

CDC HEALTH PROTECTION RESEARCH GUIDE, 2006-2015

Public Comment Draft

November 18, 2005

**Centers for Disease Control and Prevention and Agency for Toxic Substances and
Disease Registry**

Foreword

Imagine a world where infants are born healthy, are protected from diseases, injuries, and developmental disabilities and where children are cared for so they can arrive at school safe, well-nourished, healthy, and ready to learn. A world in which teenagers make informed and safer choices about their environments, activities, lifestyles, and behaviors, and where adults enjoy active, productive, and healthy lives in safe communities where they can remain independent and engaged with family and friends throughout their senior years. A world in which the places we work, play, travel, learn, and live promote health and ensure safety. This is the vision of the Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry (CDC) — healthy people living in a safe and healthy world.

CDC is the nation's premier public health agency. Our recent agency-wide strategic development initiative has resulted in the creation of strategic imperatives and a renewed commitment to achieving a greater positive impact on health. We are aligning our work to achieve specific Health Protection Goals that focus on four areas: healthy people across their lifestages, healthy places, preparedness against infectious, occupational, environmental, and terrorist health threats, and improved global health. Although we already have a great deal of knowledge that can be used to achieve these goals, we are mindful of the many gaps that still need to be filled through additional research.

As a first step toward accomplishing our goals and strategic imperatives, CDC is developing the *CDC Health Protection Research Guide, 2006-2015*. The *Research Guide* will provide a comprehensive, long-range compendium of national and global health protection needs that can be addressed through research. As CDC develops action plans to achieve its goals, the gaps in "what we know" and "what we need to know" to be successful will become apparent. At that point, we will draw upon the *Research Guide* as a useful resource for developing a prioritized *CDC Health Protection Research Agenda*. We hope others will find the *Research Guide* to be a useful tool useful for similar activities.

At this time, we are inviting the public to comment on the current draft of the *Research Guide*, which appears on the following pages. This draft is the culmination of the extensive work of many CDC employees and external partners as well as input from the public. We are now seeking comments from an even wider audience.

We thank you in advance for your thoughtful input. Only with your input can we ensure that our research addresses the most pressing public health needs in the nation and around the world, and that science remains the foundation for all our work.

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Administrator, Agency for Toxic Substances and Disease
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CDC Health Protection Research Guide 2006-2015

AGENCY: Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry

ACTION: Notice and request for public comment.

SUMMARY: The U.S. Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry (hereto referred to as CDC) announces the availability for public comment of the draft *CDC Health Protection Research Guide, 2006-2015*. CDC is requesting input on this *Research Guide* because maximizing the health impact of public health research can only be achieved through the collective efforts of CDC, other federal agencies, state and local partners, academic partners, business and worker partners, non-profit organizations, professional societies and the public. Please provide input on any aspect of the *Research Guide*, including but not limited to:

- scope and use of the *Research Guide* (including whether it has identified the areas of health protection research that most need to be addressed within the next decade);
- relevance and level of specificity of the proposed research topics;
- additions, deletions, or modifications to the proposed research topics;
- *Research Guide* development process; and
- other improvements to the *Research Guide*.

DATES: The public comment period is 60 days. Written comments must be received by close of business on January 15, 2006.

ADDRESSES: The draft *CDC Health Protection Research Guide, 2006-2015* is available for review by visiting the Internet site, http://www.rsvpBOOK.com/custom_pages/50942/index.php, or by contacting the CDC for a hard copy:

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Written comments may be submitted on-line at the Internet site listed above. Written comments may also be sent to the email or postal addresses above.

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I. Overview

A. BACKGROUND

The U.S. Centers for Disease Control and Prevention and Agency for Toxic Substances and Disease Registry (CDC) is recognized as the lead federal agency for protecting the health and safety of people at home and abroad, providing credible information to enhance health decisions, and promoting health through strong partnerships.

