implementation of service standards for community healthcare facilities. The Ministry of Health has a variety of responsibilities, including national health education, programs for the prevention of and treatment of various diseases, monitoring trends in infectious diseases, responding to public health crises such as an outbreak of an infectious disease, researching and guiding reforms in healthcare policies, standards for medical practice, studying and creating national key projects on health technology and education, and organizing national key health care research projects.

Traffic in China

There were 163,887,372 drivers in China by the end of 2007 [2]. The mix of motor vehicles (~159 million) includes cars and trucks (~57 million), motorcycles (~87 million), trailers (~869,000), and road-running tractors (~15 million). Traffic conditions are characterized by: (1) varied modes of transportation (eg, road, water, railway and flight); (2) large numbers of motor vehicle drivers with poor protection; (3) a variable traffic mix including pedestrians and a variety of vehicles (car, truck, trailer, bus,

bicycle, tricycle and tractors); (4) inadequate infrastructure with poorly graded long-distance roads in complex geographic conditions; and (5) a large, mobile population who often travel more than 1000 km to visit relatives or for work-related activities. In 2006, 20,080,000,000 total passengers were transported (growth rate: 8.7%), of which 1,260,000,000 (growth rate: 8.7%) were transported by railway, 18,450,000,000 (growth rate: 8.7%) were transported by road traffic, 220,000,000 (growth rate: 6.3%) were transported by water traffic, and 159,613,000 (growth rate: 15.4%) were transported by flight [19].

Motor vehicles are often shared among family members, friends, or colleagues. There are a large number of transport trucks and other vehicles used for agricultural purposes. Deficiencies in both the quality and maintenance of motorized vehicles create a safety hazard. Economic development has been associated with an increase in the capacity to purchase cars; however, many drivers receive inadequate training. While some drivers have no license at all, others purchase illegal licenses. Some motor vehicles are not licensed for highway use, but nonetheless they are used in that capacity.

The yearly death toll from road traffic crashes from 2001 to 2004 exceeded 100,000 people, while the yearly death toll from road traffic crashes from 2005 to 2007 decreased from 99,000 to 82,000 people [17–21]. It is estimated there is one death every six minutes and one injury per minute [3]. Traffic injuries are now the sixth leading cause of death in China, after malignancy, cerebrovascular disease, heart disease, pulmonary disorders, and injury and poisoning [16]. These figures underestimate the magnitude of the problem, as the data exclude injuries sustained while traveling off the public roads, and those that were not reported to the police.

From 1995 to 2005, approximately 75% of traffic-related deaths were men (94% in 2003) [8]. Most deaths (59%–62%) were in individuals between 16 and 45 years of age. The percentage of deaths in the population over 65 years old increased from 6.8% (1995) to 9.4% (2005). The distribution of deaths in terms of road users (2005) were: motor vehicle drivers (33.2% of the total deaths); motorcycle drivers make up 66.8% of all drivers), car passengers (24.9%), nonmotor vehicle drivers (15.5%), and pedestrians (24.8%). When compared to the fatalities caused by mechanical fault of motor vehicles and road construction fault, human error (drivers and pedestrians) was at fault in a large majority (78%–96%) of fatalities. Traffic law violations are frequent (Table 1), and the number of law enforcement officials is inadequate. Deaths caused by faulty drivers rose to 94% in 2004 and 97% of the total vehicular deaths in 2005, with speed violations cited as the most frequent cause in the death of motor vehicle drivers. The major cause of pedestrian deaths is illegal crossing of roads.

Table 1. Traffic accidents and transportation law violations in 2005 [17, 20] and 2006 [18, 19]

Variable	2005	2006
Traffic accidents	450,254	378,781
Deaths	99,000	89,455
Injuries	469,911	431,000
Transportation law violations	223,000,000	130,000,000
Citations/arrests	171,000,000	Not available
Speeding	12,390,000	16,000,000
Overloaded vehicle	1,970,000	Not available
Tired driving	Not available	200,000
Drunk driving	Not available	650,000

Deaths caused by mechanical failure of motor vehicles have decreased from about 6% to about 3% of the total; deaths related to road construction constitute less than 1%.

