CDC Injury Research Agenda





2009-2018

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Injury Prevention

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2009-2018

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Abbreviations and Acronyms

ACIPC	Advisory Committee on Injury Prevention and Control
ACL	anterior cruciate ligament
BAC	blood-alcohol concentration
BRFSS	Behavioral Risk Factor Surveillance System
CPS	Child Protective Services
CPSC	Consumer Product Safety Commission
DALYs	disability-adjusted life years
DUI	driving under the influence
DVP	Division of Violence Prevention (within CDC's National Center for Injury Prevention and Control)
ED	emergency department
EMS	emergency medical services
GDL	graduated driver licensing
HIV	human immunodeficiency virus
HRSA	Health Resources and Services Administration
IOM	Institute of Medicine
MCHB	Maternal and Child Health Bureau
MV	motor vehicle
NHTSA	National Highway Traffic Safety Administration
NICHD	National Institute for Child Health and Human Development
NIH	National Institutes of Health
NIOSH	National Institute for Occupational Safety and Health (CDC)
NORA	National Occupational Research Agenda
PTSD	posttraumatic stress disorder
SCI	spinal cord injury
SIDS	sudden infant death syndrome
SRE	sports, recreation, and exercise
SSNRs	safe, stable, and nurturing relationships
TBI	traumatic brain injury
USFA	U.S. Fire Administration
WISQARS	Web-based Injury Statistics Query and Reporting System

Foreword

We want people to live to their full potential. Every day at CDC's National Center for Injury Prevention and Control, we face the statistics that reflect how a life full of promise can be shortchanged by injury. Unintentional injury is the number one killer of children and young adults. Approximately 5 million people in the United States suffer from chronic, injury-related disabilities, and the lives of millions of others have been dramatically affected by injuries to themselves or someone they love. Although we have made significant progress during recent years to lessen the public health burden of injury, we see the possibility of doing much more.

At CDC's Injury Center, we translate science into effective programs and policies that prevent unintentional and violence-related injuries and that minimize the consequences of injuries when they occur. Research is fundamental to our success because thorough, accurate data are essential in making sound, smart investments. Research provides the knowledge that we need to understand what is possible, what is not, and the best way to proceed in our intervention efforts.

This CDC Injury Research Agenda describes our research needs and priorities for 2009–2018. Our initial research agenda was published in 2002 to guide research through 2007, and it has been invaluable in directing our research efforts. Throughout the past 2 years, we updated and revised the agenda, reviewing research accomplishments to date and progress toward achieving the goals outlined in the original agenda. In developing this update, we considered information and recommendations from the CDC report, *Advancing the Nation's Health: A Guide to Public Health Research Needs, 2006–2015*, as well as the objectives and strategies outlined in action plans associated with CDC's Health Protection Goals (http://www.cdc.gov/osi/goals/goals.html) and *Healthy People 2010* (http://www.healthypeople.gov).

Investing in the priorities outlined in this research agenda will help prevent needless deaths and painful, costly injuries. We know that we can make a difference. We look forward to working with the injury prevention and control community to implement this agenda for a safer, healthier nation — one in which all people can live to their full potential.

Ileana Arias, PhD
Director
National Center for Injury Prevention and Control

Introduction

Background

Injuries have a substantial impact on the lives of U.S. residents, their families and communities, and society. During 2005, a total of 173,753 injury-related deaths occurred, and during 2006, an estimated 29,821,159 persons with nonfatal injuries were treated in U.S. hospital emergency departments.[1] The consequences of these injuries can be extensive and wide-ranging. They are physical, emotional, and financial, and in the case of disabling injuries, the consequences are enduring.

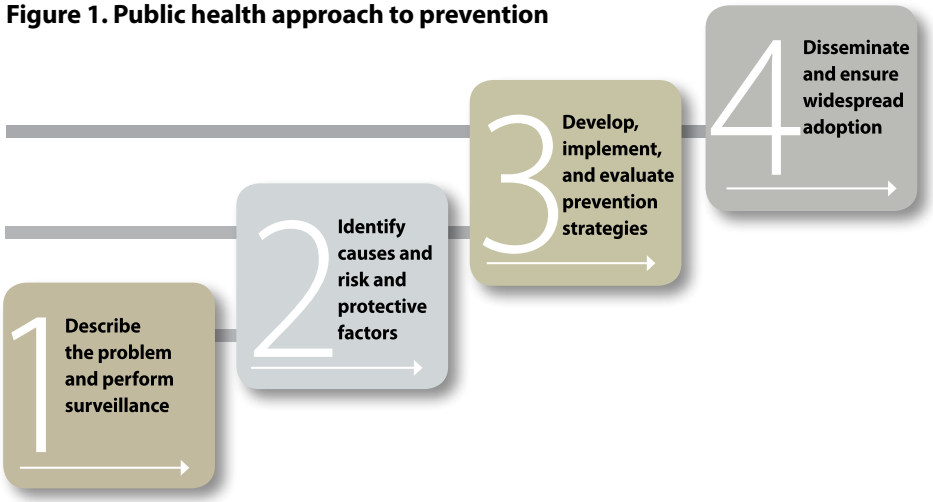
The mission of CDC's National Center for Injury Prevention and Control (Injury Center) is to prevent injuries and violence and reduce their consequences so that people can live to their fullest potential. To prevent injuries and minimize their consequences when they occur, the Injury Center uses the public health approach (Figure 1), which is a systematic process that

- describes the problem;
- identifies risk and protective factors;
- develops and tests prevention interventions and strategies; and
- ensures widespread adoption of effective interventions and strategies.

The Injury Center is the only organization in the federal government with responsibility for addressing all phases of the injury research framework, from foundational research through dissemination research, for all major causes of injury among all age groups. To reach its goal of translating science into effective programs and policies, the Injury Center collaborates with other federal agencies and partners to document the incidence and impact of injuries, understand the causes, identify effective interventions, and promote their widespread adoption.

The importance of research in diminishing the problem of injuries has been described before. For example, the 1985 Institute of Medicine (IOM) report *Injury in America* concluded that supporting injury research is necessary to substantially reduce injury rates.[2] The Injury Center's formation was, in part, a result of this IOM finding. Fourteen years later, another IOM report, *Reducing the Burden of Injury,* reemphasized the importance of a scientific foundation for injury prevention and tasked the Injury Center to work with foundations, state and local organizations, businesses, and other federal agencies to stimulate and facilitate investment in injury research activities.[3] The first Injury Center research agenda published in 2002[4] was intended to be applicable throughout 2002–2007. This revised edition outlines Injury Center priorities applicable for 2009–2018.

Figure 1. Public health approach to prevention



Step 1. Describing the problem includes not only systematically counting cases but also delineating the demographic characteristics of the persons involved, the temporal and geographic characteristics of the problem, the victim-perpetrator relationship, and the severity and cost of the injury. Closely integrated is the timely dissemination of data to decision makers and monitoring and tracking trends.

Step 2. The second step considers why injuries occur. It involves conducting research to determine the causes and correlates of injury, the factors that increase or decrease the risk for injury, and identifying the factors that might be modifiable through interventions.

Step 3. Potential strategies for preventing and controlling injuries are based on the information collected in Steps 1 and 2, and those strategies are tested through intervention research by using randomized controlled trials, experimental and control group designs, time-series analyses, or observational studies. Efficacy and effectiveness research further assesses whether an intervention reduces injuries. When programs are developed and modified on the basis of such research, the likelihood of having effective prevention programs is increased.

Step 4. The final stage of the public health model involves dissemination of information that supports prevention and the broader implementation and adoption of evidence-based strategies. This area also requires research and is an important niche for CDC. Studies focus on methods, structures, and processes to encourage communities and policymakers to adopt evidence-based programs, policies and laws that reduce unintentional injuries and violence, and on factors that increase organizational and community capacity for tailoring, implementing, and sustaining interventions.

* Figure adapted from Mercy JA, Rosenberg ML, Powell KE, Broome CV, Roper WL. Public health policy for preventing violence. Health Aff 1993;12:7–29.

Overall Public Health Burden of Injury

In 2005 in the United States, 173,753 persons died from injuries, and approximately 1 in 10 persons experienced a nonfatal injury serious enough to require a visit to a hospital emergency department (ED). Injuries, including unintentional injuries, homicide, and suicide, are the leading cause of death for persons aged 1–44 years (Table 1). Injury is the leading cause of years of potential life lost before age 65.

Among persons aged 1–34 years, unintentional injuries alone claim more lives than any other cause. In 2005, motor vehicle traffic fatalities accounted for 37.1% of unintentional fatal injuries, representing 43,667 deaths (Table 2). Poisoning, suffocation, drowning, falls, and fire each accounted for a substantial proportion of unintentional injury deaths. Adverse effects of medical and surgical care and of therapeutic use of drugs caused an additional 2,653 fatalities.

The impact of injuries resulting from violence is also substantial. Homicide is the second leading cause of death for persons aged 15–24 years and the third and fourth leading cause for every other group aged 1–34 years. Suicide is not only the 11th leading cause of death across all ages, but it ranks second for persons aged 25–34 years and third for those aged 15–24.

Injuries often do not result in death but nevertheless place a considerable burden on the injured person, his or her family, other caregivers, the community, and society. Approximately one third of all ED visits and 8% of all hospital stays are the result of injuries. Data from the National Electronic Injury Surveillance System All Injury Program indicate that in 2006, a total of 7,934,840 unintentional falls occurred, or 26.6% of all injury-related ED visits (Table 3). Another 4,262,553 visits (14.3%) were transportation-related, and 1,670,002 (5.6%) resulted from assaults.[5]

The economic consequences of injury are also substantial. The book *Incidence and Economic Burden of Injuries in the United States* describes the lifetime costs associated with injuries occurring in a single year.[6] In 2000 alone, >50 million injuries required medical attention, with an estimated total cost of $406 billion. This total cost includes $80.2 billion in medical care costs and $326 billion in productivity losses, including lost wages and benefits and the inability to perform normal household functions.[6] The topic-specific chapters that follow present more detailed information, but clearly, injuries constitute a major burden on the public's health.

Table 1. Ten leading causes of death, including unintentional and intentional injury, by age group, all race/ethnicities, both sexes — United States, 2005

	AGE GROUP (yrs)										
Rank	**<1**	**1–4**	**5–9**	**10–14**	**15–24**	**25–34**	**35–44**	**45–54**	**55–64**	**≥65**	**All Ages**
1	Congenital anomalies **5,552**	Unintentional injury **1,664**	Unintentional injury **1,072**	Unintentional injury **1,343**	Unintentional injury **15,753**	Unintentional injury **13,997**	Unintentional injury **16,919**	Malignant neoplasms **50,405**	Malignant neoplasms **99,240**	Heart disease **530,926**	Heart disease **652,091**
2	Short gestation **4,714**	Congenital anomalies **522**	Malignant neoplasms **485**	Malignant neoplasms **515**	Homicide **5,466**	Suicide **4,990**	Malignant neoplasms **14,566**	Heart disease **38,103**	Heart disease **65,208**	Malignant neoplasms **388,322**	Malignant neoplasms **559,312**
3	SIDS **2,230**	Malignant neoplasms **377**	Congenital anomalies **196**	Suicide **270**	Suicide **4,212**	Homicide **4,752**	Heart disease **12,688**	Unintentional injury **18,339**	Chronic lower respiratory disease **12,747**	Cerebro-vascular **123,881**	Cerebro-vascular **143,579**
4	Maternal pregnancy complication **1,776**	Homicide **375**	Homicide **121**	Homicide **220**	Malignant neoplasms **1,717**	Malignant neoplasms **3,601**	Suicide **6,550**	Liver disease **7,517**	Diabetes mellitus **11,301**	Chronic lower respiratory disease **112,716**	Chronic lower respiratory disease **130,933**
5	Placenta cord membranes **1,110**	Heart disease **151**	Heart disease **106**	Congenital anomalies **200**	Heart disease **1,119**	Heart disease **3,249**	HIV **4,363**	Suicide **6,991**	Unintentional injury **10,853**	Alzheimer disease **70,858**	Unintentional injury **117,809**
6	Unintentional injury **1,083**	Influenza and pneumonia **110**	Cerebro-vascular **52**	Heart disease **146**	Congenital anomalies **504**	HIV **1,318**	Homicide **3,109**	Cerebro-vascular **6,381**	Cerebro-vascular **10,028**	Influenza and pneumonia **55,453**	Diabetes mellitus **75,119**
7	Respiratory distress **860**	Septicemia **85**	Influenza and pneumonia **51**	Chronic lower respiratory disease **55**	Diabetes mellitus **202**	Diabetes mellitus **617**	Liver disease **2,688**	Diabetes mellitus **5,691**	Liver disease **7,126**	Diabetes mellitus **55,222**	Alzheimer disease **71,599**
8	Bacterial sepsis **834**	Cerebro-vascular **62**	Chronic lower respiratory disease 49	Influenza and pneumonia **55**	Cerebro-vascular **196**	Cerebro-vascular **546**	Cerebro-vascular **2,260**	HIV **4,516**	Suicide **4,210**	Unintentional injury **36,729**	Influenza and pneumonia **63,001**
9	Neonatal hemorrhage **665**	Perinatal period **58**	Benign neoplasms **40**	Septicemia **45**	Complicated pregnancy **183**	Congenital anomalies **436**	Diabetes mellitus **2,045**	Chronic lower respiratory disease **3,977**	Nephritis **4,141**	Nephritis **36,416**	Nephritis **43,901**
10	Necrotizing enterocolitis **546**	Chronic lower respiratory disease **56**	Septicemia **36**	Cerebro-vascular **43**	Influenza and pneumonia **172**	Influenza and pneumonia **354**	Influenza and pneumonia **934**	Viral hepatitis **2,314**	Septicemia **3,912**	Septicemia **26,243**	Septicemia **34,136**

HIV: human immunodeficiency virus; SIDS: sudden infant death syndrome. Produced by the Office of Statistics and Programming, National Center for Injury Prevention and Control, CDC.
Data Sources: National Center for Injury Prevention and Control. Web-based Injury Statistics Query and Reporting System. Atlanta, GA: US Department of Health and Human Services, CDC; 2008. Available at: http://www.cdc.gov/ncipc/wisqars/. Accessed July 30, 2008; and National Center for Health Statistics, National Vital Statistics System.

Table 2. Unintentional injury deaths, all ages, all race/ethnicities, both sexes — United States, 2005

Cause of death	No.	%
Motor vehicle traffic	43,667	37.07
Poisoning	23,618	20.05
Falls	19,656	16.68
Suffocation	5,900	5.01
Fires and burns	3,299	2.80
Drownings	3,582	3.04
Natural disasters, animals, and environmental exposures	2,462	2.09
Pedestrian	1,157	0.98
Struck by or against a person or object	880	0.75
Machinery	755	0.64
Firearms	789	0.67
Pedal cyclist	227	0.19
Cut or pierced by sharp object	90	0.08
Overexertion	11	0.01
Other transportation*	2,666	2.26
Other and unspecified causes†	9,050	7.68
Total deaths	**117,809**	**100.0**

* The number and percentage of other transportation deaths includes the following subcategories combined: other land transport and other transport.

† The number and percentage of other and unspecified causes of death includes the following subcategories combined: unspecified; other specified, classifiable; and other specified, not elsewhere classifiable. Produced by the Office of Statistics and Programming, National Center for Injury Prevention and Control, CDC.

Data Source: National Center for Health Statistics, Vital Statistics System.

Table 3. Leading causes of nonfatal injuries treated in hospital emergency departments, all ages, all race/ethnicities, both sexes — United States, 2006

Mechanism	No.	%	Rate*
Total	**29,821,159**	**100.0**	**10,003.39**
Unintentional injuries	27,671,499	92.8	9,282.58
Falls	7,934,840	26.6	2,647.23
Struck by or against a person or object	4,663,517	15.6	1,579.87
Overexertion	3,474,597	11.7	1,167.85
Transportation†	4,262,553	14.3	1,426.90
Cut or pierced by a sharp object	2,215,211	7.4	742.33
Bite or sting other than a dog bite	1,095,521	3.7	369.41
Poisoning	703,702	2.4	233.83
Foreign body	621,433	2.1	209.50
Fires and burns	417,540	1.4	140.03
Dog bites	306,273	1.0	103.84
Machinery	278,676	0.9	92.01
Assault	1,670,002	5.6	559.82
Sexual assault	71,296	0.2	24.23
Struck by or against a person or object	1,310,697	4.4	439.49
Cut or pierced by a sharp object	113,970	0.4	38.10
Bite or sting other than a dog bite	50,586	0.2	16.85
Firearms	52,748	0.2	17.40
Self-harm	395,276	1.3	132.63
Poisonings	216,358	0.7	72.65
Cut or pierced by a sharp object	77,058	0.3	25.82
Legal intervention§	84,383	0.3	28.36

* Per 100,000 population

† The number, percentage, and rate of transportation-related injuries includes the following subcategories combined: motor vechicle occupant, motorcyclist, pedal cyclist, pedestrian, and other transportation.

§ Injuries inflicted by law enforcement personnel during the course of official duties.

Produced by the office of Statistics and Programming, National Center for Injury Prevention and Control, CDC.
Data Source: National Electronic Injury Surveillance System (NEISS), U.S. Consumer Product Safety Commission. Available at http://www.cpsc.gov/cpscpub/pubs/3002.html. Accessed July 30, 2008.

The Injury Center Research Agenda's Scope

CDC's Injury Center works to prevent unintentional and violence-related injuries and to minimize the consequences of injuries when they occur. Its public health approach draws on such sciences as epidemiology and other biomedical sciences, biomechanics and other engineering sciences, social and behavioral sciences, and economics in the following broad topic areas:

- acute injury care;
- child maltreatment;
- home- and community-related injuries;
- sexual and intimate partner violence;
- sports-, recreation-, and exercise-related injuries;
- suicidal behavior;
- traumatic brain injury;
- transportation-related injuries; and
- youth violence.

Research regarding occupational injury, an important part of the injury field, is addressed by CDC's National Institute for Occupational Safety and Health (NIOSH). NIOSH and its partners established the National Occupational Research Agenda (NORA) to address work-related injury and death.[7] However, research conducted in occupational settings that has implications for nonoccupational injury prevention and control is also within the scope of the Injury Center research agenda.

Agenda Development Process

To ensure consideration of a broad range of research, the Injury Center invited selected external constituents to participate in developing the original 2002 research agenda.[4] For this revision, Injury Center staff first reviewed research accomplishments to date and progress toward achieving the goals outlined in the original agenda. Findings and recommendations from recent Injury Center research portfolio reviews were also examined. These portfolio reviews were conducted by external panels and focused on four specific topic areas — youth violence (conducted during 2005), falls among older persons (2006), traumatic brain injury (2007), and biomechanics (2007). Also considered were the CDC health protection goals (available at http://www.cdc.gov/about/goals.htm), the *CDC Research Guide*,[8] and *Healthy People 2010* objectives.[9] On the basis of these activities, a relatively modest revision of the original agenda was proposed as the most appropriate approach. This decision was supported by senior Injury Center leaders and the Advisory Committee for Injury Prevention and Control (ACIPC).

Injury Center subject matter experts drafted initial materials and shared them with ACIPC members for their review and comment. Additional external input was solicited from selected federal partners and nonfederal injury prevention researchers, practitioners, and organizations.

Research Phases

To organize the body of potential research regarding injury prevention and control for this revised agenda, the Injury Center used a model for the phases of research that extends from work by Mercy et al. (Figure 1).[10] This approach demonstrates the research continuum, from basic and descriptive research to intervention development and testing, to dissemination and implementation research. The research priorities in the chapters that follow address all of these phases.

The social-ecological model was also used to frame discussion and organization of the research ideas. Multiple chapters in this agenda use this model to facilitate understanding of the multifaceted nature of injury and violence. First introduced in the late 1970s for the study of child abuse[11,12] and subsequently used in other fields of research,[13–18] including unintentional injuries,[19–22] the social-ecological model is still being developed and refined as a conceptual tool. Its strength is that it helps to distinguish between the myriad influences on injury and violence while providing a framework for understanding how they interact (Figure 2).

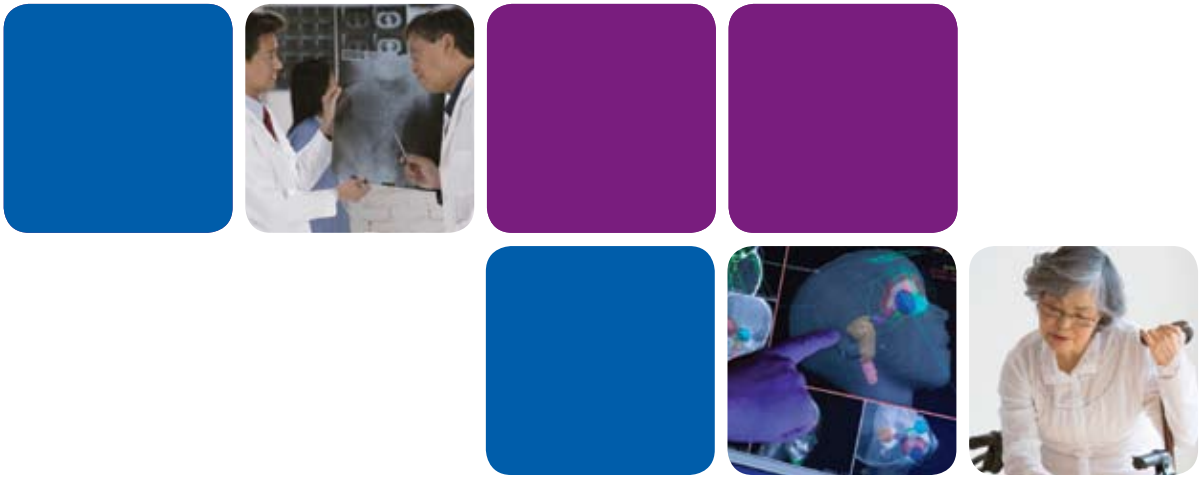
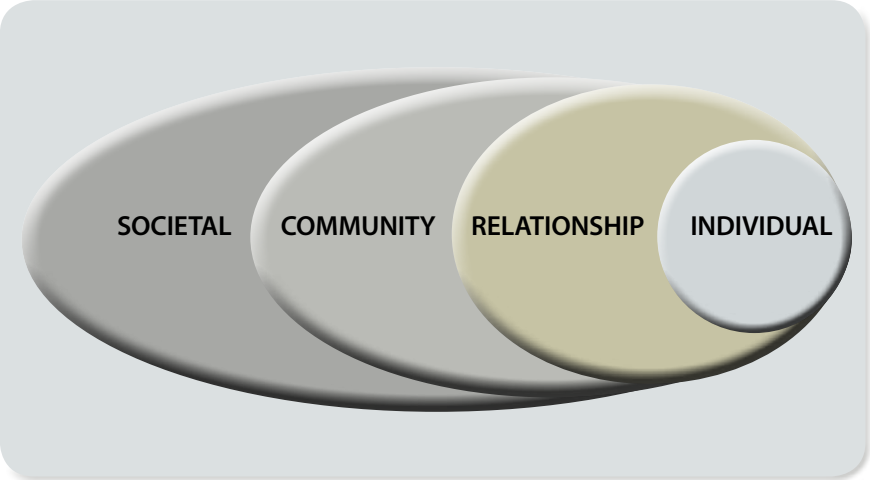


Figure 2. Social-ecological model



The model assists in examining factors that increase or decrease the risk for violence or injury or recovery from trauma by dividing them into the following four levels:

- **Individual.** The first level identifies biologic and personal history factors that influence how persons behave and their likelihood of becoming a victim of injury, or in the case of violence, becoming either a victim or a perpetrator of violence. Examples of factors that can be measured include demographic characteristics (e.g., age, education, and income), attitudes and beliefs, alcohol impairment or other substance abuse, and a history of behaving aggressively or experiencing abuse.
- **Relationship.** The second level examines such close relationships as those with family, friends, intimate partners, and peers, and explores how these relationships increase the risk for injury or for being a victim or perpetrator of violence. For example, being exposed to friends who engage in violence can increase a young person's risk for being a victim or perpetrator of violence. Similarly, inadequate supervision (e.g., by parent, caregiver, or other significant adult) can increase the risk for injuries and violence during both childhood and adolescence (e.g., children riding in a car with someone who has been drinking).
- **Community.** The third level explores the community context in which social relationships occur (e.g., schools, workplaces, other institutions, or neighborhoods) and seeks to identify the characteristics of settings that increase the risk for violence or injury. Risk at this level might be influenced by such factors as population density, crowded housing, levels of employment, the existence of a local drug trade, or inadequate designs of environmental spaces for work, travel, or leisure.
- **Societal.** The fourth level examines the broad societal factors that help create a climate in which injury and violence is encouraged or inhibited. These include absent, weak, or insufficiently enforced laws and regulations; social and cultural norms; and the health, economic, education, and social policies that help to maintain economic or social inequality between groups in society.