The new *CDC Health Protection Research Guide, 2006-2015* will serve as a blueprint for research areas that should be addressed during the next decade by CDC and its partners in response to current and future health needs and events. By health protection research, we mean public health research and prevention research¹. The *Research Guide* will serve as a resource for defining the prioritized *CDC Health Protection Research Agenda*, in support of its Health Protection Goals and priorities. In addition, portions of the *Research Guide* will be used to inform research initiatives that address other critical public health needs and research priorities of other agencies. CDC has developed the draft *Research Guide* with extensive input from its staff and a wide range of partners and stakeholders, including external researchers, other federal agencies, state and local health departments, professional associations, universities, non-governmental organizations, business and worker organizations, private citizens, community groups, and American Indian and Alaskan Native governments, Tribal leaders and Tribal organizations. At this time, CDC is seeking additional review and comment through a formal public comment period.

B. RATIONALE

The challenges of our increasingly complex and interdependent world require new approaches to generating and disseminating the knowledge and innovations needed to promote well-being and improve health. In response to these looming challenges, CDC recently underwent an agency-wide strategic planning process called the Futures Initiative. As a result, CDC has renewed its commitment to improving and protecting health and moved to a new organizational structure (Appendix III) to enhance coordination and collaboration within the agency, with its partners and the public. Thus, the time is right for an examination of the research conducted by the agency. An agency-wide *Research Guide* is a first step for taking advantage of new organizational synergies that can be used to obtain the knowledge we need to protect people's health.

¹ Research is defined as a systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge (Department of Health and Human Services. Code of federal regulations: Title 45, Subpart A, Section 46.102. Available at <http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.htm#46.102>).

CDC has also recently developed six strategic imperatives that are intimately linked to research (Table I-1). The *CDC Health Protection Research Guide, 2006-2015* can play an important role in defining the research necessary to ensure that each of these six strategic imperatives is fulfilled. Research also is critical to achieving the agency's new Health Protection Goals (Chapter II), which are designed to focus the agency's efforts on achieving a major positive impact on people's health. CDC is collaborating with academic researchers; federal agencies; state and local health departments; and education agencies; and national, international, professional, and community-based organizations. Through these strategic alliances, promising research can more rapidly be translated and disseminated through practical cost-effective policies, programs, and practices that improve health.

Table I-1. CDC Strategic Imperatives and Their Relationship to Research *

Health Impact Focus: Align CDC's strategies, goals, and performance to have the maximum impact on people's health and safety. *Research provides knowledge of how to focus on areas of greatest health impact.*

Customer-centricity: Market what people want and need to choose health. *Research reveals new ways to support customer needs and priorities.*

Public Health Research: Create and disseminate the knowledge and innovations that people need to protect their health now and in the future. *Research supports the scientific foundation of public health policies, programs, and practices.*

Leadership: Leverage unique capabilities, partnerships, and networks to improve the health system. *Research is an essential building block for a strong national public health system.*

Global Health Impact: Extend our knowledge and tools to promote health protection around the world. *Research develops new methods and tools tailored to the varied needs of diverse populations around the world.*

Accountability: Sustain people's trust and confidence by making the most efficient and effective use of their investments. *Research resources are focused on the most pressing public health problems to ensure that these resources are used wisely.*

*The strategic imperatives are in regular typeface. The relationships of research to their respective strategic imperatives are italicized.

The complexities and challenges of the 21st century require us to think in fundamentally new ways. Thus, in addition to describing the research needs within traditional public health fields, the *Research Guide* will highlight cross-cutting research that will promote interdisciplinary knowledge to improve the public's health.

Finally, by articulating a comprehensive, long-term vision of the national and global health protection needs that can be addressed through research, we can realize our vision of healthy people in a healthy world.