In Shaanxi Highway traffic accidents from 1994 to 1999, the first response was by telephone in 37.1% of incidents, 25.8% by passing drivers, 15.1% by the victims themselves on foot, while 22% were found by road administrative staff during patrol. Road administrative staff arrived at 49% of accident sites within 30 minutes [9]. The percentage of the injured that arrive at the hospital within 1 hour ranges from 28% to 56%, and 26% to 41% arrive within in 1 to 2 hours [9, 10]. The methods to transfer victims include EMSS ambulance (16%), road administration patrol car (43%), passing cars (29%), and other (14%) [9].

Partly related to varied first response mechanisms and an underdeveloped and inefficient first aid network, the death rate in all highway traffic accidents ranged from 17% to 32%. The prehospital death rate in highway accidents constituted 66 to 93% (average 80%) of the total deaths [9, 10, 31].

Medical Services in China

Medical care includes Western medicine, traditional Chinese medicine (TCM), Western medicine plus TCM, Tibetan medicine, Uygur nationality medicine, and other minor nationality medicine (Mongolian medicine, etc.). Western medicine, traditional Chinese medicine and Western medicine plus TCM are the three main types of service available in China.

Prehospital Care System and Network

The development of emergency medical centers was an important milestone in the delivery of prehospital trauma care services. The Emergency Medical Center (first aid

station) Branch of the Chinese Hospital Association was founded in 2002. It is a national nonprofit professional organization for Chinese emergency practitioners/administrators affiliated with the Chinese Hospital Association. This network of emergency centers is under the direct leadership of the Ministry of Civil Administration and Ministry of Health, in addition to the Chinese Hospital Association.

As of 2006, there were 160 Emergency Medical Centers (first aid stations) in China [5]. The distribution map and information for most emergency medical centers (first aid stations) can be found on the China Emergency Medical Service System's web pages [26]. The centers are spread out over China's vast geographic region. The distribution of care is uneven and favors more urban areas. The telephone number for emergency response is 120. Some emergency centers in municipalities, provincial cities, and some developed areas have increased capabilities. These rapidly developing emergency centers have paid attention to the development of professional personnel, to establishing emergency networks, and to developing formal cooperation with hospitals. They also establish close links with police, fire departments, and traffic departments, each of which has a well-known phone number (same throughout the nation). However, these developments vary in different areas. Prehospital emergency care in economically underdeveloped regions, especially in the western parts of the country, remain weak [8].

In-hospital Musculoskeletal Trauma Services

By the end of 2006, there were 5,279,330 health workers working in medical facilities in China, excluding those in disease prevention centers and village clinics [16]. Of these, 1,866,683 were registered doctors or assistant doctors, with 1,406,411 registered nurses. In 2006, the ratio of doctors to population was 1.55 per 1000, and the ratio of nurse to population was 1.11 per 1000 [16]. There were 308,969 facilities in the health system, excluding village clinics. Among the licensed health facilities, there were 19,246 hospitals (13,663 government funded, 1478 community funded, 158 jointly funded by government and other source, 2639 privately funded, and 1308 with other types of funding [13]), 23,000 community service centers, and 40,000 health clinics in towns and townships. Complete statistics can be found on the web pages of the statistic report on the development of the public health system in China for the year 2006 by the Statistic Information Center of Ministry of Health of the People's Republic of China, and in China's annual health statistics book of 2007 by Ministry of Health of the People's Republic of China [14, 16].

Hospital Classification System

According to function and scale, hospitals are divided into three grades [15].