The overlapping rings in the model illustrate how factors at each level are strengthened or modified by factors at another. Besides helping to clarify the causes of injury and violence and their complex interactions, the social-ecological model also illustrates that to prevent injury and violence, acting across multiple levels simultaneously is mandatory. This multilevel action includes

- addressing individual risk factors and taking steps to modify them;
- influencing close personal relationships and working to create healthy and safe family environments as well as providing professional help and support for disadvantaged families;
- monitoring such community factors and places as schools, workplaces, other institutions, and neighborhoods, and taking steps to mitigate problems that can lead to injuries or violence; and
- addressing the larger legal, cultural, social, and economic factors that contribute to violence and injury and taking steps to change them, including measures to close the gap between rich and poor and to ensure equitable access to goods, services, and opportunities.

Developing and Categorizing the Research Priorities

This agenda defines a research priority as a critical injury problem that can be meaningfully addressed with a modest number of research studies (approximately 10 to 20) and that can include related research questions. Box 1 provides an example of a research priority related to preventing injuries in the home and community.

Box 1. Example of topic, priority, and research questions

Topic

Preventing injuries at home and in the community.

Priority

Evaluate strategies for widespread dissemination and implementation of effective interventions to reduce injuries at home and in the community.

Research Questions

1. What are the barriers to disseminating effective home injury prevention programs among indigent urban populations?
2. How can effective community smoke alarm installation programs be extended inexpensively to broader populations?

Three specific criteria guided the selection of Injury Center research priorities — institutional mission, public health burden, and research opportunity (Box 2). Ultimately, the research priorities must match the Injury Center's mission of reducing the incidence, severity, and adverse outcomes of injury through application of public health methods. Thus, research that applies directly to public health practice receives primary emphasis. Consideration of the public health burden ensures inclusion of research related to the major types and causes of injuries. An emphasis on research opportunity encourages further focus on risk and protective factors and interventions associated with a substantial, preventable fraction as well as on interventions that might be ready for widespread dissemination.

Box 2. Criteria for Injury Center research priorities

Mission (Supersedes all other criteria)

- Congruent with CDC's priorities and mission (e.g., an emphasis on applying research findings and wide-ranging methods).
- Congruent with Injury Center's mission and objectives.
- Congruent with programmatic scope to advance specialization and avoid duplication of effort in practice settings.
- Opportunity for leadership and coordination in practice settings.
- Interest and demand from practitioners, policymakers, and the public.

Public Health Burden

- Absolute number of persons affected by mortality and hospitalization, economic and social costs, disability and quality of life, and effect duration.
- Equity or social justice (i.e., addresses the needs of vulnerable populations).

Research Opportunity

- Portion of the injury problem that will likely be reduced (i.e., preventable fraction).
- Likelihood that the research will lead to widespread adoption of an effective intervention within a limited period.
- Opportunity for innovation and broad application (i.e., cross-cutting knowledge).
- Availability of rigorous methods for effective and ethical research.
- Accessible populations (e.g., managed care).
- Responsiveness to emerging concerns.

The research priorities in this agenda were identified as the most critical priorities (i.e., those that warrant the greatest attention and intramural and extramural resources from the Injury Center during the next 10 years). Given the finite resources for conducting research, the research priorities listed in each chapter have been categorized into two tiers. The first tier contains those priorities that reflect the most immediate research needs and those that should be supported first as resources become available. Categorizing the priorities into two tiers does not imply, however, that the first tier of priorities is more important than the second tier or that research related to the second tier of priorities should wait until 2014 to begin. Rather, the tiers reflect the logical progression of research along the continuum from basic research to implementation of those interventions and prevention strategies that have been demonstrated to be effective. Moreover, for all priorities, special attention should be paid to vulnerable populations who experience disparate, elevated risks (e.g., racial/ethnic minorities, persons with disabilities, the youngest and oldest groups, recent immigrants and refugees, and rural residents).

Injury Center staff also identified research priorities that span topics, as well as emerging areas for consideration. These cross-cutting and emerging research priorities are described in the Cross-Cutting Priorities chapter.

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Cross-Cutting and Emerging Priorities for Injury Research

Background

This research agenda presents priorities in topic-specific chapters. However, certain injury-related concerns are relevant to multiple topics. The breadth of the Injury Center's research and its place within the broader public health field offer tremendous opportunities for investigating these cross-cutting challenges. Including these priorities enhances the applicability of the research results and increases the opportunities for independent and joint funding from multiple sponsors.

Cross-Cutting Priorities

A. **Prevent injury and violence globally.** Injuries and violence are a threat to all persons worldwide. Approximately 5 million persons throughout the world die each year from injuries and violence, with the rates of death highest among low- to middle-income countries.[1] Such countries often do not have the infrastructure or capacity to effectively address injury prevention. Global injury and violence prevention priorities include identifying the causes, consequences, and costs of unintentional injuries and violence, as well as assessing the efficacy, effectiveness, and economic efficiency of interventions to prevent injuries and mitigate consequences.[2] Other critical research concerns include determining the association among diverse aspects of globalization (e.g., economic, environmental, and cultural factors) and violence and injury; identifying risk and protective factors common to different population groups, cultures, and settings; developing primary and secondary prevention approaches that affect all populations in different settings; focusing on developing countries; and evaluating diverse international public health programs created to prevent injuries, improve injury care, and reduce adverse health outcomes.[2]

B. **Evaluate the effectiveness of interventions to reduce excessive alcohol use and alcohol dependency.** Excessive alcohol use and alcohol dependency increase the risk for both violence-related and unintentional injuries. Thousands of deaths occur each year as a result of alcohol-related injuries, and alcohol is involved in a substantial proportion of hospital admissions and emergency department visits. The problem of alcohol-related injuries is particularly high in certain geographic areas and among specific groups (e.g., American Indians/Alaska Natives) where alcohol consumption and injury rates are higher than among the general population. However, the role of alcohol in injuries is not understood well enough to facilitate development and implementation of adequate injury prevention policies and programs. Uniform collection of blood alcohol levels among trauma patients, for example, is still lacking in certain states and jurisdictions. Primary prevention strategies to reduce exposure to and use of excessive alcohol are particularly important because persons who begin drinking alcohol as preadolescents and adolescents are at greater risk for alcohol abuse and dependence during adulthood. Binge drinking is a commonly unrecognized

public health problem, particularly among youth, and can lead to serious injuries.[3] Although effective strategies have been identified to reduce alcohol harms,[4] more research is needed to better understand which factors and policies have the strongest influence on reducing alcohol-related injuries.

Secondary prevention strategies for identifying persons at high risk for alcohol use and abuse include medical screening in patient care settings. Screening and brief counseling interventions have demonstrated promising results in emergency departments and with trauma patients.[5] However, before these clinical preventive services can be broadly disseminated, further research is needed to demonstrate effectiveness in multiple settings, refine procedures and systems for implementation, and develop strategies to increase adoption and efficiencies of scale. Legislative- and community-based behavioral interventions and ecological approaches that address risky alcohol use in the community and that effectively reduce alcohol-impaired driving can also help reduce alcohol-related violence, falls, drowning, and other injuries. The entire field of public health can benefit from a stronger evidence base on alcohol-related harms and the barriers and solutions to wider adoption of effective and promising alcohol interventions that reduce injuries.[6]

Approximately 37 million U.S. residents were aged ≥60 years in 2006.

C. **Understand and reduce health disparities.** Eliminating health disparities has been identified as a national goal.[7] Examples of populations disproportionately affected by injury and violence include, but are not limited to, populations with low incomes, racial/ethnic minorities, and persons with mental and physical disabilities. For any given injury topic, disparities exist across all age groups, sexes, regions, income levels, and race/ethnicities. Efforts to better understand and reduce these injury-related disparities will enhance and facilitate prevention efforts overall. Priorities include identifying and evaluating efficient and effective programs to prevent different types of injury and violence among those disproportionately affected, as well as accelerating widespread use of effective programs for populations at highest risk.

Emerging Priorities

D. **Apply the public health approach to preventing maltreatment of older persons.** Maltreatment of older persons (also referred to as *elder mistreatment*) is any destructive behavior that is directed toward an older adult, occurs within the context of a relationship connoting trust, and is of sufficient intensity or frequency to produce harmful physical, psychological, social, or financial effects of unnecessary suffering, injury, pain, loss, or violation of human rights and poorer quality of life for an older adult.[8] Elder maltreatment is an emerging area of public health concern that might become a more substantial problem as the general population ages. Although approximately 37 million U.S. residents were aged ≥60 years in 2006,[9] by 2030, this population is expected to increase to 70 million persons. These population changes are anticipated to be accompanied by increases in incidents of elder maltreatment.

Efforts to address elder maltreatment have been hampered by a lack of data regarding the magnitude of the problem, factors affecting the likelihood of its occurrence, and effectiveness of existing interventions to prevent or mitigate its consequences. Although capturing the incidence and prevalence of elder maltreatment is difficult, these data are needed to measure, monitor, and document

trends associated with this problem. Further development of knowledge regarding risk, promotive and protective factors, and processes is also necessary to create interventions that can reduce, counteract, or moderate risks for elder maltreatment. Finally, rigorous evaluations of existing programs and strategies are required for determining their relevance, effectiveness, and impact; developing evidence-based guidance regarding ways to address elder maltreatment; and defining the most appropriate approaches for implementation.

E. Prevent consumer product-related injuries. Deaths, injuries, and property damage from consumer product-related incidents cost the nation >$700 billion annually.[10] Promotion of safe use of products that might pose fire, electrical, chemical, or mechanical hazards is critical to public health and safety. Focus has often been on products used by or disproportionately injuring children. CDC researchers work closely with the U.S. Consumer Product Safety Commission (CPSC) in identifying hazardous toys and other products and in increasing awareness of the public health dangers they pose.

In 2005, an estimated 202,300 toy-related injuries were treated in U.S. hospital emergency departments.[10] Forty-six percent of the total injuries (94,000) occurred to the head and face area.

Public health efforts contribute to examining and describing the epidemiology of product-related injury events through surveillance and research. Although CPSC can influence product design modification through standards and regulation, evidence indicates that product-related injuries often are preventable through correct product use and adult supervision. CDC's research priorities related to supervision are discussed in the Home and Community section of this agenda and have direct applicability to preventing product-related injuries.

F. Prevent poisoning-related injuries and deaths. Poisoning is no longer simply a childhood injury problem. Adults are increasingly exposed to poisoning-related incidents, including those related to prescription drugs.[11] During 1999–2005, the annual number of unintentional drug poisoning deaths in the United States increased from 11,155 to 22,448. Drug overdose became the second leading cause of unintentional injury death in the United States in 2002, with only motor vehicle injuries causing more deaths. The 35–44 age group experienced the most substantial increase.[12]

Enhancement of active surveillance for poisoning-related injuries and deaths through improved use of medical examiner data, police reports, and toxicology databases is needed. Additionally, strategies to reduce deaths from unintentional poisonings can be strengthened through examining risk factors for drug overdoses and analyzing the results of all injury deaths. New interventions for preventing poisoning-related injuries appear promising but require further evaluation. Additional changes in prescribing and dispensing practices also are critical to reducing unintentional poisoning deaths.

In conclusion, the ongoing investment in the injury research infrastructure is of equal importance with Priorities A–F in reducing the burden of injury. Since 1985, an entire field of injury control research has evolved. For injury research to move to the level of dissemination and implementation, an integrated network of researchers, mentors, and students is needed. Individual research grants alone are insufficient to continue this progress. Students should be introduced to injury research both in the classroom and through hands-on experience. Fully developing or improving existing links between classroom and community learning can cultivate opportunities for new and experienced researchers as well as community practitioners. Moreover, such links can facilitate exchange of ideas and development of a greater appreciation of the depth and breadth of the field of injury research. Carefully selected activities can serve these goals, including training programs, programs linking researchers with practitioners, professional conferences and consensus groups, effective use of information technology (including data clearinghouses and enhanced Internet technology), injury research centers, capacity building, and interdisciplinary collaborations. The injury research field can also benefit from integration with the public health research community, addressing topics other than injury (e.g., training, participating in longitudinal studies or other large-scale research projects, and developing research methods that extend beyond injury).

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Injury Response

Acute Injury Care

Public Health Burden

Injury remains a major global public health problem. Approximately 5 million deaths occur worldwide annually that are attributed to injury,[1] representing approximately one-tenth of all deaths globally.[2,3] In addition to those who die from their injuries, millions more suffer temporary or permanent impairment,[2] exacting a substantial toll on families, communities, and societies.[4] When measured in disability-adjusted life years (DALYs), the burden of injury is greater than that of cardiovascular disease, cancer, or vaccine-preventable childhood diseases.[5]

In the United States, injury is the leading cause of death for persons aged 1–44 years.[6] In 2005, injuries accounted for 173,753 deaths in the United States, with an additional 29 million injuries serious enough to involve a visit to a hospital emergency department (ED) in 2006.[6] In addition to the impact injuries have on the lives of affected persons and their families, injuries have a substantial economic impact, with lifetime medical costs for acutely injured persons in the United States estimated at $80 billion per year.[7]

Injuries, similar to other disease processes, involve interactions among host, agent, and environment, with physical (i.e., tissues, organs, and systems) and psychological impact. Injuries are often both predictable and preventable. Moreover, they have short- and long-term effects, not only on the lives of those injured but also on their families, healthcare workers, and society. Because of the diverse health effects associated with injuries, positive outcomes are often dependent on the availability of a continuum of multidisciplinary care.

The Injury Center's Approach to Acute Injury Care

CDC's Injury Center is the U.S. Federal Government organization having primary responsibility for addressing all phases of the injury research framework — from foundational research through dissemination research, as described in the 2002 *CDC Injury Research Agenda* — for all major causes of injury among all age groups.[8] As part of this responsibility, the Injury Center focuses on the entire continuum of acute injury care (e.g., emergency medical services, emergency medicine, and trauma surgery) as it relates to public health. CDC's Injury Center staff have extensive experience working with organizations responsible for the care of the acutely injured at local, state, and national levels. This experience best positions the Injury Center to set research priorities, provide technical assistance for research programs, and facilitate translation of new findings into practical methods for evaluating outcomes of the acutely injured. The Injury Center's partnerships with state health agencies, academic injury research programs, nongovernmental organizations, and healthcare practitioners provide a vital foundation for establishing and fostering a broad-based, multidisciplinary approach to acute injury care. These partners provide unique avenues and opportunities to facilitate, coordinate, and disseminate innovations in care for acutely injured persons. These relationships are also critical for system planning and preparedness activities for managing mass casualty incidents associated with acts of terrorism or natural disasters worldwide.

The Injury Center's research activities and programs in the area of acute injury care are designed to provide information on which to base efforts to reduce the impact of acute injuries and to prevent injury-associated adverse outcomes or secondary conditions. This focus differs from and complements the activities of other federal agencies involved in acute injury care. For example, federal responsibility for supporting trauma care systems to administer quality, cost-effective care at the local level resides with the Health Resources and Services Administration (HRSA), whereas CDC's Injury Center supports evaluation of the effectiveness of trauma systems and the outcomes among acutely injured persons. The Injury Center's focus on applied acute injury care research in the civilian sector complements the National Institutes of Health's focus on basic scientific research and the U.S. Department of Defense's focus on prehospital acute injury care to improve outcomes on the battlefield.

One of the Injury Center's key collaborative efforts is with the National Highway Traffic Safety Administration (NHTSA) in the area of training and research related to prehospital care. NHTSA has developed national standard curricula for training prehospital emergency care personnel and is completing work on a national emergency medical system research agenda, which addresses acute injury care in the prehospital setting.

The Injury Center staff reviewed its 2002 *CDC Injury Research Agenda*[8] chapter on acute care, disability, and rehabilitation and determined that, of the 13 priority areas for research in that chapter, only three specifically address acute injury care and none were related to acute injury care in the context of terrorism preparedness and response. In close collaboration with its partners, the Injury Center has identified critical gaps in the care of acutely injured persons and the systems that manage that care. Recognizing these gaps, the Injury Center, together with support from federal partners and national organizations representing the full spectrum of acute injury care, has worked to supplement the previous agenda with a revision of the acute injury care chapter.

This revision represents the culmination of a process that was guided by a steering committee that included 13 leaders in emergency medical services (EMS), emergency medicine, trauma surgery, epidemiology, and public health, as well as other federal agency partners. Additionally, members of the Advisory Committee on Injury Prevention and Control (ACIPC) commented on the content of the draft research agenda chapter and provided recommendations regarding its implementation. Input was also solicited from representatives of key partner organizations and agencies representing researchers, practitioners, policymakers, and the public.

Building Research Capacity. CDC's Injury Center, together with the Steering Committee and ACIPC, recognizes that the successful implementation of the acute injury care research priorities relies heavily on the simultaneous development of a research infrastructure that can support investigations in the proposed research priorities. To this end, the Injury Center recommends infrastructure development in the following four primary areas:

1. Research efforts in injury prevention and control across the spectrum of acute injury care, including development of an acute injury care research network, or use of existing networks that encourage and facilitate coordination of research activities.

2. Examination of existing data sources to determine how they might best be used to assess, evaluate, and improve systems of acute injury care, including efforts to strengthen the information infrastructure and maximize use of data sources.

3. Expansion or restructuring of existing injury care and prevention training and education programs targeting healthcare professionals. This education and training remains crucial to successful injury prevention and control efforts, is necessary for infrastructure development, and is necessary for creating a cadre of acute injury care research professionals to ensure long-term success.

4. Assessment, evaluation, and dissolution of barriers and obstacles to conducting acute injury care research, including those presented by institutional, jurisdictional, clinical, legislative, and administrative challenges.

The Injury Center's Research Priorities in Acute Injury Care

Given the finite resources available for conducting research, the following priorities are listed in two tiers. The first tier contains those priorities that reflect the most immediate research needs and those that should be supported first as resources become available. Categorizing the priorities into two tiers does not imply, however, that the first tier of priorities is more important than the second tier or that research related to the second tier of priorities should wait until 2014 to begin.

Tier 1

A. **Evaluate strategies to implement and adopt science-based recommendations and guidelines for the care of acutely injured persons and effectively translate and disseminate this information.** New treatments involving acute injury care are often not adopted uniformly. Developing and implementing acute injury treatment strategies that result in evidence-based management protocols for persons who sustain life-threatening or disabling injuries can substantially improve the care of injured persons. As the initial step in identifying and ensuring best practices, knowledge gained from clinical studies has the potential to decrease mortality and to improve the outcome of serious injuries. These studies might focus on treating or reducing the effects of specific injuries (e.g., on outcomes from such organ-specific injuries as traumatic brain injury and long-bone fractures in the patient with multiple injuries) or on specific mechanisms and circumstances associated with injury. Other examples include optimal airway support in prehospital settings, outcomes from blast injuries after explosions, optimal fluid management across the spectrum of acute injury care, and optimal management of severely injured older patients. In the conduct of these types of research activities, multicenter investigations might be required to provide sufficient statistical power to support evidence-based recommendations.

   Another related concern deals with dissemination of these recommendations throughout the acute care community. Critical research is often conducted and the results published, yet the resulting guidelines or recommendations are not always widely used because the mechanisms to ensure their translation, dissemination, implementation, and adoption are nonexistent. To achieve these goals, acute injury care researchers should first examine successful models and methods used in other arenas for dissemination, implementation, and evaluation of evidence, protocols, and guidelines to identify key principles that are applicable in acute injury care. On the basis of these analyses, strategies should be developed for effective dissemination, including not only use of existing and future technology and specialty journals, but also identification of new and novel approaches to dissemination. The Injury Center has worked in collaboration with multiple internal and external partners to develop toolkits and training materials for healthcare providers, public health professionals, and others who play a role in the acute care of injured persons and their recovery. Examples include a curriculum for terrorism-related blast injuries, educational toolkits for preventing sports-related traumatic brain injury, and the cross-cutting fall prevention materials for older adults. Determining the efficacy, effectiveness, and impact of each strategy is critical. Research is needed to identify and overcome the barriers, both administrative and legal, to effective translation

and subsequent use. Finally, methods to validate protocols, guidelines, and other materials — before and after dissemination — should be developed.