C. PURPOSE

The *CDC Health Protection Research Guide, 2006-2015* will serve the following purposes:

- 1. *Identify knowledge gaps that must be considered as CDC develops its Health Protection Goals Action Plans.*** CDC has developed Health Protection Goals (Chapter II) and is developing action plans for achieving significant impacts on the health of the U.S. population.
- 2. *Describe the range of research most needed to provide critical evidence to improve existing or establish new public health programs and interventions.*** A distinguishing and essential feature of CDC research is that it fills critical gaps necessary to improve public health programs, services, and response.
- 3. *Improve the effectiveness of a broad range of public health disciplines through supporting innovative, cross-cutting interdisciplinary and foundational research.*** This research may cut across several public health fields and thus have a profound impact on the ability to improve public health.
- 4. *Serve as a platform for discussions with federal partners about opportunities to collaborate in addressing the most pressing current and future public health problems.*** Many public health needs can be best met through a coordinated research strategy involving multiple federal agencies, which together can leverage their unique strengths and resources to more effectively solve national and global health problems.
- 5. *Provide a basis for discussions with state and local partners about identifying opportunities to collaborate with them in addressing needs across the United States.*** CDC can best identify research gaps, fulfill research needs, and communicate research findings by collaborating with state and local entities that carry out the work of public health.
- 6. *Create opportunities to partner with academic institutions, professional associations, international agencies, businesses, worker organizations, and non-profit and community based organizations to address institutional and community research needs.*** Involving non-traditional partners along with traditional federal and state partners can ensure that research findings are beneficial and practical to help people and their communities.
- 7. *Plan, promote, and market CDC research externally and internally.*** To be successful, CDC must effectively communicate and promote its research priorities and findings to improve health and public health practice.

D. SCOPE AND USE OF THE RESEARCH GUIDE

The *Research Guide's* long-term research priorities are expressed at a broad level to represent the full range of research that may be conducted within this long timeframe. This breadth also permits inclusion of new priorities that may arise in the future from emerging threats and needs. The *Research Guide* is comprehensive. It engages and provides guidance to the broad research community within and outside of CDC.

CDC's new goals implementation process will influence the future allocation of CDC resources for all of CDC's activities, including research. The *Research Guide* will be a useful resource for the development of *CDC Health Protection Research Agenda* that will emerge as the Goals Action Plans define critical knowledge gaps (Chapter II). To facilitate this, all of the draft *Research Guide's* research themes, except for cross-cutting research, are mapped to the overarching Health Protection Goals (Table II-1).

The Health Protection Goals will drive most of CDC's future work. Additionally, some types of crucial research represented in the *Research Guide* are indirectly related to these goals, including high-risk, innovative research and cross-cutting research (e.g., data science) that serves as a foundation for many public health disciplines.

The *Research Guide* will be applicable to both intramural and extramural research sponsored by CDC and other agencies. CDC Coordinating Centers and individual Centers, Institutes, and Offices (CIOs) will continue to have primary responsibility for developing and overseeing extramural and intramural research programs that fall under the agency-wide *Research Guide*, the Goals Action Plans, and categorical research agendas.

E. RESEARCH GUIDE DEVELOPMENT PROCESS

Development of Early Drafts

In 2001-2004, CDC convened three large workgroups, comprised of CDC staff, tasked with recommending a process for developing an agency-wide research agenda. In January 2005, CDC established six workgroups and a core team comprised of representatives from state and local health departments, academic institutions, advocacy groups, partners, and CIOs within CDC (Appendix IV). These latter experts were tasked with implementing the recommended process to develop the *CDC Health Protection Research Guide* (See Table I-2 for dates of key milestones). The six workgroups and the core team were advised by a group of senior external advisors who comprised the Research Agenda Steering Subworkgroup, Advisory Committee to the Director, CDC (Appendix IV). The workgroups used standardized criteria and consulted CDC staff to develop a draft Starter List of Research Priorities, which was used to stimulate discussion on the potential research themes to be included in the *Research Guide*. Each research theme candidate was evaluated and ranked on the following four standardized criteria:

1. relevance to CDC's mission and Health Protection Goals,
2. importance of the problem and public health need being addressed,
3. relevance to reducing health disparities, and
4. potential for broad impact on multiple diseases or risk factors.