Grade I hospitals, mainly community and/or township hospitals, are the most basic facilities, and mainly function to promote primary healthcare. They provide medical services, prevention/prophylaxis, and rehabilitation from illness for communities with a population less than 100,000. Their focus is on primary prevention, attention to common diseases, and the triage of complex cases to higher-level facilities. They must communicate and cooperate with higher-level facilities to coordinate patient care. Grade I hospitals are subdivided into IA, IB, and IC on the basis of capacity and construction. The bed count of each Grade I hospital should be over 20, and the ratio between the beds and work staff is 1:1-1.4. Healthcare providers (doctors, nurses, and technicians) should account for 80% to 85% of all staff working in the hospital, in which 38% are doctors, 38% are nurses, and 8% each are laboratory and radiology technicians. There are 8% each of pharmacists and others. Waste management services must be available. The hospital must have independent departments of internal medicine, surgery, obstetrics and gynecology, emergency, pharmacy, laboratory, radiology, supply room, disinfection room, and records room. Departments of pediatrics, ear-nose-throat-eye-dental-oral disorders, and traditional Chinese medicine are optional. The surgeons in the department of surgery should have the skills to diagnosis and treat common emergent abdominal disorders, stop bleeding, close and dress wounds, and perform fracture fixation. Grade I hospitals offer cardiograms, ultrasound, radiographs, and common gastrointestinal series, blood and urine tests, stool exam, and some blood biochemical tests.

Grade II hospitals, mainly prefecture- and/or county-level, are the local technical centers of disease prophylaxis and locally provide medical treatment across several communities (over 100,000 people). Their main functions are to monitor high-risk patients, take referrals from Grade I hospitals, transfer complex patients to higher-level hospitals, and to function in a coordinated manner with both higher and lower level facilities to coordinate patient care, to provide technical support for the Grade I hospitals, and to ideally promote education and scientific research. The Grade II hospitals are further subdivided into grades IIA, IIB, and IIC on the basis of hospital capacity and construction. Each Grade II hospital has over 100 beds. The ratio between the beds and work staff is 1:1.3-1.5. Healthcare providers (doctors, nurses, and technicians) should consist of over 75% of all staff working in the hospital. The ratio between doctors and nurses is 1:2. The waste water and medical waste should be decontaminated. The hospital must have independent departments of emergency, internal

medicine, surgery, obstetrics and gynecology, pediatrics, otolaryngology, traditional Chinese medicine, infectious diseases, rehabilitation and physical therapy, intensive care units (ICU) for internal medicine and for surgery, coronary care unit (CCU), pharmacy, laboratory, radiology, supply room, disinfection room, and records room. There should be over three subspecialty departments of internal medicine including respiratory, gastrointestinal, cardiology, hematology, endocrinology, and neurology, based on the construction of the hospital. There should be more than three subspecialty departments of surgery including general surgery, orthopaedics, urology, and neurosurgery, based on the construction of the hospital. Most Grade II hospitals have CT and some have MRI. Well-equipped ambulances are required. Surgeons can perform more complex surgical interventions, such as liver lobectomy, traumatic splenectomy, open reduction and internal fixation of fractures (including spine fractures), joint replacement, arthroscopy, laminectomy, discectomy, and others.

Grade III hospitals, mainly provincial, municipal, or medical university-affiliated, are the medical centers responsible for providing the highest level of service, including the full range of medical subspecialties, as well as education and scientific research. These facilities deal with high-risk, critical, complex, and difficult diseases, and receive referrals from Grade II and/or Grade I hospitals. They also help to guide or inform the services at lower-level hospitals, and to train doctors from lower-level hospitals. They are also responsible for cultivating and educating senior professionals, for undertaking provincial and/or national scientific research projects, and for taking part in and supervising primary and secondary preventive treatment. The Grade III hospitals are further subdivided into grades IIIA, IIIB, IIIC and IIID on the basis of hospital capacity and construction. Each Grade III hospital has over 500 beds. The ratio between doctors and nurses is 1:2. The hospital must have independent departments of emergency, internal medicine, surgery, anesthesiology, obstetrics and gynecology, pediatrics, ophthalmology, otolaryngology, stomatology, traditional Chinese medicine, infectious diseases, rehabilitation and physical therapy, intensive care units (ICU) for internal medicine and for surgery, coronary care unit (CCU), pharmacy, laboratory, imaging including radiology, supply room, disinfection room, records room, etc. For subspecialties, the hospital must have independent departments of internal medicine including respiratory, gastrointestinal, cardiology, hematology, endocrinology, and neurology, The hospital must have independent subspecialty departments of surgery including general surgery, orthopaedics, chest and heart surgery, urological surgery, neurosurgery, burn, and plastic surgery. All hospitals have cold running water and backup electricity. Hot running water is not a requirement.