B. Determine and evaluate the components of trauma systems that contribute to improved outcomes for acutely injured persons. Investigators have demonstrated that trauma systems save lives, but which components of a trauma system improve health outcomes other than mortality remain unknown.[9,10] Therefore, research is needed to identify and evaluate the specific components of trauma systems across the continuum of care — from prehospital through hospital and rehabilitation — that contribute to improvements in outcomes for injured persons and to determine how specific components can be tailored to improve system performance. Evaluating clinical care provided in different aspects of the system, including prehospital care, hospitals (i.e., EDs, trauma centers, operating theaters, intensive care units, and burn units), and rehabilitation facilities, is crucial. Research is needed to

- evaluate data collection and use throughout each aspect of the system;
- evaluate the field triage decision-making process and impact on outcomes;
- determine the potential for using the existing trauma care infrastructure during any disaster event, including chemical, biologic, nuclear, and conventional incidents;
- compare care within urban versus rural environments;
- evaluate application of recent advances in military medical care to injury care in the civilian sector;
- determine the health outcome effects of dispatch, response, scene time, and other prehospital system components and evaluate the impact of prehospital care; and
- define the benefits and costs of trauma care systems and their components on overall trauma care and outcomes, including morbidity, quality of life, functional outcomes, and cost.

Particular emphasis should be placed on the application and role of emerging technologies in improving care and providing information for systemic approaches to acute injury care. Such activities as vehicle and personal telematics, geographic information systems for trauma system mapping and assessment (e.g., the American Trauma Society's Trauma Information Exchange Program), prehospital data systems (e.g., NHTSA's National EMS Information System), and enhancement of existing electronic registries (e.g., the American College of Surgeons' National Trauma Data Bank) offer prime opportunities for systemic improvements in acute care delivery.

C. Determine and evaluate the impact of mass casualty events and disasters on acute injury care. Mass casualty situations and disasters related to conventional weapon terrorism (e.g., explosions), declared or undeclared military conflicts, natural phenomena (e.g., cyclonic storms, floods, tornadoes, earthquakes, tsunamis, or volcanic eruptions), or other events (e.g., structural collapses or airplane or railway crashes) remain a real and ongoing concern for acute injury care providers both in the United States and abroad. The injuries, deaths, disability, and psychosocial effects resulting from such events can create both real and perceived challenges in accessing medical care and other vital services. The impact

Research is needed to identify and evaluate trauma systems across the continuum of care.

of these events on an already overburdened system of trauma care — with regard to operations, surge capacity, staffing, and logistical concerns — remains unknown. Further examination and evaluation of these systemic effects of mass casualties is warranted, including learning from other nations that have experienced terrorist acts or natural disasters.

Optimal data systems for use during mass casualty and disaster events remain a challenge. Identifying and evaluating strategies for data collection and use, maximizing use of existing data systems, and achieving the real-time use of data during an event, all remain important research needs. Effective communication is difficult during a mass casualty or disaster event; therefore, strategies to maximize communication through improving systems' interoperability and eliminating redundancy should be developed and evaluated. Often, trauma care systems are not well-integrated with disaster planning efforts, which focus primarily on law enforcement, fire prevention, power supply, and other infrastructure challenges than on the care of the acutely injured. Strategies to integrate trauma systems with disaster planning need to be developed and evaluated. Models of field triage, which might relegate certain persons to receive no further care at the scene, should be reexamined and evaluated in the context of community resource availability, specialty services, and legal constraints. Despite the multiple educational programs available, the exact type and extent of education and training ideal for different types of care providers (prehospital and hospital) is unknown. Research should identify and evaluate the core competencies for those responding to or involved in mass casualty or disaster events to ensure an appropriate level of knowledge and expertise. Serious secondary injuries often occur after disasters; improvements in acute injury care management in these difficult environments and situations should be developed and evaluated.

D. Develop and evaluate protocols that provide on-site interventions in acute care settings or links to off-site services for patients at risk for injury or psychosocial problems after injury. Clinical preventive services for patients treated in EDs, hospital trauma units, and other acute care settings can help reduce the risk for injury and mitigate the effects of injuries that do occur. Examples of such services include screening and interventions for alcohol-associated problems, instruction for healthcare providers in use of safety restraints, and recognition of intimate partner violence or child maltreatment. For injured patients, ED visits and inpatient hospital admissions for trauma care can provide crucial opportunities for early identification of and intervention for posttraumatic stress disorder (PTSD) and other psychosocial problems that can follow or be exacerbated by injury. Assessing the baseline mental health status of trauma patients and determining intervention needs (e.g., for alcohol abuse, PTSD, or illicit drug use) is needed. Decision makers are often reluctant to fund clinical preventive services because they believe the investment needed to implement a single service in a clinical setting is too high. Research should demonstrate the effectiveness and value of such services and examine ways to implement services in the most efficient manner.

E. Develop and evaluate interventions for the personal, sociocultural, and community consequences of acute injury. The financial, psychosocial, and long-term physical effects of an acute injury can be more debilitating than the actual physical injury itself. The severity and duration of these effects is an essential determinant of long-term impairment and disability. An acute injury not only has an immediate effect on the injured person but can also result in long-term

consequences on the lives of others in the person's family and community. Healthcare providers themselves might also be subject to psychosocial consequences resulting from caring for the acutely injured persons and their families on a daily basis. In the event of a mass casualty or disaster event, these causal sequences can affect a community's societal and functional infrastructure extensively. Identifying and evaluating strategies to mitigate consequences to persons, families, and society after injury and assessing the cost-effectiveness and cost benefit of these strategies is crucial. For example, the impact of appropriate and timely referral to mental health and rehabilitation professionals should be thoroughly evaluated and incorporated into the clinical care of injured patients.

F. **Identify and evaluate new or existing health measures to better assess short- and long-term outcomes for persons treated in prehospital and hospital acute injury care settings.** Determining improvements in outcomes for acutely injured persons can be difficult if trauma centers, emergency care facilities, and hospitals focus on reducing mortality alone without focusing on morbidity and other longer term health outcomes. Therefore, a need exists for developing additional health measures in the acute care setting (e.g., healthcare costs and lost work or school days) and quality indicators related to pain management, palliative care, and stress experienced by injured persons and their families. Also, different treatments received in the prehospital and hospital acute care setting can lead to different long-term outcomes for the acutely injured. Thus, evaluation and validation are needed for both new and existing methods of reporting acute injury care and trauma system outcomes that extend beyond mortality to include long-term functional outcome, familial and social outcomes, and economic impact and outcome. New methods of measuring morbidity, quality of life, functional status, and cost will help define the benefits and costs of trauma care systems.

Tier 2

G. **Develop estimates of the associated risk factors, incidence, and prevalence of spinal cord injury and associated costs and long-term consequences, including secondary conditions.** Identifying and characterizing spinal cord injuries (SCIs) is an essential first step in conducting surveillance and outcome studies. Increased collaboration among federal agencies is crucial to such research. The Injury Center conducts population-based surveillance to develop nationally representative estimates of the incidence, prevalence, nature, and causes of injuries that result in long-term disability. This activity can lead the conduct of population-based follow-up studies to identify and track the long-term outcomes of disabling injuries. Research should investigate the unique outcomes and special needs of patients with SCI and associated secondary conditions. The spectrum of rehabilitation services and trends in service provision should be described, and access to medical, rehabilitation, and social services to prevent disabling outcomes and secondary conditions should be assessed. Better information regarding outcomes can improve estimates of the true burden of disability for persons with SCI by helping to document long-term problems resulting from these injuries.

Direct medical costs and indirect costs associated with SCIs are not well-documented; however, this information is also important for guiding decisions regarding resource allocation and other policies. Research should provide comprehensive, up-to-date information about the direct and indirect SCI-related costs. In addition, research should estimate the costs associated with secondary conditions (e.g., pressure sores, alcohol-associated problems, and depression). An improved understanding of care gaps and between needed and available services for persons with SCI and the economic impact of such injuries will be helpful in enhancing strategies to close those gaps.

H. Determine the incidence, causes, nature, and outcomes of extremity injuries. The limited number of studies regarding limb injuries has provided evidence that these injuries result in substantial impairment and disability. In fact, only 50% of persons who were working before being injured return to work within 6 months.[11] The extent of physical impairment is one key factor that influences disability, but data are limited regarding other factors. Research using population-based studies is needed to describe accurately the public health burden of limb injuries and to recommend effective interventions to prevent these injuries and resulting disability. In addition to epidemiologic studies, research regarding the biomechanics of extremity injuries (e.g., fractures and dislocations) is necessary to devise effective prevention strategies. In addition, recent military experience related to acute care and rehabilitation of extremity injuries should be evaluated for use in the civilian sector and incorporated into practice, as appropriate.

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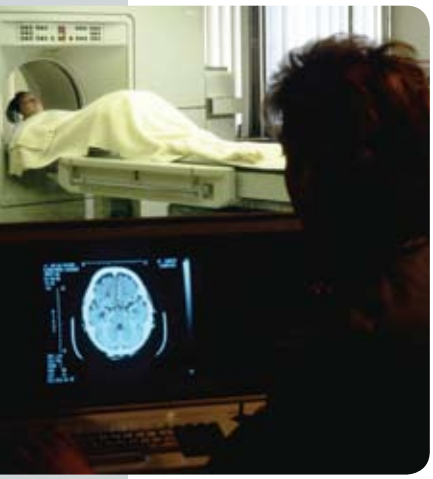

Traumatic Brain Injury

Public Health Burden

Traumatic brain injury (TBI) is defined as a blow or jolt to the head or a penetrating injury that disrupts the function of the brain. TBI is an important public health problem globally with ≥10 million TBIs serious enough to result in death or hospitalization occurring each year.[1] In the United States, an estimated 1.6 million TBIs occurred among persons treated in civilian medical facilities in 2003, including 1.2 million emergency department (ED) visits, 290,000 hospitalizations, and 51,000 deaths.[2] However, U.S. national data[2] underestimate the true occurrence of TBIs for at least three key reasons. First, the data do not include persons treated for TBI in other settings (e.g., hospital outpatient settings or doctors' offices). Second, the number of persons who receive medical care during which the TBI is undiagnosed or who experience a TBI but do not receive care, is unknown. Finally, TBIs treated in military facilities both in the United States and abroad are not included.

TBI is an increasing concern among certain groups. On the basis of studies of convenience samples, research indicates that 25%–87% of persons incarcerated in prisons and jails report a history of head injury, including TBI.[3,4] Military personnel in both combat and noncombat situations are at high risk for sustaining TBIs.[5,6] In 2003, Ivins et al. reported that 23% of noncombat active-duty soldiers at Fort Bragg had sustained a TBI during their military service.[7] Military personnel serving in Iraq and Afghanistan[5,8] are at particularly high risk for concussions and more severe TBIs, especially as a result of blasts.[9,10] Recent reports indicate that as many as one in five service members returning from Iraq and Afghanistan have screened positive for possible mild TBI.[11,12] Rescue workers and victims of terrorism-related attacks[13–15] are also at risk for sustaining TBIs. Sports and recreation-related TBIs, including concussions, are of increasing concern. According to a CDC estimate,1.6–3.8 million sports-related TBIs occur each year, including those for which no medical care is sought.[16] This estimate might also be low because concussions are often unrecognized and thus cannot be counted.

TBI can result in long-term or lifelong physical, cognitive, behavioral, and emotional consequences.[17] Even mild TBI, including concussion, can cause long-term cognitive problems that affect a person's functional abilities and limit his or her potential to return to work or school.[18–21] As a result of these consequences, TBI is one of the most disabling injuries. Although similar to that for other types of injuries, the percentage of injury-related productivity loss attributed to TBI (15.7%) is 14 times that associated with spinal cord injury,[22] another important disabling condition. Annually, an estimated 125,000 U.S. civilians are hospitalized with TBIs that are expected to result in long-term or lifelong disability.[23] Because the prevalence of disability associated with TBIs treated in other healthcare settings and those that are not treated is unknown, the true incidence of TBI-related disability might be much higher. The lifetime costs of TBI in the United States, including medical costs and lost productivity, total approximately $60 billion annually.[22] Of note, this estimate does not address the indirect effects on families or other caregivers, friends, and communities. Additional research is needed to guide medical, public health, and other TBI prevention professionals and to ensure a healthier future for persons who have sustained TBIs.

The Injury Center's Approach to Traumatic Brain Injury Response

The Injury Center's research activities and programs are focused primarily on reducing the impact or preventing development of secondary conditions and other adverse outcomes of TBI through translation of science into practice. Among CDC's unique roles is the collection, analysis, and reporting of population-based data regarding the incidence of TBI and prevalence of TBI-related disability. Findings from CDC's national TBI surveillance and CDC-funded state-based surveillance provide crucial information for guiding prevention efforts as well as policy decisions and research planning at both the state and national levels. CDC also plays an important role in supporting research aimed at improving systems for the acute care of injuries, including TBI.[22] During recent years, CDC has increased its efforts to ensure that its TBI research and programs have a positive impact not only on policy and planning, but on the lives of persons with TBIs, their families, and caregivers.

CDC's injury research activities support the work of other federal, state, and local agencies in regard to TBIs. At the federal level, these include the Defense Center of Excellence for Psychological Health and Traumatic Brain Injury, the Health Resources and Services Administration, the National Center for Medical Rehabilitation Research, and the National Institute on Neurological Disorders and Stroke of the National Institutes of Health, the National Institute for Disability and Rehabilitation Research, and the Social Security Administration. At the national level, CDC also collaborates with other TBI organizations, including the Brain Trauma Foundation, the National Brain Injury Research, Treatment and Training Foundation, the National Association of State Head Injury Administrators and the Brain Injury Association of America. At all levels, CDC collaborates with diverse acute injury care partners.[24] All of CDC's TBI research activities are aimed at including interaction among related organizations and agencies to avoid duplication and to leverage resources and enhance the usefulness of the research findings.

The Injury Center's Research Priorities in Traumatic Brain Injury Response

Given the finite resources available for conducting research, the following priorities are listed in two tiers. The first tier contains those priorities that reflect the most immediate research needs and those that should be supported first as resources become available. Categorizing the priorities into two tiers does not imply, however, that the first tier of priorities is more important than the second tier or that research related to the second tier of priorities should wait until 2014 to begin.

Tier 1

A. **Improve identification, assessment, and management of TBI.** Accurate identification, assessment, and management of concussions or mild TBIs are critical for ensuring correct diagnoses and for reducing the risks for reinjury and long-term consequences. Although advances in identification and management have been made, substantial limitations remain.[25] Thus, research is needed to develop and validate improved clinical diagnostic measures (e.g., biomarkers), symptom-based methods (e.g., the Acute Concussion Evaluation[26]), and neurocognitive performance-based assessment methods (e.g., ImPACT[27]). These include studies to determine the ecological validity of existing neurocognitive measures to determine whether inadequate performance is associated with difficulties in performing real-world tasks. In addition to symptom-based and neurocognitive assessments, development of rapid, accurate, and practical measures of motor dysfunction after mild TBI (e.g., gait, balance, and simple reaction time) can lead to improved diagnoses. Studies are needed to demonstrate the potential for implementing effective systems that result in improved identification and assessment in different primary care settings, especially in EDs where the majority of mild TBI cases are treated, as well as in schools and sports and recreation settings. Research is also needed that demonstrates how systems can better identify and assess mild TBIs among populations suspected to be at high risk for concussion that might remain undiagnosed. These populations include older adults, children (especially young children and those of any age for whom child maltreatment is suspected), persons injured as a result of terrorism-related attacks,[28] and military personnel returning from war zones. Although evidence exists that early educational information provided during the acute phase of mild TBI recovery can reduce long-term complaints,[29] further studies are needed to validate existing management protocols and to evaluate improved methods for reducing the potential for long-term disability resulting from mild TBI.

B. **Develop and apply methods for calculating population-based estimates of the incidence, costs, and long-term consequences of TBI.** Population-based surveillance and research to develop nationally representative estimates of the incidence and prevalence of disability associated with TBI, including temporal trends, are one of CDC's primary responsibilities, as described in the Children's Health Act of 2000.[30] This includes calculating the incidence and prevalence of TBI among institutionalized populations and supporting population-based follow-up studies to identify and track the outcomes of TBI. Better estimates of the incidence of mild TBI treated in outpatient settings and those that are untreated (e.g., sports-

related concussions) are needed to improve the accuracy and completeness of TBI surveillance efforts to determine the impact of TBI on the nation's population and healthcare systems. CDC has supported studies of TBI among prison inmates and nursing home residents, but estimates are needed for military personnel injured both in the United States and abroad as well as those in other institutional settings, including juvenile detention facilities, psychiatric institutions, developmental disability facilities, and child care centers. Of particular concern is the need for better data regarding the long-term outcomes among persons with mild TBI, for which estimates of the prevalence of disability are lacking,[31] including among both active-duty military personnel and veterans who have been exposed to blasts. Differences between the sexes throughout recovery from TBI, especially mild TBI, also need further study. Future research should also investigate critical outcomes of TBI that have not yet been well-described on a population level (e.g., prevalence of neurobehavioral problems, including aggressive behavior and intimate partner violence), which anecdotal evidence demonstrates might be increasing with improvements in survival of persons with severe TBI. Additional research is also needed to determine the incidence and prevalence of disability and other long-term outcomes among military personnel returning from combat and other veterans. Although updated information on the direct medical costs and indirect costs associated with disabling injuries was reported in 2006,[22] routine updates are needed to provide timely information for guiding resource allocation and other policies. In addition, research should estimate the costs associated with such secondary conditions as depression and substance abuse.

C. **Identify methods and strategies to ensure that persons with TBI receive needed services.** Meeting the need for services among persons with TBIs is critical for ensuring optimal recovery and quality of life. Among persons hospitalized with TBI, 35%–40% have at least one unmet need for services at 1 year after TBI.[32,33] Experience has demonstrated that changes to the system to ensure better linkage of persons with TBI to different types of available services are needed.[34] However, anecdotal reports and limited research indicate that the disability that persons with cognitive but not obvious physical problems experience poses unique challenges for persons with TBI in accessing health services and maintaining a healthy lifestyle.[35,36] Additional research is needed to identify service needs and barriers to accessing those services and to develop model programs for addressing these needs and ensuring that persons with TBIs are successfully reintegrated into the community. Of particular concern are military personnel returning from combat and other veterans, as well as prisoners with TBI, both while they are incarcerated and after they are released.

D. **Develop and evaluate interventions for reducing TBI-related disability.** TBI is among the most disabling conditions, but unlike such conditions as heart disease and stroke, TBI has only recently become a focus of research aimed at improving clinical care and rehabilitation.[37] Consequently, research to evaluate the effectiveness of interventions to reduce disability from TBI are lacking and additional research is needed. Among needed areas of investigation are the effectiveness of cognitive rehabilitation, especially as it relates to daily functioning, interventions to improve community integration and psychological health, and strategies to help caregivers.[37]

Among persons hospitalized with TBI, 35%–40% have at least one unmet need for services at 1 year after TBI.

An insufficient number of interventions for mild TBI have been evaluated, and published studies regarding their efficacy or effectiveness have typically been based on studies with limited samples.[29] However, research is promising and demonstrates that even simple interventions (e.g., providing an information booklet[38,39]) can result in reduced postconcussion symptoms among both children and adults, and that telephone counseling can also influence mild TBI outcomes (personal communication, Kathleen Bell, MD, University of Washington, 2007). Additional well-designed and controlled studies are needed to identify and evaluate interventions to ameliorate postconcussion symptoms and to reduce their long-term effects.[29]

Tier 2

E. Investigate the long-term effects of TBI on health and longevity. Disability is only one possible adverse outcome among persons who have sustained a TBI; increased risks for other health conditions also exist. Results from a population-based study demonstrate that at 1–3 years after injury, compared with the general population, persons who had been hospitalized with a TBI were more likely to report binge drinking[40] and have a higher risk for dying within 1 year after discharge from the hospital.[41] TBI is also related to increased risk for suicide.[42] In addition, new health problems associated with TBI can also arise in association with the aging process, including depression[43] and Alzheimer disease.[44] Chronic pain, including persistent headache, is also common after TBI.[45] Anecdotal reports indicate that TBI can also have an adverse effect on maintaining a healthy lifestyle. For example, physical impairments can lead to a decrease in exercise, and cognitive impairments can lead to difficulties in shopping for and preparing healthy foods, contributing to an increase in weight gain and increased risk for chronic diseases (e.g., diabetes); however, these associations have not been well-studied. The prevalence of such health risk behaviors as smoking and alcohol use have been investigated for persons with all types of disabilities,[46] but they have not been studied specifically among persons experiencing long-term effects of TBI. Thus, additional research is needed to further quantify the increased risk for health problems, both short- and long-term after TBI. With the aging of the U.S. population[47] and the high rates of TBIs among those aged ≥75 years,[48] research to better understand the association between TBI and changes in health with increasing age is of particular importance. Additional research regarding the longer term risk for increased mortality is also needed.

F. Improve the acute care of persons who have sustained a TBI. For mild TBI, which is treated most often in EDs, research to develop and evaluate improved methods and systems for identification, assessment, and management is needed. Research to further develop and validate clinical protocols for appropriate early management of mild TBI is a priority (see Priority A). Studies to determine the role of acute clinical interventions on outcome after mild TBI (e.g., early administration of such medications as nonsteroidal anti-inflammatory drugs [aspirin or ibuprofen] or opioid narcotics) is also needed. For more severe TBIs, research to investigate the impact of health systems on TBI outcomes is an

important area. Multiple concerns have been raised in this regard, including the effects of transportation decisions, referral and hospital admission policies, overall quality of care, and how guidelines are used in the provision of care. Trauma systems and referral and hospital admission policies greatly influence not only the characteristics of patient populations, but also the outcomes of care.[49] Although the benefits of concentration of care for more severe TBI in high volume centers have been reported,[50,51] prospective studies are needed to evaluate the effect of case load on functional outcomes. Systematic reviews of existing evidence regarding the effect of Level I trauma center volumes, quality of care, and guidelines-directed care[52] as well as lessons learned from advances in military trauma care on TBI outcomes can be useful in guiding how TBI care should be delivered and funded in the United States.

G. Develop effective and innovative methods to inform audiences regarding TBI. Results of a 2006 CDC-supported environmental scan of the literature and availability of TBI-related materials and resources provided evidence that the need continues for informing diverse audiences regarding the importance of TB as a public health problem and how to prevent and reduce the impact of TBI-related disability and other adverse outcomes (unpublished data, NCIPC, Traumatic Brain Injury: What Is Needed? What Is Available? *An Environmental Scan Review of Academic Literature and Websites, 2006).* This research demonstrated that audiences need information and resources, including educators (e.g., teachers, playground staff, and school nurses), healthcare providers, caregivers (e.g., family members and significant others of persons with TBIs), persons with TBIs, and the general public. Because identification, assessment, and management of sports-related concussion remain critical concerns, further education and training for coaches, parents, and athletes is also needed. Using evidence-based approaches in providing this information and understanding the level of knowledge and behaviors of these audiences will be critical in ensuring success in future educational efforts. Specifically, research is needed that evaluates different educational strategies for primary prevention as well as prevention of disability and other adverse effects of TBI. Although a recent review identified materials and campaigns aimed at raising awareness among the general public, educational interventions have rarely demonstrated substantial reductions in TBI incidence (unpublished data, NCIPC, Traumatic Brain Injury: What Is Needed? What Is Available? *An Environmental Scan Review of Academic Literature and Websites, 2006).*

Studies are also needed of the effectiveness and cost-effectiveness of providing information to specific target audiences (e.g., teachers, healthcare professionals, parents or other caregivers, persons with TBIs, the media, and the general public) on preventing TBI and its adverse effects. Comparing the impact of delivering such information within diverse settings (e.g., physicians' offices, hospitals, or public health clinics) and identifying mediators of any changes that are detected is also important. Research to identify new and effective strategies and technologies for information dissemination is also needed.