Other factors also were considered for determining which research themes were appropriate for inclusion in the draft Starter List of Research Priorities. Research themes addressing areas CDC has deemed as needing immediate attention (e.g., obesity, adolescent health, preparedness, and influenza) were prioritized for inclusion, as well as research ideas that were likely to have the greatest short-term impact on public health (e.g., research on the efficacy, effectiveness, and dissemination of public health interventions). To ensure that cross-cutting research achieved prominence in the *Research Guide*, additional priority was given to research themes addressing public-health-workforce capacity and training, the social determinants of health, and innovation and to those themes that could significantly impact many different sectors (e.g., public health systems, healthcare-delivery systems, educational institutions, and private industry).

The 131 research themes ranked highest by the workgroups were included on the Starter List of Research Priorities. These themes were classified to one of the following seven categories:

- a) infectious diseases
- b) community preparedness and response
- c) health promotion
- d) environmental and occupational health and injury prevention
- e) global health
- f) health information and services
- g) cross-cutting research

Initial Public Participation

Once the draft Starter List was compiled, CDC gathered public input to prepare for the initial draft of the *Research Guide*. Public participation meetings were held during March 2005 in Arlington, Virginia; Atlanta, Georgia; Seattle, Washington; and Columbus, Ohio. At these four meetings, CDC received input from a diverse group of 450 researchers, representatives of partner organizations, and the public-at-large. The draft Starter List of Research Priorities for the *Research Guide* was also made available to the public for comment through an Internet website. In addition, all CDC employees were invited to submit comments. In March 2005, CDC also held its first meeting with other federal agencies, largely those within the U.S. Department of Health and Human Services, to discuss how to build and enhance federal networks to promote the use of the *Research Guide* after it is finalized. Planning for additional meetings with federal partners to continue and expand these efforts is underway.

Each of the comments and recommendations received through the above-mentioned venues was considered by members of the workgroups that developed the *Research Guide*. Modifications and additions were made to the *Research Guide* on the basis of this feedback, resulting in the draft version that appears in this document. This draft version was reviewed and approved by CDC leadership and senior scientific staff, as well as by key external advisors.

Request for Public Comments

CDC is now seeking public comments on the draft *CDC Health Protection Research Guide, 2006-2015*. Please provide input on any aspect of the *Research Guide*, including but not limited to the following:

- scope and use of the *Research Guide* (including whether it has identified the areas of health protection research that most need to be addressed within the next decade);
- relevance and level of specificity of the proposed research topics;
- additions, deletions, or modifications to the proposed research topics;
- *Research Guide* development process; and
- other improvements to the *Research Guide*.

The formal public comment period is 60 days. Written comments must be received by close of business on January 15, 2006. See the "address" section on page three of this document for where to submit comments.

Finalizing the Research Guide

After the public comment period has ended, the *Research Guide* development workgroups will reconvene to consider and address comments received from the public to produce a final version of the *Research Guide*. It will then be given a final review and vetted by members of CDC leadership, senior scientific staff, and CDC's external advisory committees before being published. The *CDC Health Protection Research Guide* is expected to be finalized early in 2006.

Updating the Research Guide

Because the *Research Guide* is meant to be a dynamic document, it will also be revised and updated as needed throughout its shelf-life in response to unexpected or unanticipated needs, new findings, or new goals.

Table I-2. Timeline of <i>Research Guide</i> Development Key Milestones		
Milestone	Date	Complete (✓)
• CDC committees develop and propose research agenda development process	2001 - 2004	✓
• Launch workgroups and hold orientation	January 10, 2005	✓
• Gather CDC staff input	January-April, 2005	✓
• Create Starter List of Research Priorities	February 25, 2005	✓
• Hold four public participation meetings	March 8-31, 2005	✓
• Hold first federal partners meeting	March 9, 2005	✓
• Produce public comment draft	May-November 2005	✓
• Sponsor 60-day public comment period	November 18, 2005 - January 15, 2006	
• Vet and finalize Guide	Early 2006	

Greater detail regarding the *Research Guide* development process, including the names and affiliations of members of the *Research Guide* development workgroup members and external advisors, can be found at the CDC website (<http://www.cdc.gov/od/ophr/cdcra.htm>).