All hospitals mentioned above are owned by the central or local government. Theoretically, the national or local government will give financial support for the running of the hospitals, but in fact, hospitals often are supported in part by loans from commercial banks and other sources of funding. Most hospitals in China must make money to pay the salary of the staff.

Based on the hospital classification system described here, in 2006, there were 1045 Grade III, 5151 Grade II, 2738 Grade I, and 10,312 ungraded hospitals [16]. In considering the number of beds, 11,516 hospitals have less than 100 beds, 3803 hospitals have 100 to 199 beds, 2832 have 200 to 499 beds, 764 have 500 to 799 beds, and 331 hospitals have over 800 beds [16].

All Grade I hospitals and above are equipped with a radiology facility, and all Grade II hospitals and above have a CT scanner and sometimes an MRI scanner. In the hospitals above Grade II, there are orthopaedic surgeons and an independent department of orthopaedics for specialized musculoskeletal trauma care.

Most musculoskeletal trauma care services are provided in the department of surgery in hospitals Grade II level or below. Subspecialties generally cannot form independent departments at or below the level of Grade II hospital, except in economically developed areas.

In 2006, there were 271 orthopaedic hospitals (57 government funded, 37 community funded, six jointly funded by government and other sources, 131 privately funded, and 40 funded by other sources) [13]. There are 271 rehabilitation hospitals (139 government funded, 40 community funded, six jointly funded by government and other sources, 61 privately funded, and 25 funded by other sources) [13]. Generally, the orthopaedic surgeons working in state-owned, large general hospitals are experienced and skilled compared to those in mid- and small-scale municipal, county, or private hospitals. The government-owned hospitals still provide the majority of musculoskeletal trauma care.

Training and Licensing of Doctors

There are four licenses for the practice of medicine: (1) clinical (internal medicine and surgery), (2) traditional Chinese medicine, (3) oral medicine, and (4) public healthcare. Only a government-issued diploma in surgery allows a doctor to perform surgery. There are no subspecialty certificates such as orthopaedics, general surgery, neurosurgery, etc. If a surgeon has a diploma in surgery, he can legally perform any type of surgery.

After graduation from medical school and once the doctor is employed by a hospital, if he or she works in the department of orthopaedic surgery, then they are considered

an orthopaedic surgeon; if they work in the department of neurosurgery, then they are considered a neurosurgeon, and so on. Most hospitals above the township level and at the county level have orthopaedic specialists. While some surgeons focus on orthopaedics or other subspecialties, and others practice mainly general surgery, all surgeons are called upon to assist with procedures across all disciplines.

Discussion

China's large population, complex geography, and rapidly developing industry make the delivery of health care a challenge; medical care remains underdeveloped in comparison with industrial development. We have attempted to outline the past structure and status of China's healthcare and will now address its current state, future goals, and suggestions for reaching them.

Although progress has been made, we have yet to establish a national healthcare scheme that provides universal access to services. A new medical reform system is being evaluated and discussed. Although most hospitals are state-owned, funding from government agencies has been insufficient to develop and maintain medical services. Just as economic development has varied between and within different regions, so has the development of health care services, including the quality of both prehospital and in-hospital medical services. Systems for the delivery of care to the injured must be strengthened, especially in the poor areas, and this will require support from both the government and professional societies.