Finally, although recent national media coverage and educational initiatives, including those launched by CDC, have helped bring greater attention to TBIs (unpublished data, NCIPC, Coverage of Traumatic Brain Injury in Major U.S. Newspapers: An Analysis of Media Coverage, 2007), knowledge is limited regarding the levels of awareness among public health and healthcare professionals and the general public. Future research through nationally representative surveys (e.g., the Harris Poll) is needed to assess the current levels of knowledge and awareness of TBI among these audiences. Similar research focused on such target audiences as physicians and athletic coaches might also help to gauge the effectiveness and reach of CDC's national initiatives and future efforts.

H. **Determine the impact of TBI on special populations and develop and evaluate related interventions.** Research demonstrates that TBI is common among certain populations (e.g., prison and jail populations),[3,4,42] and a CDC-funded study is under way to investigate TBI's impact on community integration, recidivism, substance abuse, and homelessness.[53–55] However, additional studies are needed to determine how treatment and management strategies should be modified to help reduce the likelihood of these adverse outcomes. TBI among other special populations should be investigated as well, including a national estimate of TBI prevalence within psychiatric facilities, studies of racial/ethnic disparities in identification and treatment of TBI in clinical settings, prevalence of TBI among victims of intimate partner violence, and prevalence of TBI among homeless populations.

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Unintentional Injury Prevention

Home and Community

Public Health Burden

During 1997–2001 in the United States, approximately 12 million persons were injured each year at home severely enough to warrant an emergency department (ED) visit.[1] Injuries at home constituted 33% of all injury-related ED visits.[2] Multiple factors and events contribute to injuries in the home and community. For the purposes of the Injury Center's research agenda, home and community safety research includes fires, falls, dog bites, poisonings, consumer product-related injuries, choking (including unintentional strangulation and suffocation), scalds and other nonfire-related burns and injuries. Transportation-related injuries and sports-, recreation-, and exercise-related injuries are included as separate topics after this section on home and community.

Two major sources of injuries at home and in the community are fires and falls. In 2005, fires were the third leading cause of injury-related deaths among children aged 1–9 years and the fifth leading cause among adults aged ≥65 years. Falls were the third leading cause of injury-related deaths among U.S. residents of all ages and were the leading cause of injury-related deaths among adults aged ≥65 years. Of older adults who fall, 20%–30% suffer moderate-to-severe injuries that reduce mobility and independence and increase the risk for premature death. The total direct cost of fall injuries among adults aged ≥65 years in 2000 was $19 billion.[3] Falls are the leading cause of ED visits among children aged <15 years, accounting for an estimated 2.2 million visits in 2006.[4] Infants and children who fall from low heights are at substantial risk for head injuries, and those falling from heights of ≥10 feet can also sustain other, multiple, serious injuries.

The Injury Center's Approach to Preventing Injuries at Home and in the Community

Injuries occurring in the home and in the community represent a substantial public health burden in healthcare costs, injuries, and deaths. CDC's Injury Center can lessen this burden by developing, evaluating, and promoting effective interventions in the home and in the community. Public perception that injuries are "accidents" that cannot be prevented hinders prevention efforts. By using the public health approach to injuries, CDC's Injury Center conducts surveillance, injury risk and protective factor research, and intervention and adoption research. The Injury Center also translates that research into effective public health practice.

Residential and community injuries derive from multiple sources and involve different products, environments, and risk groups. Addressing this complexity requires varied approaches and multiple partners. One of the Injury Center's key partners is the U.S. Consumer Product Safety Commission (CPSC), which conducts research to protect the public from unreasonable risks for injury or death caused by consumer products. CPSC and the Injury Center jointly conduct nationally representative ED surveillance for injuries.

The National Institute for Child Health and Human Development (NICHD) conducts research on home and community safety, including pilot work regarding child supervision. The Injury Center has funded developmental and applied research on parental supervision. The Federal Emergency Management Agency works with the Injury Center to support research on strategies to improve community fire safety. The Injury Center works with the U.S. Fire Administration (USFA) to improve fire and burn surveillance. CDC works closely with the Administration on Aging to evaluate the costs of implementing evidence-based programs and the long-term impact of fall prevention programs, and with the Center for Medicare and Medicaid Services to evaluate risk factors and long-term outcomes for falls among the Medicare population. The Maternal and Child Health Bureau (MCHB) of the Health Resources and Services Administration provides training and technical assistance in injury prevention. The Injury Center complements MCHB work through state health departments by funding prevention programs in states with active MCHB programs. The U.S. Department of Housing and Urban Development works with CDC to improve healthy and safe housing. The Bureau of Indian Affairs (U.S. Department of the Interior) and the Indian Health Service (U.S. Department of Health and Human Services) work with the Injury Center to improve the health and safety of American Indians and Alaska Natives.

Nonprofit organizations conduct programs to promote safety in the home and community, including among others, the Home Safety Council, SAFE KIDS Worldwide,® the National Council on Aging, the National Fire Protection Association, the Home Safety Council, Meals on Wheels Association of America, and the National Safety Council. The Injury Center often pursues opportunities for collaboration with these agencies to support science and public health practices that promote home and community safety. Examples include research on smoke alarm technology; analysis of residential fires, including their causes and risk factors; prevention of falls among older adults; poisoning and overdose prevention; and promotion of effective childhood injury prevention strategies.

The Injury Center's Research Priorities for Preventing Injuries at Home and in the Community

Given the finite resources available for conducting research, the following priorities are listed in two tiers. The first tier contains those priorities that reflect the most immediate research needs and those that should be supported first as resources become available. Categorizing the priorities into two tiers does not imply, however, that the first tier of priorities is more important than the second tier or that research related to the second tier of priorities should wait until 2014 to begin.

Tier 1

A. **Develop and evaluate strategies for widespread dissemination and implementation of effective interventions to reduce injuries at home and in the community.** Research has demonstrated that interventions at home and in the community are often effective in preventing home injuries, including for example, smoke alarms, bicycle helmets, swimming pool fencing, stair gates and window bars, secured storage for poisons, and child-resistant cigarette lighters. However, these strategies have not gained wide acceptance in certain areas and among particular racial/ethnic and socioeconomic groups because of purchase or installation costs or for other reasons. Encouraging widespread adoption of these efficacious interventions requires dissemination- and implementation-related research, especially when related to large-scale community injury prevention programs and policies. Demonstration programs should be developed and evaluated to determine the effectiveness of communication techniques, audience segmentation, dissemination strategies and communication channels, tailored messaging, and collaboration models to speed dissemination and to widen adoption.[5]

B. **Develop and evaluate strategies and intervention programs to prevent injuries from residential fires and study the dissemination of community-based programs.** Approximately 80% of all fire deaths occur in the home. In 2006, residential fires killed 2,580 persons and injured 12,925.[6] Researchers have identified the major causes of residential fires — cooking, heating and electrical equipment, and candles. The groups at highest risk for injury from fires are young children, older adults, persons with disabilities, and persons who live in poverty. Additionally, research has demonstrated that functioning residential smoke alarms in all homes can prevent one third of fire deaths by providing early warning of fires, which often occur at night when residents are sleeping.[7]

   Researchers should develop prevention strategies based on behavioral responses to a fire, examine fire risk perceptions, and test interventions among selected populations at high risk (e.g., older adults and young children). Because vulnerable populations (e.g., rural residents, homebound and older adults, persons with disabilities, and children) are at higher risk for residential fires or fire-related injury death, interventions and programs to reduce these disparities are needed.[8] Rural residents are >2 times more likely to die in a fire than urban dwellers.[9] Interventions and programs to reduce this disparity are needed. In addition, rigorous evaluation of community-based programs, legislation and policy strategies, and engineering advances should be conducted to identify the most effective approaches.[10] Research on the effectiveness of automatic fire-suppression systems (e.g., residential sprinklers) is also needed.

Falls account for 43% of injury deaths among adults aged ≥65 years.

C. Develop and evaluate strategies and interventions to prevent falls among older adults and study dissemination of community-based programs. Approximately 30% of older adults and 40% of those aged >80 years report having fallen during the previous year. Falls account for 43% of injury deaths among adults aged ≥65 years[4] and result in 300,000 hip fractures annually. Individual factors known to increase the risk for a fall include decreased muscle tone and balance problems, vision problems, polydrug and psychotropic medication use, and sedentary lifestyles. Less conclusively, research indicates that certain home hazards and lifestyle behaviors might also contribute to the risk for falling.[11]

Research regarding fall prevention interventions is needed for three phases — development, efficacy and effectiveness, and dissemination. For such proven interventions as strength and balance training and medication review and adjustment (especially for psychotropic drugs), research is needed to identify barriers to widespread adoption by public health and healthcare professionals. Researchers have already identified certain barriers. For example, health professionals lack adequate information regarding interventions demonstrated to be effective; others might have the information but do not use it in their work with patients and the public. After researchers have identified the barriers to widespread adoption, they should develop and test strategies for overcoming those barriers.

Research is needed to translate effective fall prevention interventions into community-based programs. This includes research to identify the best formats and channels for delivering interventions to ensure that older adults adopt them. Health services and operations research is necessary for developing model infrastructures for service delivery that include partnerships between public health agencies and networks that serve the aging community. Research is also needed to identify persons most in need of fall prevention programs and to discern whether different programs work for different subgroups (e.g., frail older adults, persons who have fallen previously, and persons with a fear of falling).

Finally, researchers and practitioners only have limited information regarding fall-related interventions' effectiveness when broadly applied in the community. Two examples are vision enhancement (e.g., vision screening and correction and home lighting improvements) and the effectiveness and use of hip pads. Research should evaluate these types of interventions and determine how best to implement them in community settings with older adults. Further, researchers should use the results of biomechanics research to design and test new interventions.

D. Determine the burden and nature of nonpediatric poisoning and develop and evaluate intervention and dissemination strategies. Unintentional poisoning is an example of an emergent public health problem and is second only to motor vehicle traffic crashes as a leading cause of unintentional injury death in the United States. Ninety-five percent of poisoning deaths are attributed to drugs, including a substantial number resulting from prescription drugs. Unintentional poisoning mortality rates tripled in the United States during 1990–2004. In 2005, a total of 23,618 unintentional drug poisoning deaths occurred in the United States, exceeding the number of homicides that year (18,124).[4,12,13]

Active surveillance for deaths by using medical examiner data, police reports, and toxicology databases is needed to further characterize unintentional poisonings. Research examining the risk for overdose by drugs, prescription history of those

persons who die from drug overdoses, and results of all injury deaths is necessary to target strategies to reduce deaths from unintentional poisonings. Evaluations of new interventions (e.g., naloxone [a drug used to counter the effects of opioid overdoses], distribution programs, and Medicaid lock-in programs [restriction of selected Medicaid recipients from receiving prescriptions for abusable drugs]) and changes in prescribing and dispensing practices are critical to reducing unintentional poisoning deaths.

Tier 2

E. Determine the immediate causes of the most severe and disabling types of injuries among young children and develop and evaluate interventions to prevent them. Annually, injuries are the cause of half of the deaths that occur among children aged 1–4 years, and >6.4 million children aged <15 years are examined in U.S. EDs for injury.[4] Of approximately 9 million ED visits each year for unintentional injuries among children and adolescents, >25% occur among infants, toddlers, and preschoolers.[4] In 2000, total lifetime medical costs of injuries for children aged <5 years totaled $3.7 billion.[14] The most common causes of injury deaths for young children are suffocations, fire and burns, and drownings.[15] In addition, >1 million young children are examined in EDs each year for fall-related injuries.[4] Research should better characterize childhood injuries and then develop and evaluate interventions in home and community settings to reduce the major risks and most serious consequences of injuries for this age group. Research is needed to test the effectiveness of population-based parenting and caregiver programs that can be implemented in a cost-effective manner to produce changes in childhood injury risks and injury outcomes.

F. Define and measure aspects of supervision for children and impaired older adults that improve injury prevention. Supervision is considered one of the strongest yet least understood protective factors against home and community injuries; potentially, enhanced supervision can reduce playground injuries, drowning deaths, dog bites, injuries to infirm older adults, and child pedestrian injuries. Prior CDC research has demonstrated that the developmental ability, temperament, and cognitive and physical abilities of children affect their requirements for supervision and the effectiveness of supervision.[16] These factors also influence the degree of supervision needed for impaired older adults (e.g., persons with Alzheimer disease, Parkinson disease, or stroke) and for children with special needs. Research should continue to focus on developing and validating classification schemes for supervision to capture patterns used throughout all ages and cultures. Researchers should develop measurement tools to describe and compare styles of supervision and test different supervisory interventions to measure their relative effectiveness in preventing injuries.

G. Develop and evaluate community-based, comprehensive interventions to prevent unintentional injuries and to promote safe and healthy homes. An average 18,048 deaths from unintentional home injuries occur annually, and another 12 million unintentional home injuries require some form of medical attention.[1] In 1998, the cost of these injuries was estimated at $217 billion.[17] The five leading causes of unintentional home injury death are falls, poisonings, fires or burns, choking or suffocation, and drownings; together these causes account for 90% of all unintentional home injury deaths. [1]

For proven interventions (e.g., smoke alarm installation and education or home modification for fall prevention), implementation and dissemination research is needed. Research that targets changes in the built environment18 and interventions to modify the social environment (e.g. social norms) to reduce injuries at home19 are also needed. This includes research to identify the best formats and channels for delivering interventions to ensure that households and communities adopt them. Health services research is necessary to develop model infrastructures for service delivery that include partnerships between public health agencies and networks that serve the community.

As part of dissemination research, investigators should identify barriers to widespread adoption by public health and healthcare professionals and organizations, as well as by individual home residents. Methods for overcoming those barriers should also be tested.[5]

Testing also is needed to determine the effectiveness of removing or reducing physical hazards in the home.[20] Poisoning, choking or suffocation, and drowning prevention need particular attention. Healthy home assessments should be made and strategies tested to improve home safety among hard-to-reach populations and those at high risk. Studies are also needed to detect the influence of home type or age on injuries, and the influence of single and multihazard prevention programs.

H. Determine the impact of legislation, litigation, and regulation in preventing specific home and community injuries. Legislation, litigation, and regulation have been used to prevent injuries, but their relative effectiveness and cost-effectiveness have not been firmly established. Legislation addresses the design, manufacture, sale, possession, or use of products, changes in human behavior, or changes in physical, social, or environmental risks. Litigation is used to uphold laws, and regulations address specific problems (e.g., building codes or ordinances banning specific dog breeds).[21] Research should evaluate the effectiveness and cost-effectiveness of each of these approaches, their impact on individual and community risk, and their association with injury severity and costs.

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Sports, Recreation, and Exercise

Public Health Burden

Participation in sports, recreation, and exercise (SRE) is increasingly popular and widespread in U.S. culture. SRE activities include organized sports (e.g., school- or club-sponsored); unorganized sports (e.g., backyard or pick-up basketball, football, and hockey); recreational activities at home and in national parks, forests, and waterways (e.g., boating, camping, rafting, hiking, biking, skiing, swimming, and playground activities); and exercise and training activities (e.g., weight-lifting, aerobics, and jogging).

Participation in SRE activities contributes to health-related fitness; however, the risk for injury is inherent in any physical activity and in high-risk environments. In 2005, unintentional drowning was the second leading cause of injury death among children aged 1–14 years, killing 3,582 U.S. residents that year.[1] Approximately 11,000 persons receive treatment in U.S. emergency departments (EDs) each day for injuries sustained during SRE activities.[2] One of every six ED visits for an injury results from participation in sports or recreation. During July 2000–June 2001, an estimated 1.4 million U.S. residents were examined in EDs for injuries sustained while playing basketball, baseball, softball, football, or soccer. Injuries are also a leading reason people stop participating in potentially beneficial physical activity.

Risk for injury varies by factor, including specific activity and participant age. Children aged <15 years account for 23% of all drownings[1] and approximately 45% of all SRE-related ED visits.[2] They might be at risk because of immature or underdeveloped coordination, skills, and perception. Adolescents and young adults aged <25 years have high participation rates in SRE activities and experience approximately 29% of all SRE-related injuries.[2] The population of older adults is increasing, but knowledge is limited regarding their injury risk during participation in SRE.

Data are limited regarding injury incidence and prevalence, costs, relative risks for injury from different activities, risk and protective factors, and effective programs to prevent SRE injuries. Although ED surveillance data are available, they lack exposure information and exclude the substantial proportion of SRE injuries that are treated in primary care settings, sports medicine clinics, orthopedic clinics, and chiropractic clinics.

The Injury Center's Approach to Sports, Recreation, and Exercise Safety

CDC's mission includes both promoting physical activity and preventing injuries. Although CDC's National Center for Chronic Disease Prevention and Health Promotion has an active research program in physical activity, the Injury Center includes a focus on SRE injury prevention. The scope and depth of this research has been limited, and the Injury Center is uniquely positioned to provide epidemiologic and prevention research regarding SRE-related injuries. Although other federal agencies or national organizations sometimes fund SRE injury research, that research has not been as broad-based as activities in the Injury Center. Examples of federal agencies with particular interest in SRE include the National Institutes of Health (NIH), the National Park Service, the U.S. Coast Guard, and the U.S. Consumer Product Safety Commission (CPSC). NIH supports foundational research in SRE-related trauma and injury prevention; the Coast Guard supports boating safety programs and surveillance; and the National Park Service has a visitor's safety program. CPSC provides selected ED surveillance; however, its information does not include data related to participation rates (i.e., exposure data) that might facilitate comparisons. CPSC traditionally focuses on product-based research to protect consumers from hazardous products. With Injury Center funding, CPSC expanded its surveillance to include all injuries treated in EDs, regardless of cause.[1]

The Injury Center's Research Priorities in Sports, Recreation, and Exercise Safety

Given the finite resources available for conducting research, the following priorities are listed in two tiers. The first tier contains those priorities that reflect the most immediate research needs and those that should be supported first as resources become available. Categorizing the priorities into two tiers does not imply, however, that the first tier of priorities is more important than the second tier or that research related to the second tier of priorities should wait until 2014 to begin.

Tier 1

A. **Examine strategies to increase dissemination and adoption of effective interventions to prevent sports-, recreation-, and exercise-related injuries.** Effective interventions exist to prevent SRE-related injuries, but they frequently are not used. Examples include bike helmets and other protective equipment, break-away baseball bases, impact-reducing playground surfacing, and swimming pool fencing. Research should assess factors that hinder or encourage adoption of these effective interventions, including sociocultural and environmental influences, organizational leadership and infrastructure, community engagement, and coalition building. Studies should also assess different methods to increase awareness of effective interventions, test different strategies to disseminate effective interventions, tailor programs to local circumstances, and maintain fidelity to intervention guidelines.[3] Research should strengthen the successful implementation of interventions and programs related to drowning prevention, playground safety, bicycle safety, and other SRE injury prevention activities.

B. **Develop and evaluate environmental, behavioral, and legislative or regulatory interventions to prevent sports-, recreation-, and exercise-related injuries.** Existing interventions are often promising but have not yet been evaluated. The lack of evidence regarding the effectiveness of interventions in SRE is apparent, including the effects of modifying aspects of the physical environment (e.g., changing playground designs), equipment (e.g. hockey sticks or baseballs), use of existing and newly designed safety gear, and sex- and age-specific equipment use requirements and rules of play.[4] The importance of the presence and training of coaches and certified athletic trainers, supervision of young children participating in SRE, and the roles of caregivers, schools, and physicians in preventing injury during organized sports activities should be examined. Finally, research is needed to assess the effects of policies and practices regarding safety gear usage (e.g., bike helmets), school and club practice guidelines, modification in the rules of play for organized sports, and the use of highly skilled officiating.

C. **Evaluate existing and develop new methods to obtain exposure and injury incidence data for sports-, recreation-, and exercise-related injuries.** Recent reports estimate that approximately 4.2 million ED visits occur each year for injuries related to participation in sports and recreation.[2] However, without reliable methods for estimating frequency and duration of participation during these physical activities (i.e., exposure data to calculate denominators), researchers cannot determine injury rates and compare them across activities. Population-based SRE-related injury information can be obtained from multiple sources. Population-based participation surveys exist and, if validated, can serve as sources of denominator data for such studies. Accurate estimates of numbers of injuries combined with participation rates will enable researchers to examine risk and protective factors and to develop prevention strategies. These findings will facilitate more effective, programmatic decision making.

Tier 2

D. **Determine the short-term economic costs of injuries related to sports, recreation, and exercise.** SRE-related injuries are not a major source of mortality; however, they place a substantial burden on the healthcare system for both initial care and rehabilitation. They also result in costs related to lost productivity and other economic factors. Despite the considerable number of ED visits for these injuries, the majority of medical treatments for SRE-related injuries are administered by healthcare providers outside of emergency settings, indicating that the magnitude of the problem is much greater than ED statistics indicate. For example, in the United States, anterior cruciate ligament (ACL) knee injuries are usually sports-related and can be debilitating enough to prevent continued physical activity. The cost per ACL injury is approximately $17,000, and surgical and rehabilitative costs total approximately $646 million annually in the United States.[5] Data from other countries also demonstrate that the cost of other SRE-related injuries is considerable. Quantifying healthcare and other economic costs to society of SRE-related injuries and delineating the sources of those costs will provide a critical foundation for documenting the public health burden of these injuries.

Approximately 4.2 million ED visits occur each year for injuries related to participation in sports and recreation.

E. Identify ways to minimize injury risk among persons initiating or increasing physical activity. Certain factors influence recommendations for starting and increasing physical activity, including age, sex, fitness level, nutritional status, anthropometry, and injury history. In 1996, persons aged ≥65 years made 53,000 sports-related ED visits. This represented an increase of 54% since 1990.[6] As the U.S. population continues to live longer, they will likely remain active longer, increasing the risk for injury with aging. Research should identify strategies to reduce injuries while attempting to improve physical fitness of participants at all fitness levels. Knowledge regarding differences in human tolerance by age, fitness level, and sex is an important prerequisite for prevention. Researchers should develop science-based guidelines for choosing an activity, and they should recommend the frequency, intensity, and duration of participation, given a prospective participant's fitness level, propensity toward injury, and injury history. Research should also evaluate use of personal protective devices and training programs. Special populations, including children, older adults, women, and persons who are obese or undernourished, should receive particular attention. Additionally, research indicates that exercise is critically needed among older persons to maintain physical and mental health and independence. Research in this area should focus on understanding the risks related to different SRE activities among this population and, where possible, examine those at risk in relation to the benefits of these activities.