F. ORGANIZATION OF THE RESEARCH GUIDE

The *Research Guide* is organized into three tiers. The broadest tier consists of the seven **major research areas** that are presented in Chapters III through IX, respectively. The major research areas, or chapters, represent an evolution of the seven broad research categories contained in the draft Starter List of Research Priorities. (The relationship between the Starter List categories and the corresponding *Research Guide* chapters is shown in Table I-3). Each chapter addressing a major research area contains three to eight specific **research categories** that further describe the major research area. Each research category, in turn, contains one to ten more specific **research themes** that further define the research within that research category. Each research theme presents a **scope of research** designed to specify research at a level that could be described in a collection of related requests for applications (RFAs).

Table I-3. Relationship between Starter List of Research Priorities Categories and *Research Guide* Chapters

Starter List Category Title	<i>Research Guide</i> Chapter Title
Infectious Diseases	Prevent and Control Infectious Diseases
Community Preparedness and Response	Promote Preparedness to Protect Health
Health Promotion	Promote Health to Reduce the Burden of Chronic Diseases and Disability
Environmental and Occupational Health and Injury Prevention	Create Safe Places to Live, Work, Learn, and Play
Global Health	Work Together to Build A Healthy World
Health Information and Services	Manage and Market Health Information
Cross-Cutting Research*	Cross-Cutting Research*

*Because cross-cutting research priorities are intended to infuse all areas of the *Research Guide*, some overlap exists between the cross-cutting research described in Chapter IX and the other more discipline-specific research categories and themes that appear elsewhere in the *Research Guide*.

II. Relationship of Research Themes to CDC Health Protection Goals

A. CDC'S HEALTH PROTECTION GOALS

CDC is committed to achieving measurable and significant improvements in the health of all persons living in the United States. To do this, the agency is defining specific Health Protection Goals to prioritize and focus its work and investments and measure progress for all of its activities, including research. CDC has developed four overarching Health Protection Goals for healthy people, healthy places, preparedness, and global health (Table II-1). Each overarching Goal is associated with several more specific goals. (See <http://www.cdc.gov/about/goals> for additional information about the goals.)

The healthy people goals under each overarching health protection goal were developed from the knowledge that people's health protection requirements vary by stages of life. Goals have been created for each of the five life stages—infants and toddlers, children, adolescents, adults, and older adults—to better meet each group's unique health concerns and risks.

The healthy places goals focus on the environments in which people live, work, learn, and play. With a focus on communities, homes, healthcare settings, schools, institutions, workplaces, and the places we travel and use for recreation, the activities associated with CDC's healthy places goals will help ensure a holistic approach to achieving health across the lifespan in all environments, from birth through retirement and beyond. By improving the quality and safety of our environments, CDC and its partners will continue protecting and improving the health of all persons living in the United States in all aspects of their daily lives.

The preparedness goals focus on improving capacity to respond to health threats, including naturally and intentionally introduced biological, environmental, chemical, radiologic, and bombing and other explosive events. The preparedness goals focus not only on improving public health capacity, but on timely and accurate identification and reporting of health threats; dissemination of information regarding those threats; provision of countermeasures and health guidance to those affected; reduction in the time needed to restore safety; improvement in long-term follow-up after an event occurs; and reduction in response time following public health threats.

The global goals seek to promote health around the world through sharing knowledge, tools and other resources; to protect against health threats at home and abroad through improved transnational prevention, detection, and response networks; and to promote and protect global health through effective health diplomacy.

To set priorities and measure progress, CDC is currently developing Goals Action Plans, which will specify objectives and prioritized actions, including research, for the Health Protection Goals.

Table II-1. CDC's Overarching Health Protection Goals

1. Healthy People in Every Stage of Life

All people, especially those at higher risk due to health disparities, will achieve their optimal lifespan with the best possible quality of health in every stage of life.