Alongside the rapid development of the economy, there have been substantial increases in the volume of motor vehicles on the roads, increasing musculoskeletal trauma in China. Prevention is the most effective way to reduce the number of injuries, and will require a comprehensive approach including traffic safety law enforcement and public education. Although the law on traffic and safety became active in May of 2005, and was revised in May of 2008 [25], traffic violations are still common. More efficient law enforcement is required, and licensure must be maintained. Adequate road infrastructure must be provided, as well as quality control for vehicles.

Traffic safety awareness is very important for the public. Due to the Chinese lifestyle and the historical shortage of motor vehicles, the public awareness of traffic safety is very low. The traffic safety laws are just a few years old and the public must be widely educated about the law and rules on the road. The media has helped in this regard, and safety awareness must reach remote areas, as well as those who do not have motor vehicles. Improvements in road traffic education should take place alongside developments in the transportation industry. While the media

(television, newspapers, journals, meetings, booklets, and advertisements) has adequately reported disastrous events to enhance public awareness and education, these channels have not raised the profile of issues such as injuries and road traffic crashes. Increased efforts are needed for educating the public about negative aspects of traffic trauma, and the positive aspects of road safety. Adequate prehospital care must be stressed, including the ABCs of basic life support, and the proper way of moving and transferring victims. Basic life support should be taught in schools and public forums, especially for police officers, road administrative officers, firefighters, and drivers to prevent further injury during the process of first aid and patient transfer.

Following the May 2008 Wenchuan Earthquake [6], it was reported that approximately 139,642 medical staff participated in quake relief work nationwide, and 91,298 medical staff participated in quake relief work in Sichuan Province including medical staff from overseas [4, 28], 113,080 army and armed police troops [27], and 13,434 firefighters were mobilized from the entire country [24] to respond to the disaster areas. There are about 1,122,000 volunteers registered in Sichuan province, and there are about 667,000 volunteers working directly in earthquake relief [7].

Because this natural disaster allowed little time to prepare, and due to the unfavorable geographic terrain including valleys, mountains, landslides, road damage, rainy and cloudy weather, and widespread problems in the quake regions, the troops were ill-equipped to handle initial earthquake relief efforts. Soldiers had to remove rubble by hand and walk to disaster locations to assist in rescue efforts, and security forces overall were limited by a general lack of training in disaster relief.

In a natural disaster of this type, military and paramilitary troops are generally the first response team to arrive, but they are not properly equipped to effectively triage the victims. Although first on scene, they are not well-trained in musculoskeletal first aid. A vast number of rescue personnel pour into the earthquake regions in a very short time, and organization and coordination between the different response teams is crucial. Appropriate training of military and paramilitary troops to prepare them to deal with a disaster of this proportion cannot be overemphasized. First-response teams should be educated in evacuation, rescue, and first aid and a protocol developed to standardize relief efforts. These skills are important not only for rescue teams, but for the population at large.

The prehospital emergency medical service system can be enhanced by training more people (both health professionals and lay people) and by improving the mechanisms to transfer the injured to a treatment facility. A referral system should be established within the trauma care system. More emergency medical facilities should be

established to provide timely care to the injured. While orthopaedic surgeons are the major providers of definitive musculoskeletal trauma care, their training has not been uniform, and there is great variability in the level of services they provide. No orthopaedic and/or trauma subspecialty license is available for establishing and keeping the quality of the trauma care service. Trauma care service accessing system and certification procedures should be applied.

An effective trauma care system must be well-organized at multiple levels, and requires input and dedication from multiple stakeholders including the government, the police, the firefighting service, motor vehicle producers, transportation companies, communication companies, the road construction industry, the prehospital emergency medical service system, the medical service providers (eg, hospitals), the media, and others. Smooth cooperation and coordination will most effectively improve the quality of musculoskeletal trauma care.

The burden of injury in China is large, and musculoskeletal injuries are responsible for considerable morbidity. The burden is felt by the individual, his or her family, as well as the community and the society. A great number of factors influence the final outcomes, offering the opportunity to intervene at many levels. No single department or agency can deal with it alone and it will require a multidisciplinary effort.

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