F. Identify risk and protective factors for and evaluate interventions to prevent injuries in outdoor recreation environments. Extreme and protected environments (e.g., national parks, forests, and waterways) offer wide-ranging recreational opportunities (e.g., wilderness camping, mountaineering, trail hiking, rafting, swimming, boating, and biking) and attract tens of millions of visitors each year. During January 2004–December 2005, approximately 425,400 persons were treated in EDs in the United States for outdoor recreational injuries. However, data are limited regarding injury circumstances and risk and protective factors related to injury in these environments.[7] Because of the diverse types of activities in which visitors to these locations engage, the origin and experience level of these visitors, and the inherent risks within these protected settings, visitor risk management in the extreme outdoor environments continues to be an injury problem of increasingly complexity.[8,9] Furthermore, because federal recreational lands are often preserved and protected, common engineering solutions are not always feasible. Risk management evaluation and health communication research can enhance federal land managers' efforts in identifying effective injury prevention strategies that also protect the natural environment and preserve opportunities for tourism. Studies should address education, protective equipment use, road and vehicle design, the influence of alcohol and posted warnings, and public policy and legislative interventions applicable to outdoor recreation environments.

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Transportation

Public Health Burden

Transportation-related injuries occur during travel on the ground, in the air, and on open water. The overwhelming majority of these deaths and injuries result from motor vehicle (MV) ground transportation. Transportation injuries for the purposes of this research agenda include drivers, occupants, and pedestrians affected by motorized vehicles. In 2005, MV crashes resulted in 45,343 deaths and were the leading cause of death in the United States among persons aged 1–34 years.[1] Annually, approximately 8,000 children ages 0–19 years die from transportation-related injuries, with the highest rates among those aged 15–19 years.[2] In 2006, an estimated 4,262,553 persons suffered nonfatal transportation–related injuries that required an emergency department (ED) visit, and of those, 346,813 required hospitalization or were transferred for specialized care.[1] The economic impact is substantial. In 2000, MV crashes cost >$230 billion in property damage, lost productivity, and medical expenses. These estimates do not include the unquantifiable costs of pain and suffering or the value of lives lost.[3]

Despite such achievements as increased safety belt use and declining numbers of alcohol-related crashes, injuries and fatalities caused by MV crashes remain a serious public health problem. Data reveal the need to direct prevention efforts toward specific groups (e.g., child safety and adolescent and older adult drivers). Pedestrian fatalities are a growing problem, and alcohol and drug use persist as key factors in crashes and injuries. Collaboration among partners is essential in preventing transportation-related injuries.

The Injury Center's Approach to Transportation Safety

CDC's Injury Center conducts and sponsors population-based epidemiologic, public health, behavioral, biomechanics, and trauma research to develop practical, evidence-based prevention strategies for MV–related injuries. CDC has been instrumental in framing MV injury as a public health problem and in helping to raise public awareness that these injuries are predictable and preventable.[4,5]

The Injury Center's research programs focus on determining the magnitude, severity, and cost of MV injuries; the size and vulnerability of populations at risk; the influence of coexisting medical conditions on crashes and injuries; and causes, risk factors, and effective interventions applicable to public health settings. Its use of hospitals and EDs for collecting MV injury data and for conducting brief interventions add critical contributions to the field. The Injury Center's peer-review process for selecting and funding research also distinguishes its work and advances this area of study; grantees publish their findings in peer-reviewed literature, accelerating the accessibility of knowledge for scientists and public health practitioners. Finally, multiple CDC-funded academic Injury Control Research Centers conduct studies regarding transportation-related injury.

The Injury Center's research priorities in MV safety build on CDC's focus on the public health implications of traffic injuries, one of the major causes of death and disability in the United States and globally. Ongoing research includes behavioral risk factor surveillance for alcohol and driving and identification of risk and protective factors related to child safety seats. An emphasis on older drivers reflects CDC's focus on healthy aging. Similarly, the Injury Center's focus on adolescent drivers takes advantage of CDC's expertise in quantifying and understanding adolescent health risks and implementing effective interventions (e.g., graduated driver licensing [GDL] laws). For example, CDC's Youth Risk Behavior Surveillance Survey tracks self-reported MV injury risk behaviors among adolescent drivers.[6] The Injury Center takes a developmental-risk perspective regarding adolescent drivers, which is characterized by its cooperative research with the National Institutes of Health (NIH) in studying the effects of persuasive communication, parental monitoring of youth driving behavior, and GDL systems for adolescents. The Injury Center also focuses on populations traditionally underserved and at high risk through such projects as the Tribal Motor Vehicle Injury Prevention program, which works to decrease deaths and injuries on the road among Americans Indians/Alaska Natives. It also emphasizes evaluation of community-based interventions. Its research in this area provided the science base for the MV injury prevention chapter in *The Guide to Community Preventive Services* (available at http://www.thecommunityguide.org), in which recommendations are made regarding use of evidence-based strategies to reduce alcohol-impaired driving and to increase use of safety belts and child safety seats.[7]

The Injury Center works closely with other federal agencies, nonprofit organizations, and researchers. For example, it has a strong partnership with the National Highway Traffic Safety Administration (NHTSA), the lead regulatory agency for MV safety. The Injury Center's efforts complement those of NHTSA, which sponsors and conducts research and produces technical reports on supporting traffic safety regulations, MV safety standards, and legislative initiatives. In partnership with the World Health Organization, the Injury Center developed surveillance guidelines and recommended strategies for MV injury prevention for developing countries, coauthoring the *World Report on Road Traffic Injury Prevention*.[8] Injury Center staff also participate on Transportation Research Board committees on transportation for an aging society, alcohol-impaired driving, pedestrian safety, and school transportation safety. Other key partners in transportation safety include NIH's National Institute for Child Health and Human Development, the National Transportation Safety Board, the Transportation Research Board of the National Academy of Sciences, the Insurance Institute for Highway Safety, the American Automobile Association's Foundation for Traffic Safety, SAFE KIDS Worldwide,® and the National Safety Council.

State and local health departments are a natural constituency for the Injury Center's research, and they provide key entries for developing and implementing effective interventions in communities. CDC's long history and close associations with all 50 state health departments, local health jurisdictions, and schools of public health provide a foundation from which the Injury Center can support effective collaborations to prevent transportation-related injuries.

The Injury Center's Research Priorities in Transportation Safety

Given the finite resources available for conducting research, the following priorities are listed in two tiers. The first tier contains those priorities that reflect the most immediate research needs and those that should be supported first as resources become available. Categorizing the priorities into two tiers does not imply, however, that the first tier of priorities is more important than the second tier or that research related to the second tier of priorities should wait until 2014 to begin.

Tier 1

A. Evaluate strategies to implement and disseminate known, effective interventions for reducing alcohol-impaired driving and test the effectiveness of new, innovative strategies. Driving after drinking alcohol is a major risk factor for MV crashes and is associated with >16,000 deaths and 250,000 injuries annually.[9] In 2000, alcohol-related fatality rates increased for the first time in years, accounting for approximately 40% of MV deaths.[10] For motorcyclists, the rate of alcohol involvement in fatal crashes is even higher. Children are frequent victims of alcohol-impaired drivers. Annually, hundreds of children aged <15 years die in MV crashes while riding with drivers who are impaired by alcohol.[9,11] In addition to the human costs, crashes involving alcohol are expensive. In 2000, these crashes cost U.S. residents $51 billion in direct costs and lost earnings.[12] Law enforcement sources report 1.4 million arrests for driving under the influence (DUI) every year; however, according to the annual Behavioral Risk Factor Surveillance System, >150 million self-reported episodes of DUI also occur.[13]

Since 1970, states and communities have implemented an array of strategies for reducing alcohol-impaired driving, with varying success. Laws and enforcement strategies for deterring alcohol-impaired driving and controlling the sale or public consumption of alcohol are among the most widely used strategies. Community-based interventions including sobriety checkpoints, lower legal limits for blood-alcohol concentration (BAC), zero-tolerance laws, enhanced enforcement of alcohol control policies, and training programs for servers of alcoholic beverages have been demonstrated to be effective.[14–16] However, a better understanding of the factors that most influence successful implementation of these prevention strategies and policies is needed. Research should include strategies drawn from health communication, policy development, enforcement, advocacy, and other approaches relevant to improving dissemination and adoption of effective interventions.

Research should assess existing interventions directed toward groups at high risk and those implemented in special settings; screening and early intervention for alcohol-impaired driving in public settings; licensing requirements; and the benefits, costs, and social acceptability of successively lower BAC standards. Simultaneously, searches for new and innovative strategies for reducing alcohol-impaired driving should continue.

B. **Develop methodologies for and evaluate the effectiveness of translating transportation safety research findings into public policy.** Laws have been applied at both state and federal levels to prevent MV injuries. However, tools are rare by which to measure how research translates into laws and regulations that encourage drivers to adopt safer behaviors. Research regarding the evolution of prevention strategies — from scientific evidence to legislation to product design and manufacturing changes — has the potential to reduce injury rates on a substantial scale. For example, research on the effectiveness of 0.08% BAC was critical to the success of the passage of new 0.08% BAC legislation.[15] Research on the role of tort litigation is needed to measure its effectiveness in changing industry practices or personal safety behaviors behind the wheel. Research should also evaluate the types of information used to support successful policies and regulatory decisions (e.g., GDL laws). Although the most comprehensive GDL systems are associated with the greatest benefits, states vary widely in their implementation, and the reasons for this lack of uniformity are largely unkown.[17]

   To determine the components of a successful MV injury prevention program, campaign, or policy action, research should evaluate the persuasiveness of data regarding injury's incidence, prevalence, severity, costs, and related outcomes of MV–related injuries (e.g., disabilities and functional impairments). Likewise, evaluation data are needed regarding the cost and cost-effectiveness of interventions and the power that a personal or family member car crash can have on opinions and legislative action. Research is also needed that examines the effects of broad policy shifts (e.g., reforms in traffic enforcement, vehicle safety improvements, or speed cameras), the effects of policies directed specifically at younger or older drivers (e.g., driving curfews, restrictive licensing, or retesting before driver license renewals), and the effects of policies aimed at scaling up effective interventions to achieve population impact.

C. **Identify the underlying behavioral and situational factors associated with crashes involving adolescent drivers and develop and evaluate appropriate interventions to address those factors.** In 2006, approximately 7,500 young drivers died of injuries caused by MV crashes.[18] Research indicates that young drivers are more likely than others to speed, fail to stop at red lights, make illegal turns, ride with an intoxicated driver, and drive after using alcohol or drugs. They are more likely than other drivers to underestimate the dangers of hazardous situations, and they have less experience coping with those situations. Youth who drive after consuming alcohol pose an inordinate risk to themselves, their passengers, and other road users.

   To prevent MV crashes among young drivers, research should evaluate strategies that limit access to driving and increase new drivers' time behind the wheel under safe driving conditions (e.g., those implemented in GDL programs). Research is needed to determine the most efficient combination of elements in GDL laws to protect young drivers, limit adolescents' access to

Driving after drinking is associated with ≥16,000 deaths and 250,000 injuries annually.

alcohol, and increase use of safety belts. Research should also identify behavioral and developmental characteristics that predispose certain adolescents to take greater risks than their peers. Research to identify constellations of risk factors that can be used to develop and target interventions should focus on behavioral rather than epidemiologic studies, and it should examine both protective factors and risk factors (e.g., the roles of supervision, family, peers, risk perception, decision-making skills, and community characteristics).

D. Develop and evaluate interventions that address correct and consistent use of measures for protecting child occupants in motor vehicles. In 2005, a total of 1,617 children aged ≤15 yeas were killed while riding in MVs,[1,19] and an estimated 225,096 sustained nonfatal injuries requiring an ED visit in 2006.[1] Correct installation of age-appropriate child restraint systems (e.g., child safety seats or booster seats) and correct placement of children in those restraints increase safety. Data demonstrate that in the United States, Hispanics have lower rates of child safety seat use than non-Hispanic whites. Research also indicates that children seated in the back seat are safer than children seated in the front seat.

Further research regarding the efficacy, effectiveness, and safety of using air bags with child passengers and using booster seats for children who have outgrown their child safety seats is needed. More research is needed to document the efficacy and effectiveness of booster seats in preventing injury and to establish more rigorous guidelines for their correct use on the basis of such variables as age, height, weight, and other relevant anthropometric variables. This research can provide information for performance standards development and highway safety regulation implementation.

Research should also assess the impact of child safety seat and booster seat laws as well as enforcement strategies and training or seat-checking programs intended to increase correct use. Continued research is needed regarding the effectiveness of universal fasteners and alternative restraint designs, including devices that improve comfort and convenience. Research should evaluate strategies to improve correct use and decrease misuse of safety devices and to improve communication efforts to promote child occupant safety.

In addition to restraint use, research should investigate factors that persuade drivers to place children in the back seat or to refrain from drinking alcohol before transporting children. The results of such research should guide intervention development, evaluation, and dissemination. A focus on special populations (e.g., innercity or non-English–speaking groups) not reached by common communication channels is crucial, and a focus on researching the effectiveness of health literacy efforts with these populations is needed.

E. Evaluate the effectiveness of behavioral and environmental strategies to prevent pedestrian injury. Pedestrians account for approximately 13% of MV–related deaths in the United States. Annually, >5,000 pedestrians are killed and another 170,000 are injured in MV incidents.[1] The majority of pedestrians injured or killed are young children, older adults, or alcohol-impaired persons.[20] Pedestrian injuries that occur in rural areas are more likely to be fatal than those occurring in urban areas.[21]

Because the problem is complex and ecological — involving pedestrian and driver behaviors, road characteristics, travel patterns, vehicle speed, and environmental variables — no single intervention is likely to sufficiently reduce the number of pedestrian injuries. For example, infants are injured in strollers; toddlers are injured in driveway backover incidents; and preschoolers and elementary school-age children are injured when they dart out between cars parked on residential streets, particularly during play. As with MV crashes, adult pedestrian injuries often involve alcohol.

Multidisciplinary approaches involving theory-based education and training programs, engineering solutions, and strong law enforcement will be necessary to effectively reduce pedestrian injuries. Research should include interventions that focus not only on pedestrians but also on drivers and the driving environment (e.g., strengthening enforcement strategies for speed limits, yield-to-pedestrian laws, and school zones). Changes in pedestrian and driver behaviors and modifications in roadway environments, including traffic-calming measures that slow traffic and improve road conditions for pedestrians and bicyclists, might provide the strongest mix of prevention strategies. Researchers should develop and evaluate strategies that reduce the risk for collisions with pedestrians (e.g., increased pedestrian and vehicle visibility or the influence of roundabout intersections on pedestrian behaviors) and address the different risk factors for groups in urban and rural settings.

Tier 2

F. **Among older adults, identify and measure factors that affect safe motor vehicle use and develop and evaluate interventions that reduce motor vehicle–related deaths and injuries.** In 2005, a total of 7,381 persons aged ≥65 years died in MV crashes, and 261,722 were injured.[1] These numbers are likely to increase with the expected growth among this population segment. Older adults often change their transportation habits to allow for declining performance with age (e.g., not driving at night because of vision limitations), yet knowledge is limited regarding how functional capacity, medical conditions, medications, and other factors affect safe MV use.[22] Multiple approaches are available to document these associations, including cognitive testing, simulator studies, and applied biomechanics research. Studying the effects of vehicle design on these human interactions is another potential direction for related research. Findings from these areas of research can be used to identify older adults at greatest risk and to design public health programs to reduce the risks for crashes and injuries among this group.

G. **Develop and evaluate interventions to increase use of occupant protection devices (e.g., seat belts and child safety seats) among populations at high risk and those traditionally difficult to reach.** Certain groups (e.g., those with low socioeconomic status and non-English–speaking, immigrant, and rural populations) and those who do not perceive the risks related to driving unprotected are at higher risk for MV–related injuries. These groups might also be difficult to reach through traditional prevention messages or interventions, and further reductions in MV–related injury rates will require tailoring interventions to them.

Research should evaluate the effectiveness of changes in vehicle and restraint design and strategies to increase adoption and maintenance of safety belt use. Developing and conducting intervention research regarding hard-to-reach populations presents special challenges for transportation safety. Investigations should include prevention programs and interventions that are targeted, tailored, and evaluated.

H. Develop and evaluate interventions to reduce motorcycle crashes and injuries. Per mile driven, motorcyclists are approximately 35 times more likely than passenger car occupants to die in a traffic crash.[23] Motorcycle safety initiatives have placed major emphasis on wearing helmets and on helmet laws to prevent crash-related head injuries and deaths, yet helmet use has declined from 71% in 2000 to 48% in 2005.[24] A higher percentage of motorcycle operators in fatal crashes had BACs of ≥0.08 g/dL than drivers of other types of MVs.[25] Approximately one of every four motorcycle operators in fatal crashes was operating the vehicle with an invalid license. Research should identify methods for promoting the most effective interventions and identifying the barriers to implementing and sustaining effective interventions (e.g., motorcycle helmet laws).[26] However, research should extend beyond the focus on helmets to determine the effectiveness of other strategies for preventing not only injuries and deaths but also motorcycle crashes — strategies that improve motorcycle safety training and skills, reduce alcohol-impaired motorcycle driving, and enhance licensing interventions. In addition to behavioral approaches, research regarding the effectiveness of different motorcycle helmet designs might improve riders' comfort, convenience, and acceptability of helmets. Policy research to understand motivations for repeal of motorcycle helmet laws is needed. Efforts are also needed to identify factors that result in helmet use in states without laws requiring their use.

I. Evaluate the effects of emerging vehicle technologies on the risks for crashes, the risk for injuries during crashes, crash avoidance, and the perception of these risks. Emerging technologies can improve traffic safety; however, these same technologies might have unintended negative consequences. For example, first-generation air bags provided limited additional crash protection in certain situations but increased injury to smaller stature adults and young children. Also, certain display devices allow drivers to obtain more information while driving, but these same displays can also exceed information-processing thresholds, or they might confuse older drivers who have declining cognitive skills. Research should evaluate how such innovations as side air bag deployment, driver distractions (e.g., cellular telephone use), new seat and headrest designs, visual displays, early warning systems (e.g., laser crash-detection devices), or telematic or other similar devices, affect driving performance, crashes, and injuries. Additional cognitive demands imposed by new technologies in vehicles should be investigated, especially those related to intelligent vehicle technology and telematics. Researchers should focus on the impact of vehicle and auxiliary equipment design on changes in risk and in drivers' perception of risk.

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Violence Prevention

Child Maltreatment

Public Health Burden

Child maltreatment is any act or series of acts of commission or omission by a parent or caregiver that results in harm, potential for harm, or threat of harm to a child. Child maltreatment can be divided into two broad types. Acts of commission (i.e., abuse) involve words or overt actions that cause harm, potential harm, or threat of harm to a child. Acts of omission (i.e., neglect) include indirect forms of maltreatment (e.g., failure to provide for a child's basic physical, emotional, or educational needs, or to protect a child from dangerous or possibly dangerous situations). Much of the child maltreatment field divides acts of commission into three broad categories — physical, sexual, or emotional abuse (e.g., psychological or verbal abuse and mental injury). Acts of omission are often referred to as child neglect and divided into two categories — failure to provide for a child's basic needs (e.g., physical, emotional, medical/dental, or educational neglect) and failure to protect a child (e.g., inadequate supervision or exposure to violent or unsafe environments).[1]

The magnitude of child maltreatment in the United States is not easily determined, but is clearly substantial. In 2006, Child Protective Services (CPS) confirmed approximately 905,000 cases of child maltreatment in the United States, and an estimated 1,530 children died as a result of abuse or neglect.[2] However, confirmed cases of maltreatment represent only a fraction of the true magnitude of the problem because cases often are not reported to social service agencies. Survey data provide a more troublesome picture of the problem of child maltreatment. Estimates based on a national survey of children aged 2–17 years conducted during 2002–2003 indicate that approximately one in eight children reported having experienced maltreatment.[3] Surveys of adults also reveal high rates of childhood maltreatment, with 20%–32% of women and 14%–40% of men reporting some form of abuse or neglect during childhood.[4,5]

Child maltreatment often has immediate sequelae (e.g., traumatic brain injury, death, and childhood emotional and behavioral problems), but research in neurobiologic, behavioral, and social sciences indicates that early childhood experiences also affect the long-term development of the brain and subsequent vulnerability to multiple mental and physical health problems during adolescence and adulthood. Such problems range from anxiety disorders and depression to cardiovascular disease and diabetes.[6–9]

The Injury Center's Approach to Child Maltreatment Prevention

The mission of CDC's child maltreatment prevention program is to prevent maltreatment and its consequences through surveillance, research and development, capacity building, communication, and leadership. In pursuit of this mission, CDC's public health approach complements such other approaches as those of the criminal justice and mental health systems. In particular, CDC's approach emphasizes primary prevention of perpetration of child maltreatment or efforts that focus on preventing maltreatment before it occurs. CDC places emphasis on rigorous science in its efforts to monitor and track trends, research risk and protective factors, rigorously evaluate interventions, and learn how best to implement them. This multipronged effort adds to the knowledge base regarding violence and how to prevent it. The long-term goal of

CDC's work in child maltreatment prevention is to achieve lasting change in the factors and conditions that place children at risk through making changes at the individual, family, community, and societal levels of the social ecology that reduces rates of child maltreatment among populations.

The Division of Violence Prevention (DVP) has identified safe, stable, and nurturing relationships (SSNRs) between caregivers and children as the foundation of a unified strategic approach and message to empower parents and caregivers and to reduce child maltreatment. Further, SSNRs have been identified as a means to strengthen parenting practices that prevent child maltreatment by focusing on positive caregiving behaviors. The relationships between children and the key adults in their lives are fundamental to the healthy development of the brain and consequently, physical, emotional, social, behavioral, and intellectual capacities.[8,10] Accordingly, promotion of SSNRs can have synergistic effects on health problems as well as contribute to development of skills that enhance acquisition of healthy habits and lifestyles.