2. Healthy People in Healthy Places

The places where people live, work, learn, and play, will protect and promote their health and safety, especially those at greater risk of health disparities.

3. People Prepared for Emerging Health Threats

People in all communities will be protected from infectious, occupational, environmental, and terrorist threats.

4. Healthy People in a Healthy World

People around the world will live safer, healthier and longer lives through health promotion, health protection, and health diplomacy.

B. RELATIONSHIP OF RESEARCH TO CDC HEALTH PROTECTION GOALS

CDC is accountable for using research dollars where they will have an important impact on people's health. Good management of research involves identifying research priorities, translating these priorities into a balanced portfolio of intramural and extramural research, evaluating research programs and outcomes, coordinating closely with federal partners, and incorporating lessons learned from evaluation into future research priorities. These are the principles of CDC's goals implementation process. The research proposed in the draft *CDC Health Protection Research Guide, 2006-2015* is designed to be integrated with this process and CDC's Health Protection Goals.

To illustrate this alignment, the research themes included in the *Research Guide* have been mapped to the overarching CDC Health Protection Goals (Table II-2). Because the research themes specify long-term research priorities, they are relatively broad (see Scope and Use of the *Research Guide*, Chapter I). Thus, some research themes map to more than one overarching goal. In addition, the *Research Guide* contains some research themes that are not directly related to specific Health Protection Goals, but support a range of Goals. These themes are classified as "cross-cutting" research in Table II-2.

Shorter-term public health research priorities will be identified in the Goals Action Plans that are currently under development. The comprehensive *Research Guide* will be used to supply existing research needs to inform the process and development of short-term priorities as part of the Goals Action Plans. If the Goals Action Plans identify additional critical science gaps and research needs that are not contained in the *Research Guide*, it will be updated to reflect these needs.

Table II-2. Map of Research Themes to CDC’s Overarching Health Protection Goals and Cross-Cutting Research. Table II-2 shows the research themes (which are numbered and unbolded) organized by their related research categories (which are lettered and bolded) and major research areas.

Themes	Overarching Health Protection Goals				Cross Cutting
	People	Places	Preparedness	Global	
PREVENT AND CONTROL INFECTIOUS DISEASES					
A. Emerging and Re-emerging Infectious Diseases					
1. Antimicrobial Resistance					✓
2. Bioterrorism-related Environmental Microbiology			✓		
3. Emerging Infections					✓
4. Healthcare-associated Infectious and Patient Safety	✓	✓	✓		
5. Zoonotic and Vectorborne Diseases (ZVBDs)	✓		✓	✓	
B. Pandemic and Annual Influenza					
1. Influenza Pandemic and Interpandemic (Annual)	✓		✓	✓	
C. Infectious Disease Surveillance and Response					
1. Infectious Disease Diagnostic Methods					✓
2. Infectious Disease Surveillance and Response					✓
3. Infectious Disease Elimination	✓		✓	✓	
D. Vaccines and Immunization Programs					
1. Immunization Services Delivery Research	✓		✓	✓	
2. Vaccine Epidemiology and Surveillance	✓		✓	✓	
3. Vaccine Safety	✓		✓	✓	
4. Vaccine Supply					✓

Themes	Overarching Health Protection Goals				Cross Cutting
	People	Places	Preparedness	Global	
<i>E. Behavioral, Social, and Economic Research in Infectious Diseases</i>					
1. Behavioral and Prevention Research to Promote Health	✓				
2. Economic Analyses of Infectious Diseases					✓
<i>F. Host-Agent Interactions</i>					
1. Applied Genomics in Infectious Diseases					✓
2. Infectious Disease and Chronic Disease Associations	✓				
<i>G. Special Populations and Infectious Diseases</i>					
1. Health Disparities and Infectious Diseases					✓
2. Infectious Diseases Among High-Risk Populations	✓		✓	✓	
3. Perinatal and Neonatal Infectious Diseases	✓				
PROMOTE PREPAREDNESS TO PROTECT HEALTH					
<i>A. Vulnerable Communities and Populations</i>					
1. Determinates of Community Vulnerability to Extreme Events		✓	✓		
2. Risk Appraisal and Adaptive Behavior During an Extreme Event	✓		✓		
3. Predictive Strategies for Risk and Recovery in Vulnerable Populations After an Extreme Event		✓	✓		
4. Assessment Strategies for Populations Affected by Extreme Events			✓		
5. Extreme Event Response Strategies			✓		