To promote SSNRs and reduce maltreatment, additional research is needed across the different social contexts in which children develop and interact, including the individual, family, peer, community, and society. These nested social ecologies provide a framework and context for examining the relationships children have both within and outside the immediate family. Research is needed to investigate the prevalence of SSNR behaviors and activities by caregivers to develop a foundation from which to study positive caregiver behaviors and child outcomes. A complete etiologic picture of child maltreatment is still emerging, and the myriad risk and protective factors related to child maltreatment at all levels of the social ecology and their relation to SSNRs remains unexplored. Evidence is available that different types of maltreatment have different etiologies and lead to different child outcomes.[11] Further, strong evidence exists that different types of maltreatment events often co-occur.[12] Thus, prevention efforts for differing and multiple co-occurring forms of maltreatment might require distinct prevention strategies. For example, the most common sexual abuse prevention strategies have focused on educating children by using school-based programs. In contrast, the most commonly investigated and implemented prevention efforts for child physical abuse and neglect have targeted adults, or more specifically caregivers, by providing education and skills training programs. Additional research is needed to examine the most efficacious prevention strategies for each type of maltreatment. Training of caregivers in child-rearing and management strategies is a basic approach to facilitating SSNRs, and establishment of SSNRs in environments children encounter outside the home and the central family unit are essential. Further, critical questions regarding the effectiveness of prevention programs still remain. As noted in the Institute of Medicine report, *Reducing the Burden of Injury,*[13] rigorous research is needed to assess the effectiveness of prevention programs and to determine which among them merit widespread use. To ensure the feasibility of widespread use of child maltreatment prevention programs, research is also needed to assess program cost-effectiveness and the cost of initiating or expanding effective programs.

In looking toward the future, preventing such adverse exposures as maltreatment by ensuring that all children are protected and raised in a safe, stable, and nurturing environment is strategic for achieving measurable and lasting impacts on health throughout life. This research agenda is designed to provide a foundation from which to accomplish this goal during the next 10 years.

The Injury Center's Research Priorities in Child Maltreatment Prevention

Given the finite resources available for conducting research, the following priorities are listed in two tiers. The first tier contains those priorities that reflect the most immediate research needs and those that should be supported first as resources become available. Categorizing the priorities into two tiers does not imply, however, that the first tier of priorities is more important than the second tier or that research related to the second tier of priorities should wait until 2014 to begin.

Tier 1

A. **Examine the context and development of child maltreatment perpetration and SSNRs to identify populations at risk, modifiable risk and protective factors, and optimal times and settings for prevention.** Caregiving behaviors occur in a broad context and develop with time. Understanding the development of caregiving behaviors and how the context influences child development is key to understanding which prevention strategies, programs, and policies will promote SSNRs and reduce child maltreatment. To gain a full understanding of the ideal times and settings for prevention, research is needed that examines how SSNRs and negative caregiving behaviors, including child maltreatment, develop. Previous work has focused primarily on individual- and family-level influences, with relatively limited attention paid to community- and broad societal-level factors (e.g., policies, broad social norms, and collective efficacy). Community and societal-level factors might influence development of SSNRs or maltreatment directly, and they might interact with individual- and family-level factors. Additionally, prevention strategies, programs, and policies that operate at a community or societal-level might reach broader segments of a population and be influential in widespread promotion of SSNRs and reductions in child maltreatment. Finally, understanding the development of different forms of child maltreatment perpetration (e.g., physical abuse, neglect, and sexual abuse) is critical because the different forms of child maltreatment might have different etiologies and thus require different strategies and timing.

B. **Identify and quantify the social and economic burden of child maltreatment victimization and factors that mitigate child maltreatment outcomes.** Victims of child maltreatment are at risk for multiple detrimental health outcomes, including biologic, psychological, and social deficits.[14–16] Child maltreatment not only negatively affects the victims but society as a whole. For example, maltreated children are at increased risk for becoming perpetrators of violence and for engaging in criminal behavior that exacts considerable societal cost. Additionally, substantial economic costs are incurred for victims of maltreatment in terms of medical and nonmedical resources consumed, losses in productivity, and human capital development. Further research quantifying the social (including health- and nonhealth-related outcomes) and economic burden (i.e., direct and indirect costs) of child maltreatment is warranted. Research is also needed to examine factors that can mitigate the burden of maltreatment, with an emphasis on potential mechanisms that might influence positive outcomes for maltreated persons. A greater understanding of the association between child maltreatment and its social and economic burden can help guide future policy development regarding prevention and intervention.

C. **Evaluate the effectiveness of parenting-focused strategies for preventing child maltreatment and promoting SSNRs**. Healthy parent-child relationships are fundamental in protecting children from child maltreatment and for development of the brain, and consequently, development of children's physical, emotional, social, behavioral, and intellectual capacities. Parent training programs have been used to promote positive caregiving behaviors and to address child behavior problems among populations at risk, including caregivers involved with child protective service agencies. Parent training programs can be used to teach parents or caregivers to care for children properly and to manage their children's behavior by using positive parenting strategies and noncoercive discipline strategies. Because much of physical child maltreatment stems from attempts at discipline, parent training programs can be used to preempt the negative behaviors that can lead to maltreatment. However, research is still needed to examine the extent to which parenting programs can be used for the primary prevention of child maltreatment and for the promotion of SSNRs on a broad scale. For example, can parenting programs be broadly implemented in communities to reduce the overall incidence of child maltreatment and to promote SSNRs at a population level? Evaluating the costs and cost-effectiveness of parenting-focused prevention strategies is needed so that widespread use of strategies can focus on those that are most cost-effective.

D. **Evaluate the effectiveness of public and organizational policies for preventing child maltreatment and promoting SSNRs.** Public and organization policies potentially play a key role in contributing to child maltreatment and in preventing it. Public or organizational policy can be defined as a course of action or inaction chosen by public or organizational authorities to address a problem. Public policy is expressed in the body of laws, regulations, decisions, and governmental action. An organizational policy is reflected in the rules and regulations governing its operation. These policies can be critical in shaping the environment in which child maltreatment occurs. For example, laws that impose criminal penalties for child maltreatment might increase the safety of children by deterring such acts, or legislation that permits parents to take time off during family crises might help relieve stress, promote nurturing relationships, and reduce child maltreatment. Moreover, organizational policies in child-serving agencies that establish procedures for hiring and appropriate interactions between staff and children can also serve to prevent child maltreatment and ensure safe environments. These and other types of policies should be evaluated to determine if they are effective in promoting SSNRs and preventing maltreatment. The cost-effectiveness of evidence-based policies should also be determined where feasible.

E. **Evaluate the dissemination and implementation of evidence-based strategies for preventing child maltreatment and promoting SSNRs.** Identifying and evaluating efficient and effective methods for dissemination and implementation is critical in optimizing the access and reach of evidence-based programs to prevent child maltreatment and to promote SSNRs. For example, research has documented the efficacy of prevention programs (e.g., skill-based parenting programs and home visitation programs) in positively changing parental behavior and decreasing the manifestation of abusive and neglectful acts within families at risk.[17–23] Despite the success of these and other programs in preventing child maltreatment risk, research that examines how to best disseminate and implement existing empirically supported prevention strategies is substantially limited. To address this gap, at least five steps are needed. First, researchers should evaluate strategies for translating empirically supported

programs into such products as training manuals that can guide implementation in the field.[23] Second, methods for providing the training and consultation needed to support implementation in the field should be examined. Third, the degree to which programs should be implemented as developed (i.e., with fidelity) or can be adapted for local settings and groups without compromising the program's effectiveness warrants investigation. Fourth, how characteristics and capacities of persons, practice settings, organizations, and communities influence implementation and dissemination of evidence-based strategies for preventing child maltreatment and promoting SSNRs should be examined as should the methods used to increase these necessary capacities. Finally, economic evaluation related to product development, training, and capacity-building should be conducted to determine the most efficient methods for bringing prevention programs to scale. Such work will facilitate the dissemination of successful prevention programs from research to real-world settings.

Parent training programs can be used to teach parents or caregivers to care for children properly and to manage their children's behavior by using positive parenting strategies.

Tier 2

F. **Develop and evaluate surveillance methods for child maltreatment and behaviors or activities that promote SSNRs.** Data are limited regarding how to monitor the incidence and prevalence of child maltreatment, and the data that exist are of questionable validity and reliability; therefore, better tracking and monitoring methods are necessary to support prevention efforts. To develop better surveillance systems, research has been undertaken to examine (1) the sensitivity and specificity of alternative definitions of child maltreatment and (2) the incidence and prevalence of child maltreatment mortality using secondary data sources traditional to public health. Further research is needed to assess the utility of alternative surveillance methodologies (e.g., survey surveillance to examine child maltreatment). Additionally, SSNRs have been identified as a unifying concept for promotion of positive parenting and prevention of child maltreatment. Surveillance efforts are needed to develop a foundation from which to monitor positive caregiving behaviors and child outcomes.

   Child maltreatment morbidity and mortality and SSNRs are likely to require different approaches to surveillance. Rigorous evaluation of child maltreatment surveillance methods should be incorporated into research projects to provide feedback regarding the most suitable approach to surveillance for different aspects of maltreatment. Improved surveillance methods will render better information for guiding program development and evaluation. Because states and localities often lack adequate monitoring systems, improved surveillance will be particularly valuable to them as they expand their efforts to address child maltreatment as a public health concern.

G. **Evaluate the impact of extreme community and environmental stressors on child maltreatment.** Chronic community stressors (e.g., severe poverty or the demise of a critical local industry) as well as catastrophic events (e.g., natural or intentionally created disasters or terrorism) might exacerbate both the incidence and sequelae of child maltreatment in affected communities, but research in this area is still emerging. Research is needed to assess the impact of community and environmental stressors, both chronic and discrete, on the relationships between caregivers and children. In addition to assessing the impact of such events, development of evidence-based tools and materials that can be implemented to buffer the impact of these stressors are needed. Research after hurricane-related disasters demonstrates a need to screen volunteers as well as a need for public information messages about family cohesion and parental monitoring and

supervision of children; however, materials, tool kits, and appropriate messages are sparse, and information is lacking regarding their efficacy and effectiveness. Injury Center-related research on these topics will complement CDC's other work related to disaster preparedness and terrorism response. Research is also needed to facilitate development of approaches for addressing chronic community stressors and outcomes throughout the lifespan related to these chronic stressors. Findings from this research can aid service agencies as they develop and implement appropriate responses and public advisories during periods of extreme stress and provide a roadmap for developing strategies to address chronic stressors.

H. **Evaluate development and delivery of training strategies for professionals that build capacity and skills for supporting parents in providing SSNRs for their children and for promoting policies and practices that create supportive social environments for children.** Programs are common for training professionals in child maltreatment recognition, intervention, diagnosis, treatment, and to a lesser degree, prevention. However, evaluation of these training programs is needed to determine their impact on the practices of professionals, particularly with regard to primary prevention and promotion of healthy caregiving and organizational practices. Strong evidence points to SSNRs as the buffer against maltreatment and other adverse exposures occurring during childhood that compromise health throughout the lifespan. Professionals who interact with and provide services for caregivers and children have important roles to play in supporting caregivers and promoting SSNRs. Professional training programs rarely have been developed specifically to build the capacity of professionals to integrate policies and practices that promote protective factors into their service setting. Training programs that (1) incorporate anticipatory guidance in healthcare settings, (2) build practices in child care settings that support caregivers and promote protective factors, (3) develop professionals' knowledge of support services in the community and skills for early recognition of need and referral to these services, and (4) identify and promote organizational policies that help create safe and nurturing environments and relationships for children, are all needed. Additionally, research is needed regarding whether professionals who receive such training might be better equipped to support parents in ensuring SSNRs for their children.

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Sexual Violence and Intimate Partner Violence

Public Health Burden

Sexual violence and intimate partner violence have a substantial effect on public health. Victims of violence can experience the immediate consequences of physical injury and long-term physical and mental health consequences, including depression, anxiety, posttraumatic stress, suicide attempts, substance abuse, chronic pain, gastrointestinal problems, cardiovascular disease, and a range of reproductive health concerns.[1–3] The economic cost of intimate partner violence against women has been conservatively estimated at $5.8 billion/year, a figure that includes only the medical and mental health expenditures, lost productivity, and lost lifetime earnings[4]; however, no national estimate of the total cost of intimate partner and sexual violence has yet been calculated.

Sexual violence includes completed or attempted sex acts against the victim's will or involving a victim who is unable to consent, abusive sexual contact, and noncontact sexual abuse, including sexual harassment. Child sexual abuse is also included in the range of behaviors considered sexual violence. Sexual violence can be committed by a current or former intimate partner, a nonintimate partner family member, a person in position of power or trust, a friend, an acquaintance, another nonstranger, or a stranger.[5] Both women and men are victims of sexual violence, although women are >3.5 times more likely to report experiencing rape or attempted rape during their lifetime then men, according to data from 23 states and two territories that employed the sexual violence module of the Behavioral Risk Factor Surveillance System (BRFSS) (18.5% and 5.8%, respectively) (unpublished data, Black MC, Basile KC, Breiding MJ, and Ryan GW, Prevalence of sexual violence in 24 states and two U.S. territories, BRFSS, 2005). For women, 22% of all first attempted or completed rapes occurred before they were age 12 years, and 32% of first attempted or completed rapes occurred during ages 12–17 years. For men, 48% of first attempted or completed rapes occurred before they were age 12 years, and 23% occurred during ages 12–17 years.[6] Lifetime prevalence estimates of child sexual abuse range from 7% to 36% for women and from 3% to 29% for men.[7,8]

Intimate partner violence is defined as actual or threatened physical, sexual, psychological, or emotional abuse by a current or former spouse (including common-law spouse), dating partner, or boyfriend or girlfriend. Intimate partners can be of the same or opposite sex. Data from the 2005 BRFSS (16 states and two territories) indicate that approximately one in four women (26.4%) and one in seven men (15.9%) reported some form of physical intimate partner violence victimization (threatened, attempted, or completed physical violence) or nonconsensual sex by an intimate partner during their lifetime.[9] Twelve-month prevalence of nonconsensual sex or completed physical violence was 1.4% and 0.9% for women and men, respectively, translating to >25 million women and 7 million men annually. Findings from other national studies have yielded varying estimates; prevalence measures are influenced substantially by the behaviors included and the context (e.g., health, crime, or family conflict) in which the questions are asked.[6,10,11] Although considerable partner violence occurs to both women and men, women experience greater injuries and harms from intimate partner violence than men.[6,12]

The Injury Center's Approach to Preventing Sexual Violence and Intimate Partner Violence

Multiple agencies and organizations have developed programs and prevention strategies to respond to sexual violence and intimate partner violence. However, as noted in the Institute of Medicine report, *Reducing the Burden of Injury*, only a limited number of these programs have been evaluated thoroughly enough to assess their effectiveness and to determine which among them merit widespread adoption.[13] The Injury Center emphasizes rigorous research with direct implications for achieving health impact. This research perspective complements the work of other federal agencies. For example, the Injury Center's focus on identifying ways to prevent development of perpetration of sexual and intimate partner violence complements the U.S. Department of Justice's focus on persons already charged with violent offenses also being associated with these behaviors. The Injury Center's focus on applied prevention in these areas complements the National Institutes of Health's focus on basic scientific questions.

The majority of efforts that address sexual and intimate partner violence focus on reducing victims' risks for future violence, mitigating the consequences of exposures to such violence (i.e., secondary and tertiary prevention), and holding perpetrators accountable through the criminal justice system. Greater attention is needed to prevent sexual and intimate partner violence from occurring in the first place (primary prevention). This might require researchers and practitioners to take new approaches in addressing sexual and intimate partner violence. Certain questions, particularly questions regarding early risk and protective factors related to perpetration, remain unanswered, seriously hindering development and identification of effective violence prevention strategies. Thus, the Injury Center must focus on perpetration research to support future development of effective prevention programs. Such research will complement efforts focused on preventing initial victimization and revictimization. Documenting program costs and cost-effectiveness, when appropriate, will help practitioners and policymakers understand what resources are needed to implement effective programs. As effective strategies are identified, research examining how to best disseminate, implement, and adapt evidence-based prevention strategies will become increasingly important.

That research related to understanding and preventing sexual and intimate partner violence examine a full range of potential social-ecological influences is critical. According to social-ecological models,[14] such behaviors as sexual and intimate partner violence perpetration are influenced by different variables, including individual-level influences, small-group influences (e.g., dyads, peers, and families), and community and societal influences. Although research has been done regarding the individual and small-group levels of the social ecology, more empirical work is needed on how the upper levels of the social ecology (i.e., community and societal levels) influence sexual and intimate partner violence and how those influences interact with lower levels to influence behavior.

Finally, although this chapter includes discussion of both sexual and intimate partner violence, understanding the similarities and differences between the two is important. Sexual violence can be perpetrated by an intimate partner and is one type of intimate partner violence, but other persons also perpetrate sexual violence. Studies have reported the most common type of perpetrators of sexual violence are acquaintances or friends (unpublished data, Black MC, Basile KC, Breiding MJ, and Ryan GW, Prevalence of sexual violence in 24 states and two U.S. territories, BRFSS, 2005).[15] Sexual and intimate partner violence share common risk factors, but they also have unique risk and protective factors. Understanding the common risk factors can lead to prevention strategies that address both of these public health problems. Understanding the unique risk factors to both sexual and intimate partner violence, as well as risk factors unique to subtypes of each, can ensure that appropriate prevention strategies are developed. Finally, sexual violence prevention research is less well-developed than intimate partner violence prevention research. Less is known regarding how sexual violence perpetration develops and how to prevent that development. Thus, the research needs for sexual violence are greater than for intimate partner violence.

The Injury Center's Research Priorities in Preventing Sexual Violence and Intimate Partner Violence

Given the finite resources available for conducting research, the following priorities are listed in two tiers. The first tier contains those priorities that reflect the most immediate research needs and those that should be supported first as resources become available. Categorizing the priorities into two tiers does not imply, however, that the first tier of priorities is more important than the second tier or that research related to the second tier of priorities should wait until 2014 to begin.

Tier 1

A. **Develop and evaluate surveillance methods for sexual violence and intimate partner violence victimization and perpetration**. Improved surveillance methods are needed to better understand the prevalence of and trends in sexual and intimate partner violence at the state and national levels, to provide information on which to base development and evaluation of prevention and intervention programs, and to monitor and measure the effectiveness of prevention efforts. A substantial need exists to use uniform definitions and survey methods in measuring sexual and intimate partner violence victimization and perpetration temporal trends. Particularly with regard to perpetration, innovative methods are needed to improve the reporting when using survey methodology. In addition, new methods for conducting and improving surveillance should be explored, as well as the cost-efficiency of different ways of conducting such surveillance through cost-efficient means. Ultimately, establishing cost-efficient and timely surveillance systems for all states, by using consistent definitions and uniform survey methods, will assist states by providing their policymakers much-needed information for enhancing prevention efforts at the state level.

B. Examine the etiology of sexual violence and intimate partner violence perpetration to identify modifiable risk and protective factors and optimal times and strategies for prevention. Effective primary prevention of sexual and intimate partner violence should focus on preventing first-time perpetration. Although addressing the needs of victims is critical, such approaches fail to address the root causes of violence. Multiple individual, relationship, community, and societal factors and their cumulative and interactive effects are believed to contribute to the likelihood of perpetrating violence.[16] Research examining such factors and their interactions at all levels of the social ecology is key to understanding how perpetration of violence develops and to determining optimal times, settings, and strategies for preventing sexual and intimate partner violence. Priorities for etiologic research in sexual and intimate partner violence should focus on

- identifying modifiable risk factors at the outer levels of the social ecology (i.e., relationship, community, and societal levels) — In particular, increased understanding of community (e.g., chronic and acute environmental stressors) and societal-level factors (e.g., cultural norms conducive to violence and sexualization of women and children in advertising and other media) that contribute to violence can inform policymakers regarding prevention strategies that have the broadest impact.
- examining developmental trajectories for the perpetration of sexual and intimate partner violence — Such research will be essential in identifying optimal times and strategies for prevention efforts.
- identifying protective or buffering factors that can alter adverse developmental trajectories or moderate the impact of risk factors to prevent violence from occurring.
- identifying promotive factors for development of nonviolent and respectful environments and relationships (e.g., for intimate partner relationships, factors that promote shared decision-making, trust, belief in nonviolent conflict resolution, and effective communication skills) — This research has the potential to provide information needed for the development of health promotion approaches to ending sexual and intimate partner violence.

C. Clarify the contexts within which violence occurs and the associations among types and subtypes of sexual violence and intimate partner violence, other types of violence, other risk behaviors, and other health outcomes to determine implications for prevention of perpetration. Research has demonstrated that different types of violence are interrelated and frequently co-occur.[17,18] Certain factors associated with multiple types of violence and health risk behaviors have been identified (e.g., being socioeconomically disadvantaged). However, additional understanding of the shared modifiable risk and protective factors will be important in developing and implementing broad violence prevention strategies, and such understanding will have the potential to affect multiple violence and health promotion outcomes. Such general approaches have the potential to be a more efficient use of resources. In contrast, research on different types, subtypes, and contexts of sexual and intimate partner violence (e.g., research on batterer typologies, sexual violence perpetrated within

and outside of relationships, different types of sexual and intimate partner violence, or intrafamilial and extrafamilial child sexual abuse) indicates certain different and unique etiologic or contextual contributors that might require more tailored prevention approaches to be effective.[19,20] Disentangling these common and unique etiologic factors will be essential in identifying the most efficient and effective approaches for preventing violence and other adverse health outcomes.

D. **Examine the role of disparities in the occurrence and development of sexual violence and intimate partner violence and determine implications for prevention of perpetration.** Research provides evidence that different subgroups of the population are at greater risk for perpetrating or experiencing sexual or intimate partner violence.[21,22] One risk factor that has been consistently identified for both types of violence is socioeconomic disadvantage, which differentially affects certain minority groups. These disparities and inequities might be rooted in cultural as well as institutional practices and policies, yet the role of different cultural factors, norms, and policies, either as risk or protective factors for sexual and intimate partner violence, is inadequately understood. In addition, the majority of perpetrators of sexual violence tend to be male,[23] whereas women and children of both sexes are at greater risk for victimization. Similarly, women tend to be at greater risk for harm from intimate partner violence,[12] indicating the need for greater attention to sex- or gender-associated disparities. Such research can provide information for development or tailoring of prevention approaches to make them more relevant and effective. In addition, after effective approaches have been identified, research on disparities can assist dissemination and implementation efforts.

E. **Evaluate the efficacy and effectiveness of programs, strategies, and policies across all levels of the social ecology to prevent and interrupt development of perpetration of sexual violence and intimate partner violence.** Intervening in ways that prevent perpetration of violence, that alter developmental trajectories leading to initial perpetration of violence, and that promote an environment of nonviolence and respect is key to eliminating sexual and intimate partner violence. The number of efficacious or effective primary prevention strategies that have been identified for sexual or intimate partner violence is limited.[24] Because multiple individual, relationship, community, and societal factors and their interactions might influence the perpetration of violence, a critical need exists for research to evaluate prevention strategies at and across all levels of the social ecology. For example, research should examine the effects of changing organizational and public policies and societal norms, given the success of these approaches in addressing other health behaviors (e.g., smoking and human immunodeficiency virus risk behavior). Although a limited number of effective primary prevention strategies have been identified at any level of the social ecology, prevention strategies implemented at the community and societal levels might have a broader reach and result in greater reductions in sexual and intimate partner violence.

F. **Evaluate the efficacy and effectiveness of programs, strategies, and policies to prevent both sexual violence and intimate partner violence, multiple types of sexual violence and intimate partner violence, and other forms of violence.** Studies have indicated that sexual and intimate partner violence perpetration overlap and that they overlap with other forms of violence perpetration. That is, perpetrators of one type of violence often perpetrate other types of violence.[17,18] A single prevention strategy might be able to prevent more than one form of violence, resulting in a more efficient use of resources. For example, within the field of intimate partner violence, researchers have distinguished between physical violence that occurs with aspects of psychological abuse and control versus violence that occurs without those aspects.[20] These researchers have recommended that different prevention strategies are needed for the two forms of intimate partner violence. Physical intimate partner violence might require different types of strategies than sexual violence among partners. Similarly, different types of sexual violence perpetration (e.g., sexual harassment, date rape, or child sexual abuse) might require multiple prevention approaches. Although evidence indicates that sexual and intimate partner violence share certain common risk and protective factors, research is needed to determine if an approach targeting these shared factors will adequately reduce both types of violence as well as other types of violence and risk behaviors. Among all types of violence, for example, certain prevention strategies (e.g., interventions promoting overall social or emotional health) can address a range of violent behaviors that emerge during adolescence (e.g., dating violence, youth violence, or suicide).

Tier 2

G. **Assess the cost and health burden of sexual violence and intimate partner violence throughout the life span.** No national cost estimates for sexual violence victimization are available; therefore, a national study that estimates the full range of costs of sexual violence is needed. Further, estimates of the cost and health burden of intimate partner violence[4] have been limited by the quality of the methodology and approaches used to measure cost and health burden, and they have not included the full range of costs caused by intimate partner violence. For example, the 2003 Injury Center report, *Costs of Intimate Partner Violence Against Women in the United States,* included medical costs and costs resulting from lost productivity and earnings, but excluded other costs (e.g., social service costs to victims and perpetrators, costs from pain and suffering, and the healthcare costs of female victims who eventually died from intimate partner violence). Also, the 2003 report was limited to costs associated with victimization of women only, not men. Improved estimates of cost and burden are needed for intimate partner violence for both sexes.

Preliminary research might be needed to facilitate the accurate estimation of sexual and intimate partner violence costs. For instance, although research has demonstrated substantial short- and long-term physical and mental health consequences for female victims,[1–3] the methodology and approaches used to assess health burden have not controlled for confounding factors, which include among others, experiencing multiple forms of violence (e.g., intimate partner violence, youth violence, or suicide) nor sufficiently included male victims of intimate partner violence and sexual violence. Also, methods and tools might be needed that allow a fuller examination of the

various costs associated with victimization and perpetration, including costs to those close to the victim or perpetrator. As surveillance methods and research findings improve, better estimates of cost and health burden can be generated. A better understanding of the cost and health burden of sexual and intimate partner violence is essential for examining and comparing the cost-benefit and efficiency of prevention strategies.

H. Evaluate the economic efficiency of programs, strategies, and policies to prevent perpetration of sexual violence and intimate partner violence. A limited number of evidenced-based programs for preventing sexual and intimate partner violence have been identified. As research identifies additional programs that work, measuring the cost of those programs to understand their cost-effectiveness relative to one another is critical. Given that the resources for sexual and intimate partner violence prevention are limited, economic efficiency is crucial to ensuring that available resources are used wisely. Research also might be needed to understand the best ways to conduct cost and cost-effectiveness analyses of sexual and intimate partner violence programs, strategies, and policies. This might include, for example, understanding which violence outcomes can be adequately addressed by using the same approach and which might need separate programs or strategies. A single, more intensive program that affects multiple outcomes might be more economically efficient than a shorter one that affects only one outcome. Researchers should build on ongoing effectiveness research and test new methods for determining the economic efficiency of prevention measures as well.

I. Evaluate interventions for persons exposed to sexual violence and intimate partner violence to reduce risk for associated negative health consequences. Children, adolescents, or adults with previous exposure to sexual or intimate partner violence are at increased risk for multiple adverse health outcomes,[1] including later perpetration of violence and revictimization.[18] Interventions are needed for populations with previous exposure to sexual or intimate partner violence (e.g., children who have witnessed or experienced such violence) and populations with previous histories of perpetration. Interventions are needed that disrupt developmental pathways that might lead witnesses or victims to become perpetrators and that might lead to revictimization or reperpetration. One example of such an intervention that has received considerable attention is screening for partner violence in healthcare and social service settings. Such interventions should be evaluated to determine if they can prevent revictimization and the long-term health consequences of sexual and intimate partner violence. However, other types of interventions for persons already exposed to such violence are also needed (e.g., screening and intervening with adolescents at high risk).

Children, adolescents, or adults with previous exposure to sexual or intimate partner violence are at increased risk for multiple adverse health outcomes.

J. **Conduct dissemination and implementation research regarding programs, strategies, and policies used in the primary prevention of sexual violence and intimate partner violence.** Research that identifies the best audiences and methods for disseminating and implementing evidenced-based programs, strategies, and policies used in the primary prevention of sexual and intimate partner violence is substantially limited. Multiple types of dissemination and implementation research are needed to support adoption of evidence-based prevention approaches.[25] First, researchers should evaluate methods for synthesizing, translating, and packaging programs, strategies, and policies into products as training manuals or technology that can guide implementation. Second, what and how characteristics and capacities of persons, organizations, and communities influence implementation and dissemination of science-based programs, strategies, and policies for preventing sexual and intimate partner violence should be examined. Third, methods (i.e., technical assistance, coaching, monitoring, and funding) for building personal, organizational, and community capacities, readiness, and partnerships to support implementation of science-based programs, strategies, and policies in the field should be examined. Finally, economic evaluation related to product development, training, and capacity-building should be conducted to determine the most efficient methods for ensuring widespread adoption of science-based programs, strategies, and policies.

K. **Examine when and how to adapt effective programs, strategies, and policies to prevent sexual violence and intimate partner violence for new settings and among diverse populations.** Effective prevention programs, strategies, and policies are often modified when they are delivered in new settings. To what extent these modifications affect the effectiveness of prevention programs, strategies, and policies is largely unknown. Information is also needed regarding organizational and community barriers and facilitators to implementing programs, strategies, and policies with fidelity. Research is needed in multiple areas to address these gaps. First, the effects of implementing a program, strategy, or policy, as originally developed (i.e., fidelity to the approach) should be compared with the effects of changing the content or delivery format (i.e., adaptation). Research should also work to identify the core components of a program, strategy, or policy that are critical to leading to successful outcomes. This body of inquiry can illuminate key topics, exercises, or other facets of a program, strategy, policy, or practice that should not be changed or eliminated. Identifying core components can also enable practitioners to maintain effectiveness while setting the stage for efforts to adapt prevention strategies to meet the needs of diverse populations or settings. Also, research is needed to examine whether effective programs, strategies, and policies can be used effectively among different populations (e.g., racial/ethnic groups or younger versus older populations). This research should use data to define approaches for dealing with practical and logistic differences between original and evolving settings, because such differences might facilitate or impede implementation efforts. Finally, adaptation research needs to identify organizational and community barriers and facilitators to implementing programs, strategies, and policies with fidelity. This research might indicate that modification of a program, strategy, or policy is unnecessary, compared with building organizational and community capacities and readiness to implement them with fidelity.

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Suicidal Behavior

Public Health Burden

Self-directed violence encompasses a range of behaviors, including acts of fatal and nonfatal suicidal behavior, suicidal ideation (i.e., thinking about, considering, or planning for suicide), and nonsuicidal intentional self-harm (i.e., behaviors with the intention not to kill oneself, as in self-mutilation). Although injury from self-directed violence is a major public health problem throughout the United States and the rest of the world, fatal and nonfatal suicidal behaviors have the most pronounced morbidity and mortality and thus will be the focus of this chapter.[1–3]

In 2005 in the United States, suicide was the 11th leading cause of death overall, resulting in 32,637 deaths[4]; it was the third leading cause of death among persons aged 15–24 years, fourth among persons aged 25–44 years, and eighth among those aged 45–64 years.[5] Although suicide continues to be problematic throughout the lifespan, overall rates of death resulting from suicide are highest among groups aged ≥80 years, followed by those aged 45–49 years.[4] The number of completed suicides reflects only a limited portion of the impact of suicidal behavior. Substantially more persons are hospitalized as a result of nonfatal suicidal behavior than are fatally injured, and an even greater number are treated in ambulatory settings or are not treated at all for injuries resulting from suicidal acts than those who are hospitalized.[5]

Comparative descriptions of suicidal ideation and behavior demonstrate certain key differences among population groups. For example, rates of suicide are higher among males than among females, but studies of suicidal thoughts and nonfatal suicidal behavior routinely indicate females have higher rates than males.[6] Suicide rates are exceptionally high among certain population groups, including white males aged >75 years, American Indians/Alaska Natives, and certain professions (e.g., health professions and police).[1] National data also demonstrate a high prevalence of nonfatal suicidal behavior among adults. For example, in 2006, a total of 395,276 persons with nonfatal self-harm injuries were treated in U.S. hospital emergency departments.[4] Other research indicates that >70% of persons who engage in suicidal behavior never seek health services.[7] Consequently, prevalence figures based on health records substantially underestimate the societal burden of suicidal behavior.

Total lifetime costs associated with nonfatal injuries and deaths caused by suicidal behavior in 2000 were approximately $33 billion, including $1 billion for medical treatment and $32 billion for lost productivity.[8] Compounding these costs is the incalculable impact of loss of life and the emotional trauma experienced by surviving family, friends, and communities that are affected by each person's fatal or nonfatal suicidal behavior.[9]

Suicide is less likely to occur within communities, schools, and families with strong social cohesion.

The Injury Center's Approach to Preventing Suicidal Behavior

Injuries and deaths resulting from suicidal behaviors represent a substantial drain on the economic, social, and health resources of the nation. CDC's Injury Center seeks to lessen these burdens by developing and promoting the widespread adoption of policies and practices that effectively prevent fatal and nonfatal suicidal behaviors. In pursuit of that goal, the Injury Center's public health approach complements such approaches as those of the criminal justice and mental health systems. Thus, the Injury Center is uniquely positioned to address the need for effective, population-based prevention and intervention strategies. However, public perceptions that suicide is solely the purview of mental health practice and a lack of scientific knowledge regarding effective population-based strategies hinder efforts to prevent suicide.[1,10]

To address these challenges, the Injury Center draws on historical strengths and continues to expand into areas where identified needs are substantial. One area of promise includes promotion of social connectedness as a global strategy for preventing suicidal behavior. Social connectedness can be defined as quality social ties and supportive relationships between individual persons and their peers, families, and communities; the connections between persons and their families to community organizations; and the connections among community organizations and social institutions. Typically, suicide is less likely to occur within communities, schools, and families with strong social cohesion or among persons who have strong interpersonal connections. Increasing social connectedness is likely to have universal as well as targeted impact on suicidal behavior. By supporting healthy interpersonal relationships (e.g., family, peer, and intimate partner relationships) and by encouraging communities to care about and care for their members, the population at large is likely to experience more positive health and well-being, resulting in lower risk for suicidal behavior.

The Injury Center works with multiple partners at the local, state, and national levels to disseminate scientific information about suicide prevention. These efforts are directed toward the public, policymakers, health departments, faith- and community-based organizations, and other entities. By promoting research that addresses the information needs of constituents, the Injury Center contributes substantially to encouraging widespread adoption of effective suicide prevention strategies.

Communities have often implemented programs that attempt to reduce injuries and deaths resulting from suicidal behavior; however, knowledge is limited regarding the effectiveness of these programs. Finding successful strategies, especially those that focus on developing positive skills and social relationships, might also have a broad impact on violent behaviors. Given the Injury Center's ongoing activities in child maltreatment, youth violence, and intimate partner violence prevention, it is in a unique position to support development and evaluation of programs, within an integrated framework, that address suicide and interpersonal violence prevention throughout the lifespan. In addition, although domestic and international research has identified critical risk and protective factors related to suicidal behavior, key gaps remain in our understanding of community- and societal-level factors that influence rates of suicidal behavior and the mechanisms through which these factors exert an influence.[11] Developing a better understanding of the dynamics of suicidal behavior is essential for building effective prevention strategies, programs, and policies.

Other federal agencies and national organizations focus considerable research efforts on understanding the causes of suicidal behavior and its prevention. The Injury Center collaborates regularly with these groups as evidenced by the release of the U.S. Surgeon General's *National Strategy To Prevent Suicide.*[6] The Injury Center's contributions to suicide prevention highlight public health and broad-based strategies that complement important mental health research and treatment efforts conducted by such key federal partners in the U.S. Department of Health and Human Services as the Office of the Surgeon General, the Public Health Service, the National Institute of Mental Health (within the National Institutes of Health), the Substance Abuse and Mental Health Services Administration, the Indian Health Service, and the Administration on Aging.

The Injury Center's Research Priorities in Preventing Suicidal Behavior

Given the finite resources available for conducting research, the following priorities are listed in two tiers. The first tier contains those priorities that reflect the most immediate research needs and those that should be supported first as resources become available. Categorizing the priorities into two tiers does not imply, however, that the first tier of priorities is more important than the second tier or that research related to the second tier of priorities should wait until 2014 to begin.

Tier 1

A. **Develop better methods for operationalization, measurement, and monitoring of fatal and nonfatal suicidal behavior, including the social and economic burdens of suicidal behavior.** Having accurate, timely, and accessible information regarding self-directed violence (e.g., suicides, nonfatal suicidal behavior, and nonsuicidal intentional self-injury) is crucial, both for monitoring the problem and for evaluating the impact of prevention efforts.[1] However, the Division of Violence Prevention's primary focus is on suicidal behavior. Because the number of suicides reflects only a limited portion of suicidal behavior (i.e., substantially more persons are hospitalized as a result of nonfatal suicidal behavior than are fatally injured),[5] collected information should include data related to suicidal behaviors that result in death, hospitalization, or outpatient medical treatment, as well as those where no medical care is sought. Although national data exist that describe fatal and nonfatal suicidal behavior, this information is either limited in its collection of potentially modifiable variables or does not contain state or locally representative data. Research is needed to enhance the quality of nonfatal suicidal behavior data collected from hospital emergency departments and from population-based surveys. To create and implement enhanced surveillance strategies, researchers should (1) refine and validate definitions of suicidal and related behaviors; (2) collect more specific data regarding methods and circumstances surrounding suicide; (3) develop better methods for implementing high-quality, timely data collection systems, including data systems outside of health and medical communities; and (4) evaluate the utility, quality, and efficiency of the data and collection procedures.

In addition to routine monitoring and surveillance, quantifying the social and economic burden of suicidal behavior is needed. Fatal and nonfatal suicidal behaviors result in considerable medical, economic, and social costs, including lost wages, pain, and reduced quality of life for victims, and trauma for family members and friends. Information about these costs will be useful in educating the public regarding the need for suicide prevention efforts and for helping decision makers assess the economic efficiency of suicide prevention programs.

B. Evaluate strategies to build professional, organizational, and community capacity for practicing effective suicide prevention. Research has demonstrated that simply providing information about prevention programs typically is not enough to change prevention practice.[12] Organizational and community capacity is critical for implementing effective suicide prevention and health promotion strategies. Consequently, efforts to build individual and organizational capacities for using effective strategies to prevent suicide should be explored further. For example, the type and quality of technical assistance (e.g., training, coaching, or monitoring) necessary to support effective implementation is inadequately understood.[13] Research is needed to determine the most effective ways to build, strengthen, and sustain capacity for implementing suicide prevention. Studies that examine state and community suicide prevention plans, explore agency cooperation and coordination across systems, identify key infrastructure requirements, and identify barriers to implementation of suicide prevention strategies can be used to develop approaches for overcoming these barriers. Research that clarifies the adequate content, intensity, and frequency of training and refresher sessions needed to implement suicide prevention programs will provide information on which to base efforts in supporting sustainability of approaches.

Studies should also examine how different components of a community collectively become ready and motivated for implementing a comprehensive suicide prevention program and which characteristics, skills, and capacities are needed to implement a suicide prevention program effectively. The results from this line of research can support efforts to build capacity for adoption of successful suicide prevention strategies.

C. Evaluate the efficacy and effectiveness of programs and policies to prevent suicidal behavior. One of the greatest challenges in suicide prevention practice is identifying strategies and programs that prevent and interrupt development of fatal and nonfatal suicidal behavior. Existing suicide prevention activities include school-based gatekeeper training programs, strategies to increase primary care providers' awareness of suicide and to promote patient screening for suicidal thoughts, and multicomponent programs and policies delivered in highly structured communities. However, evaluations of these activities for their effects on suicidal behavior are limited. Moreover, other possible approaches, including strategies for enhancing such potential protective factors as social connectedness,[14,15] community-level efforts to reduce social isolation and stigma associated with seeking help for personal crises, and programs and policies designed to reach groups at high risk (e.g., males aged 45–49 years), are in need of development and evaluation.

D. **Examine the influence of community- and societal-level factors on rates of suicidal behavior.** Previous research indicates that multiple social factors can substantially affect rates of fatal and nonfatal suicidal behavior.[2] These include such societal- and community-level factors as social connectedness; the structure of social relationships (e.g., the percentage of persons in the community who are involved in religious activities); changes in the economy; community norms, values, and attitudes; the availability of resources for persons who are struggling with day-to-day difficulties; and severe community and environmental stressors (e.g., natural and human disasters).[16] The evidence also demonstrates that these influences can vary in their presence and impact across population groups.[17,18] Researchers do not fully understand the mechanisms through which these broad, community-level factors affect rates of suicidal behavior, which hinders their ability to design effective prevention strategies.[19] Researchers, practitioners, and public health agencies need multidisciplinary information that addresses the interaction of factors to design and test more community- and society-level approaches that can effectively reduce suicide-related injuries and deaths among particular communities.

E. **Clarify the contribution of individual-level risk and protective factors other than those related to mental health on suicidal behavior, emphasizing the identification and role of protective factors.** Although mental health problems can contribute substantially to a person's suicidal behavior, mental disorder alone does not cause suicide.[20] Additional factors can increase the risk for suicidal behavior, including stressful life events (e.g., the death of a relative or losing a job), ongoing difficulties (e.g., child maltreatment, bullying, intimate partner violence, or physical illness or disability), or social isolation characterized by living alone and having limited or no social supports.[21,22] However, researchers still lack insight into the relative contribution of these problems on suicide risk. Studies have indicated that persons exposed to multiple suicide-related risk factors are able to avoid engaging in suicidal behavior because of the presence of protective factors.[23] Research perspectives, however, often miss opportunities to assess these protective factors for future use in suicide prevention.[24] As a result, knowledge is limited regarding how to recognize and bolster such potentially protective effects as social connectedness. Research in this area can contribute substantially to development of effective prevention strategies by providing a more dynamic and socially informed understanding of suicidal behavior.

F. **Evaluate whether evidence-based programs for other forms of violence can also prevent suicidal behavior.** Surveillance and epidemiologic data provide evidence that substantial overlap exists in suicidal behavior and interpersonal violence. Victims of interpersonal violence (e.g., child maltreatment or intimate partner violence) have a higher risk for suicide than nonvictims.[25,26] In addition, both previous and continuing perpetrators of interpersonal violence are at increased risk for suicidal ideation and behaviors.[27,28] From these and other studies, evidence also continues to accumulate that suicidal behavior and interpersonal violence share certain complex risk and protective factors.

Given the overlap between suicide and interpersonal violence, strategies to prevent shared risk factors for both or later suicidal behavior (e.g., violent victimization as a child, youth, or adult) indicate strong potential for preventing suicidal behaviors. Strategies to prevent violent behaviors with risk and protective factor profiles similar to suicide (e.g., perpetration of youth interpersonal violence or intimate partner violence) also demonstrate potential for preventing suicidal behaviors.[29] However, only a limited number of evaluations of effective interpersonal violence prevention strategies have examined the direct impact on suicidal behaviors. By examining evidence-based interpersonal violence prevention programs that target common risk or protective factors for suicidal behavior, researchers can build on existing programs to minimize costs, eliminate redundant or competing infrastructures, and create more comprehensive and effective programs.

G. **Evaluate the impact and feasibility of restricting access to lethal means used in suicidal behavior.** Research indicates that the means used in suicidal behavior (e.g., jumping from a bridge or using a firearm versus taking pills) has a substantial impact on whether the act results in severe injury or death.[30] Evidence exists that rates of suicide-related death and injury can be reduced by restricting access to specific means. Examples include installing bridge barriers,[31] detoxifying gases,[32] pesticide regulation,[33] and blister packaging for certain medications.[34] Strategies related to means restriction, however, have rarely been rigorously evaluated in terms of their impact and feasibility for broader implementation. In addition, the majority of the previous evaluations of means-restriction strategies have been conducted internationally; therefore, studies in the United States are needed. Also, knowledge is limited regarding the effects of means restriction on different age groups, especially youth, and how means substitution (i.e., switching from one suicide method to another) will limit the effectiveness of means-restriction strategies.

   Furthermore, if researchers demonstrate that means-restriction policies effectively reduce suicide mortality and serious injury, additional investigation will be necessary to identify how to increase the widespread implementation and enforcement of these policies. Finally, focusing research and prevention efforts on the methods that are most lethal or to which access is most easily modified should accelerate effects.

Tier 2

H. **Evaluate the factors that affect implementation in practice settings of effective strategies for preventing suicide.** For suicide prevention strategies to be useful, they must be implemented within practice settings. Implementation occurs at the organization, community, state, or national levels with varying degrees of success, influenced by such factors as knowledge, motivation, and ability necessary to implement a specific suicide prevention strategy. Therefore, understanding how personal, organization, and community characteristics influence implementation and sustainability of evidence-based strategies to prevent suicide is critical. Research is also needed to understand how partnerships at the national, state, and community levels can facilitate adoption, implementation, and sustainability of evidence-based strategies.

In addition, research is needed to prepare for adopting and adapting prevention strategies in alternative settings. For example, suicide prevention strategies designed for certain institutional settings (e.g., military, schools, inpatient mental health wards, or elder-care facilities) need to be evaluated for applicability to less structured settings (e.g., after-school programs, universities, workplaces, or community centers) before broader implementation. The tension between fidelity of implementation and adaptation to improve the fit of a strategy to a new setting is a common dilemma. Although adaptation frequently occurs in practice, knowledge is limited regarding the kinds of modifications (e.g., number of sessions, components, or content changes) that are likely to influence effectiveness.[35] Research clarifying the difference between what types of adaptations should never be attempted, what types should be attempted with caution, and what types are harmless to program implementation can provide valuable information for planning adaptations. By supporting research in this area, the Injury Center will contribute to the larger effort to plan for and implement effective suicide prevention activities at the local, state, and national levels.