Themes	Overarching Health Protection Goals				Cross Cutting
	People	Places	Preparedness	Global	
6. Extreme Event Management Strategies			✓		
B. Infrastructure and Prevention					
1. Critical Environmental Infrastructure Systems and Processes			✓		
2. Public Health, Mental Health, and Medical Response Systems			✓		
3. Human Migration and Mobility Issues Associated with Extreme Events	✓		✓	✓	
4. Community Actions in Extreme Events		✓	✓		
5. Local and Regional Operational Strategies for Managing Extreme Events			✓		
C. Public Health Workforce Preparation and Front-line Prevention and Response					
1. Community and Regional Response During Extreme Events			✓		
2. Support Front-line Personnel Involved in Health Protection Functions During Extreme Events			✓		
3. Proficiency of the Public Health Workforce in the Event of Disaster			✓		
D. Detection and Diagnosis of Hazards and Medical Consequences Associated with Emergency Events					
1. Public Health and Medical Surveillance Systems Involved in Extreme Events			✓		

Themes	Overarching Health Protection Goals				Cross Cutting
	People	Places	Preparedness	Global	
2. Post- Emergency Rapid Clinical Diagnostic Capabilities			✓		
3. Post-Emergency Environmental Detection and Decontamination			✓		
4. Exposure and Impact Data Generated from Extreme Events			✓		
E. Communications					
1. Risk Communication and Information Dissemination		✓	✓		
2. Post-Emergency Response Communications			✓		
PROMOTE HEALTH TO REDUCE THE BURDEN OF CHRONIC DISEASES AND DISABILITY					
A. Health Across the Lifespan					
1. Implement Effective Health Promotion Strategies	✓	✓			
2. Reduce the Burden of Chronic Diseases					✓
3. Reduce Disparity in Chronic Disease Burden and Risk Factors					✓
B. Infant and Maternal Health					
1. Pregnancy Planning and Pre-conception Care	✓				
2. Genetic Causes of Birth Defects and Blood Disorders					✓
3. Healthy Birth Outcomes	✓				
4. Promote Safe Motherhood and Infant Health	✓				
C. Health and Development of Children and Adolescents					
1. Optimal Child Development	✓	✓			
2. Optimal Adolescent Development	✓	✓			

Themes	Overarching Health Protection Goals				Cross Cutting
	People	Places	Preparedness	Global	
D. Adult and Older Adult Health					
1. Reduce the Burden of, Disparities in, and Risk Factors for Chronic Diseases Among Adults	✓				
2. Reduce the Burden of, Disparities in, and Risk Factors for Chronic Diseases Among Older Adults	✓				
E. Health Among Persons with Disabilities					
1. Health Across the Lifespan Among Persons with Disabilities	✓				
2. Early Identification of Developmental Disabilities	✓				
3. Health Among Infants, Children, and Adolescents with Disabilities	✓				
CREATE SAFE PLACES TO LIVE, WORK, LEARN, AND PLAY					
A. Environmental Health					
1. Environmental Risk Factors	✓	✓			
2. Complex Environmental Exposures	✓	✓			
3. Environmental Bio-monitoring Methods and Tools					✓
4. Environmental Health Interventions	✓	✓			
5. Lead Exposure and Health	✓	✓			
6. Environmental Data and Information Systems					✓
B. Occupational Safety and Health					
1. Fatal and Nonfatal Injuries at the Workplace	✓	✓			
2. Occupational Diseases	✓	✓			
3. Occupational Musculoskeletal Disorders (MSDs)	✓	✓			
4. Safe Workplace Design	✓	✓			