I. **Examine how characteristics of specific institutional or occupational settings affect risk for suicidal behavior and evaluate the effectiveness of prevention strategies, programs, and policies designed to reduce risk in these settings.** Knowledge is lacking regarding how the physical and social characteristics of specific institutional or occupational settings (e.g., schools, correctional facilities, military installations, or long-term healthcare establishments) interact with other factors (e.g., personal, relationship, or community) to heighten or lessen the risk for suicidal behavior.[36,37] More research is needed to understand how suicidal persons can be recognized within specific social and institutional settings. Researchers should also examine the organization or institutional factors that promote social cohesiveness and connectedness, as well as those factors that facilitate effective interventions when suicidal persons are identified. Such factors include bonding among students and staff at school and membership in organized activities, physical features of the built environment that allow staff to monitor students or clients effectively, and students' or clients' abilities to access means for engaging in suicidal behavior.

J. **Examine the development, progression, and long-term consequences and other health outcomes of suicidal behavior.** To decrease the population-level risk for suicidal behavior, research should focus on gaining a better understanding of the developmental pathways that lead to suicide; that is, research should investigate how suicidal behaviors and thoughts develop, what factors increase or decrease the likelihood that persons or groups will exhibit later suicidal behavior, and what factors protect against suicidal behaviors and thoughts. This understanding is critical for identifying developmentally optimal prevention strategies and settings.

Research is also needed to improve understanding of the progression and consequences of suicidal behavior. Researchers typically conceptualize the range of suicidality as a continuum extending from suicidal ideas and thoughts that are not acted upon to nonfatal suicidal acts to completed suicide.[38] Only a limited number of those who engage in suicidal ideation engage in self-harm, and even fewer die from these behaviors. Improved knowledge regarding how ideation moves into action — both for the first time and during the course of repeated acts — will help researchers develop strategies that can counter the process more effectively. Relatedly, among those who have a history of nonfatal suicidal behavior, an increased risk for subsequent suicide exists, yet research is lacking regarding the long-term outcomes of nonfatal suicidal behavior, especially nonsuicide-related outcomes (e.g., delinquency, criminal behavior, or chronic somatic health problems[39]). Research should examine whether persons who have engaged in nonfatal suicidal behavior have an increased risk for other adverse health outcomes as well as the key personal, family, and community protective factors for those who do not die by suicide.

K. Evaluate the influence of news and entertainment media on suicidal behavior. Prevention specialists believe that greater public understanding of suicidal behavior enhances prevention efforts. However, media messages intended to increase awareness and understanding of suicidal behavior should be founded in science so that the risk for suicide is not increased inadvertently. Previous domestic and international research has documented that characteristics of news media reporting of suicide can substantially affect the likelihood of suicide contagion, particularly among adolescents; however, the effect of fictional portrayals on vulnerable persons remains unclear.[40] Further research is also needed to understand the effects technologic innovations in media (e.g., the Internet, e-mail, text-messaging, or social-networking sites) and entertainment have on suicidal behavior.

Guidelines have been developed for the media regarding ethical reporting of suicides so that risk for suicide is not increased[40–42]; however, additional research related to creating effective public health messages that complement other suicide prevention strategies is needed. For example, studies should examine the successful media components of other suicide prevention programs (e.g., the U.S. Air Force, which demonstrated substantial reduction in suicide through a broad-scale campaign) as well as successful media campaigns targeted at other health outcomes.[40,41,43] Using different media might also provide an avenue for prevention efforts among traditionally hard-to-reach populations at risk (e.g., rural communities or socially isolated persons).

L. Examine effective approaches to synthesizing, translating, and packaging evidence-based strategies for preventing suicide. Research has identified individual-, family-, and school-level strategies to reduce risk factors for suicidal behaviors; however, these empirically supported prevention strategies are not widely used in practice settings. Consequently, a gap exists between research and practice in preventing suicidal behavior in real-world settings.[44] To address this gap and to increase dissemination and uptake of evidence-based strategies in practice settings, research should examine optimal ways to synthesize, translate, and package effective suicide prevention and social connectedness strategies for use by practitioners. For example, survivor groups are strong advocates for suicide prevention, yet evidence in support of science-based strategies is rarely translated into practical language or communicated in ways survivor groups can embrace. Research is needed to understand which formats (e.g., paper, electronic, or direct contact) most effectively communicate scientific knowledge for integration into suicide prevention programs. Greater understanding of the variation and content of different formats as well as which elements are most critical in changing practice behavior will benefit this area of practice substantially. By addressing the research-to-practice gap, the Injury Center can increase the likelihood of dissemination of effective practices and programs.

M. Examine how effective programs and policies can be developed or modified for use among diverse and culturally distinct populations. Accumulated evidence indicates that rates of suicidal behaviors and suicide risk profiles can vary substantially among distinct social and cultural groups. The factors commonly used to define disproportionately affected populations (e.g., race/ethnicity, sex, age, sexual orientation, and geographic region) typically are not modifiable factors that programs and policies can address easily. Therefore, prevention strategies should focus not only on intervening with a specific population but on the conditions and behaviors that help explain why documented disparities exist among different groups. For example, research can determine if a particular disparity can be explained by such modifiable factors as social connectedness, impulsivity, or access to lethal means. Programs and policies can then be developed or adapted to address the underlying explanatory factors for a specific population.

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Youth Violence

Public Health Burden

Youth violence, perpetrated both by and against young persons, results in considerable physical, emotional, social, and economic consequences. Although rates of youth homicide have declined substantially during recent years, much work remains in reducing this public health burden. Homicide is the second leading cause of death among youth aged 10–24 years.[1] Among this age group in 2005, homicide was the leading cause of death for non-Hispanic blacks; the second leading cause of death for Hispanics and non-Hispanic Asian/Pacific Islanders; the third leading cause of death for non-Hispanic American Indians/Alaskan Natives; and the fourth leading cause of death for non-Hispanic whites.[1] Moreover, this represents approximately one-third of all homicide victims that year. Guns are a factor in the majority of youth homicides — In 2005, a total of 81.6% of homicide victims aged 10–24 years were killed with a firearm.[1]

Violence is also a critical cause of nonfatal injuries among youth. In 2006, a total of 720,371 youths aged 10–24 years were treated in emergency departments for nonfatal injuries sustained from assaults.[1] Although nonfatal acts of violence are relatively common on school property, the majority of acts of serious and fatal violence occur outside of school. For example, <1% of all violent deaths among school-age children occur in school, on the way to or from school, or at school-sponsored events.[2]

Apart from deaths and injuries, youth who are victims of violence or who witness violence in their communities suffer other serious consequences, including posttraumatic stress disorder, depression, anxiety, and substance abuse.[3] They might also experience longer term health problems associated with the effects of such exposure.[4] Communities with high rates of youth violence suffer as well through its negative effects on safe mobility, the nature and quality of social relations, business activity, and housing prices.[4,5] Overall, the direct and indirect costs of youth violence (e.g., medical, lost productivity, and quality of life) exceed $158 billion a year.[6] These data highlight the need for prevention programs and policies that address risk and protective factors for youth violence, including policies and programs aimed at promoting prosocial behavior, strengthening families, and creating communities in which youth are safe from violence.

The Injury Center's Approach to Youth Violence Prevention

For years, the predominant approach to youth violence was reactive; disproportionate attention and resources were given to the medical treatment of injured victims and the apprehension and incarceration of violent offenders. A public health approach to solving the problem of violence includes an emphasis on and a commitment to identifying policies and programs for preventing youth violence. Such an approach derives from a tradition of collaboration among multiple scientific disciplines, organizations, and communities. Multiple factors, including the availability of effective prevention strategies, social determinants, disparities, parenting practices, and school and neighborhood safety all affect trends in violence. Because public health encompasses different disciplines and perspectives, its approach is well-suited for examining and addressing such multifaceted problems as violence. The public health approach also highlights the potential utility of applying different scientific tools (e.g., epidemiology, behavioral and social sciences, and engineering) explicitly toward identifying effective prevention strategies. When these key tools are applied, the perspective and methods of public health complement those of criminal justice and other sectors in understanding and responding to youth violence.

In pursuit of its mission to prevent violence-related injuries and deaths, CDC's Injury Center places a special emphasis on primary prevention — that is, preventing youth violence before it occurs. The Injury Center also is dedicated to understanding the links between youth violence and other types of violence (e.g., intimate partner violence, sexual violence, child maltreatment, and suicidal behavior), as well as links between youth violence and other health problems.

The Injury Center's violence prevention research is intended to have practical implications and immediate relevance for prevention. For example, studies regarding risk and protective factors are conducted to guide prevention programs and policies. The Injury Center's evaluation studies focus on determining not only how well programs work but also on identifying the processes through which they have an impact. This information is critical in helping schools and communities identify and use the best existing evidence to prevent violence.

Other federal agencies, including the U.S. Departments of Education and Justice and the U.S. Department of Health and Human Services' National Institutes of Health study the causes and consequences of youth violence and work to prevent it. The Injury Center routinely collaborates with these agencies and with nongovernmental organizations to study youth violence and to ensure that research findings are applied to practice. For example, recent partnerships with the Departments of Education and Justice have facilitated studies regarding school-associated violent deaths and nonfatal injuries from such violent crimes as assault, robbery, and rape. The Injury Center's research regarding violence across contexts (e.g., school, family, and community), roles (i.e., victim or perpetrator), and proximal causes (e.g., intoxication, bullying, or robbery), combined with CDC's emphasis on primary prevention strategies, complements and extends the violence-prevention activities of other federal agencies and community-based organizations.

The Injury Center's Research Priorities for Youth Violence Prevention

Given the finite resources available for conducting research, the following priorities are listed in two tiers. The first tier contains those priorities that reflect the most immediate research needs and those that should be supported first as resources become available. Categorizing the priorities into two tiers does not imply, however, that the first tier of priorities is more important than the second tier or that research related to the second tier of priorities should wait until 2014 to begin.

Tier 1

A. **Evaluate dissemination and implementation strategies for effective youth violence prevention programs and policies.** Research has identified multiple individual-, family-, and school-based approaches that effectively reduce youth violence and aggression, some of which have also demonstrated effectiveness with diverse populations in different settings. However, these empirically supported prevention approaches are not widely used in practice settings; thus, a gap exists between research and action to prevent youth violence in real-world settings.[7–9] To bridge this gap, at least three research areas require attention. First, to increase the adoption of evidence-based strategies in practice settings, research should examine optimal ways to synthesize, translate, and package effective prevention approaches.[10,11] Second, efforts to build individual,[12] organizational,[13] and community capacities[14,15] to use effective approaches should be examined further. For example, the type and quality of technical assistance (e.g., training, coaching, or monitoring) necessary to support effective implementation is inadequately understood.[16] Third, understanding how individual, organizational, and community characteristics influence the adoption and effective use of empirically supported youth violence prevention approaches is critical.[17–19]

B. **Evaluate strategies for adapting effective prevention programs, policies, and practices.** Effective prevention programs, policies, and practices are often modified when they are delivered in new settings. However, certain areas require further attention. First, after an effective prevention approach is adopted, the effects of implementing the program, policy, or practice as originally developed (i.e., fidelity to the approach) should be compared with the effects of changing the content or delivery format (i.e., adapting). Second, limited empirical evidence exists to guide decisions regarding what can be modified without reducing effectiveness and what must be delivered exactly as originally developed to be effective. To this end, research should examine the core components that are critical to a prevention strategy's effectiveness. This body of inquiry can illuminate the key topics, exercises, or other facets of a prevention strategy that should not be changed or eliminated. Identifying core components can also enable practitioners to maintain effectiveness while setting the stage for efforts to adapt prevention strategies to meet the needs of diverse populations or settings.

A related need is research that establishes the effectiveness of original programs and the suitability of their theories and methods when implemented within a different population group. This research should use data for approaches to deal with practical and logistic differences between original and evolving settings, because such differences might facilitate or impede implementation efforts. Lastly, process and effectiveness research are needed to assess the extent to which adaptations of effective programs have achieved desired reductions, to define strong points for preservation, and to recommend limitations to be subsequently addressed and improved.

C. **Evaluate the effectiveness of community- and societal-level strategies, programs, and policies to prevent youth violence.** Youth violence is the result of a complex interaction between person and context. Previous research indicates that violence is high within chronically impoverished environments — ones that are characterized by concentrated poverty and high levels of residential instability and family disruption, in neighborhoods where trust and the social connections that bind persons together are lacking, and where economic, educational, and recreational opportunities are diminished.[20–23] However, the evidence base for modifying or eliminating these factors — the majority of which are related to racial/ethnic and socioeconomic disparities that exist in rates of youth violence — is not well-developed.

Certain potential strategies at the community and societal level need rigorous evaluation, including strategies to

- increase social integration and community cohesion;
- change social norms;
- improve the physical and social characteristics of neighborhoods through environmental design changes;
- improve financial, housing, and employment opportunities in impoverished areas;
- support optimal parenting practices and increase the care and formal and informal supervision of youth (e.g., increasing the availability of, access to, and quality of child care, preschool enrichment programs, and after-school programs); and
- reduce community density and availability of alcohol and drugs.

Research is also needed in examining the effects of broad policy shifts (e.g., reforms in public assistance and housing), the effects of policies directed specifically at youths (e.g., school policies and curfews), and the effects of policies aimed at scaling up effective individual-, relationship-, or family-level interventions to achieve population impact. This work has key implications for policies designed to reduce injury and adverse health outcomes other than youth violence. It is also an area of research that is not being addressed by other funding agencies but that is directly relevant to CDC's focus on community and population-based health.

D. **Examine the economic efficiency of strategies, programs, and policies designed to prevent youth violence.** Prevention science should be accountable and responsive to public health problems; therefore, evaluating not only the effectiveness of strategies, programs, and policies, but also the cost to the public to implement these prevention measures on a broad scale is needed. Given that resources for youth violence prevention are limited, economic efficiency is crucial for ensuring that available resources are used wisely. For example, information regarding the costs, required resources, and relative contribution of individual components can be used to improve program efficiency, particularly with prevention efforts that include more than one strategy (e.g., a school-based curriculum combined with a parenting program). Researchers should build on ongoing effectiveness research and test new methods for determining the economic efficiency of prevention measures as well.

E. **Identify modifiable factors that protect youth from becoming victims or perpetrators of violence**. The attention given to identifying modifiable factors that protect against risk factors for youth violence has risen substantially in the past decade.[24] In response to calls to define such protective factors, influences that might exhibit protective effects relative to risks, contexts, and ecological levels have been proposed and examined by using varying procedures. Although these efforts have identified selected variables with demonstrable protective effects, critical questions remain. For example, etiologic research should continue to focus on identifying protective factors while extending this work to

- test factors that buffer against risk factors (e.g., moderators) from those that have a direct inverse association with behavior (e.g., promotive effects) and from those that have both buffering and promotive effects[25];
- investigate the specificity and potency of protective effects in relation to varying risk factors and particular violence-related outcomes;
- determine whether protective and promotive effects are replicable across studies involving diverse populations and study designs;
- clarify the mechanisms and processes through which protective and promotive effects are exerted; and
- examine the duration of protective and promotive effects across different developmental periods.

Research should also be expanded to investigate the existence of societal- and community-level protective factors and modifiable factors that protect against risks at multiple ecological levels.[26]

Improved understanding of protective factors has immediate implications for ongoing youth violence prevention efforts among families, schools, and communities. For example, as information becomes available regarding how parents in low-income communities can protect their children from violence, that information can be communicated immediately through existing parenting programs and public service announcements. Research about modifiable protective factors has important, immediate implications for prevention.

F. Identify the processes by which modifiable sociocultural and community factors influence youth violence. Although research has established that youth violence is influenced by sociocultural and community factors, the processes, pathways, and mechanisms through which this influence is exerted have not been well-defined or clearly described empirically. For example, the strong negative association between socioeconomic indicators and youth violence is well-documented; however, knowledge is limited regarding the mechanisms linking low socioeconomic status to youth violence.[27–29] Greater attention should be given to demonstrating how such social and economic forces might cause or increase the likelihood of youth violence. Understanding these underlying mechanisms will be critical in improving existing community programs and developing new programs for low-income communities. Additionally, studying processes and pathways of influence can yield information regarding intervention points that can be effectively targeted to disrupt those processes or pathways that promote youth violence. Similarly, such information can assist efforts to produce social and economic differences in the youth violence public health burden.

Although socioeconomic indicators are the most commonly studied sociocultural and community factors, other factors should also be examined. In particular, research should delineate the pathways through and conditions under which youth violence is shaped by illicit drug markets, the nature and quality of public housing, formal and informal social networks, social norms defining communities and other social spaces, and community status regarding social capital. Such research can reveal how these factors act and interact with other key variables to elicit violent behaviors among youth. Lastly, youth violence occurs within and is shaped by physical as well as social contexts. Although this fact is commonly accepted, work to specify ways that physical and social structures combine to create or deny opportunities is still developing. Future research should thus continue to examine interactions between physical and social environments and assess how modifications in the physical environment influence behavior and risk for violence.

G. Clarify the associations among youth violence, other forms of violence, and other risk behaviors, and determine implications for prevention. Research has consistently demonstrated that different forms of violence — that is, child maltreatment, intimate partner violence, sexual violence, youth interpersonal violence, and suicide — are interrelated. For example, youth who engage in violence with same-sex peers are at increased risk for engaging in dating violence, and both forms of violence are associated with suicidal behavior.[30] In addition, youth who are most at risk for engaging in violence are also at higher risk for involvement in other health risk behaviors, including substance abuse, dangerous driving, and high-risk sexual behavior.[31] The majority of prevention strategies focus on specific forms of violence or other health risk outcomes. Because school-based violence prevention specialists often seek programs with fewer topic-specific curriculum modules and more integrated approaches to improving health outcomes, prevention strategies that are effective in multiple areas will be of substantial value.

Research regarding the associations among different forms of violence and other health risk behaviors can guide development and evaluation of prevention programs that reduce multiple forms of negative health outcomes. Efforts to include multiple forms of violence in studies of risk and protective factors for negative health outcomes or evaluation studies are needed to improve researchers' understanding of the specificity of youth violence prevention strategies and the ability to generalize their results. Given the limited funding available to prevent youth violence, strategies should address multiple forms of violence whenever feasible.

Tier 2

H. Evaluate the effectiveness of strategies, programs, and policies designed to enhance protective and promotive factors that reduce youth violence. As research continues to identify factors that protect youth from becoming victims or perpetrators of violence (see Priority E), the question becomes how best to modify these factors so that youths can experience the benefits. Research should assist in developing and evaluating the strategies, programs, and policies that enhance factors that buffer against risks (e.g., moderators) as well as those that have a direct inverse association with violent behavior (e.g., promotive effects). Protective factors can exist at the individual, family, school, and community levels, and prevention strategies, programs, and policies might target factors from any level.[24] Research in this area might include universal efforts to enhance protective and promotive factors within entire populations or efforts directed at the groups who are most at risk for violence. Research should examine the extent to which prevention strategies, programs, and policies contribute to greater levels of the protective and promotive factors of interest, the sustainability of these factors, and the impact the prevention strategies, programs, and policies have on youth violence victimization and perpetration.

I. Identify and evaluate strategies to decrease inappropriate access to and use of firearms among youth. Firearms are used in the majority of youth homicides.[1] In addition, approximately 1 in 10 male high school students reported having carried a gun at least once during the previous 30 days.[32] Although the prevalence and correlates of inappropriate gun carrying among youths and the consequences of gun use are well-known, less is known regarding the factors associated with youths' access to and use of firearms to threaten or injure others. Research related to youths' access to firearms and gun carrying is needed to improve existing strategies, develop novel strategies, and evaluate whether strategies actually prevent inappropriate gun carrying and use and reduce firearm-related injuries.

J. Assess the economic and social burden of youth violence. Evaluations of the economic and social burdens of violence typically focus on violence as a broad class of behaviors affecting persons of all ages. Although isolated studies have described the effects of specific forms of violence (e.g., child and elder abuse) on relevant age groups, the magnitude of the social and economic burden of youth violence has not been documented systematically. Data regarding the social and economic burden of youth violence are needed to achieve a comprehensive understanding of the full nature of this public health problem.[33] Acquiring these data is essential to advancing comprehensive attempts to address youth violence because the data can enable assessment and appreciation of the full impact of youth violence on the well-being of individual persons and their communities. These data can also aid in determining activities with the greatest potential to moderate the adverse effects of youth violence.

Burden measures are typically used to describe the costs of violence. Consequently, the most common measures include direct costs (e.g., medical expenses) and indirect costs (e.g., lost productivity). Although collecting such cost information in relation to youth violence is key, obtaining data regarding functional and social effects and quality of life is also crucial. Initial work in evaluating effects in these dimensions should focus on developing, using, and critiquing burden measures that are specific enough to capture the diverse experiences or exposures encountered by the perpetrators and victims of youth violence, yet broad enough to allow population-level assessment.

K. Examine the media's impact on the risk for youth violence and evaluate strategies for reducing the harmful impact or enhancing the positive impact. Although consensus is growing regarding the influence of different forms of media — including television, film, radio, music, print, podcasts, video games, and the Internet — on the risk for violent behavior, important questions remain about the processes that explain this association and the impact exposure to violence-related media has on severe forms of violence.[34] Media can potentially deter or exacerbate risk for youth violence in multiple ways, including by educating youth about violence, providing models of behavior, or changing perceived norms related to violence, or by providing virtual interactions with others. Young persons are particularly susceptible to the influence of the media they use. Because of the pervasive presence of all forms of media, a critical need exists for rigorous research to understand its influence on youth violence, identify the subgroups of youth who are most vulnerable, and to evaluate relevant prevention strategies. Prevention strategies might include efforts to change the accessibility, content, or format of media; methods for using media to deliver violence prevention messages; or approaches for buffering vulnerable youth against the harmful impact of media. The results of such research should provide valuable information on which to base prevention policies and practice for decreasing youth susceptibility to violence portrayed in the media and to enhance the potential for media to promote prosocial alternatives to violence.

L. Identify situational factors that contribute to incidents of violence. Knowledge is relatively limited regarding how the factors immediately associated with an incident of violence (e.g., the behavior of bystanders, the lack of adult supervision, the presence of alcohol or weapons, or other physical factors) interact with individual-level factors in influencing risk for violent behavior. Research should build on information related to the circumstances under which interpersonal conflicts are most likely to result in injury or death. The results of this research should be incorporated into existing prevention efforts and help generate novel strategies to address situational factors.

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