Themes	Overarching Health Protection Goals				Cross Cutting
	People	Places	Preparedness	Global	
5. Organization of Work	✓	✓			
6. Emerging Workplace Hazards	✓	✓			
C. Injury and Violence					
1. Injury and Violence Prevention Interventions	✓				
2. Risk and Protective Factors for Unintentional Injury	✓	✓			
3. Risk and Protective Factors for Interpersonal Violence and Suicidal Behavior	✓	✓			
4. Trauma Systems Research					✓
5. Connection Between Multiple Forms of Violence					✓
WORK TOGETHER TO BUILD A HEALTHY WORLD					
A. Supporting Millennium Goals for Global Health					
1. Global Mortality Among Mothers and Young Children	✓			✓	
2. Immunization to Eliminate and Protect Against Global Diseases			✓	✓	
3. Global Micronutrient Malnutrition	✓	✓		✓	
4. Global Efforts for Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome, HIV/AIDS, Tuberculosis (TB), and Sexually Transmitted Diseases (STD)	✓			✓	
5. Global Water Safety		✓	✓	✓	
B. Disease and Injury Prevention and Control in Global Settings					
1. Global Infectious Diseases					✓
2. Global Burden of Non-Communicable Diseases					✓
3. Global Burden of Injuries					✓
4. Global Occupational Health		✓		✓	

Themes	Overarching Health Protection Goals				Cross Cutting
	People	Places	Preparedness	Global	
C. Health of Vulnerable Populations in Global Settings					
1. International Complex Humanitarian Emergencies (CHEs)	✓		✓	✓	
2. Public Health Consequences of Exploitation of Women and Children in Global Settings	✓		✓	✓	
3. Orphans and Other Vulnerable Children in Global Settings	✓		✓	✓	
D. Societal Determinants of Health in Global Settings					
1. Relationship Between Socioeconomic Status and Health					✓
2. Human Resources and Health Outcomes in Global Settings					✓
E. Tools for Global Public Health					
1. Global Measurement of Health, Disease, and Injury					✓
2. Health Marketing and Health Education in Global Settings					✓
3. Evaluation of the Effectiveness of Global Health Interventions					✓
MANAGE AND MARKET HEALTH INFORMATION					
A. Public Health Data					
1. Statistical and Data Science					✓
2. Data Collection					✓
3. Integrating Health and Policy Data					✓
4. Data Mining					✓
B. Public Health Informatics					
1. Analytical Methods					✓

Themes	Overarching Health Protection Goals				Cross Cutting
	People	Places	Preparedness	Global	
2. Information and Data Visualization					✓
3. Communications and Alerting Technologies					✓
4. Decision Support					✓
5. Electronic Medical Records					✓
6. Knowledge Management					✓
C. Health Marketing					
1. Informed Consumer Health Choices					✓
2. Integrated Health Marketing Programs					✓
3. Health Awareness to Health Action					✓
4. Niche Marketing					✓
5. Public Health Brand					✓
6. Message Bundling					✓
7. Emergency and Risk Communication					✓
8. Entertainment Education					✓
9. Health Literacy and Clear Communication					✓
10. Customizing Health Marketing Campaigns					✓
CROSS CUTTING RESEARCH					
A. Physical Environment and Health					
1. Global Climate Change					✓
2. Natural and Built Environment and Health					✓
B. Public Health Systems and Professionals					
1. Health Systems					✓
2. Workforce and Career Development					✓
C. Public Health Science, Policy, and Practice					
1. Social, Anthropological, and Behavioral Sciences in Public Health					✓

Themes	Overarching Health Protection Goals				Cross Cutting
	People	Places	Preparedness	Global	
2. Economics and Public Health					✓
3. Community-Based Participatory Research (CBPR)					✓
4. Public Health Evaluation Research					✓
5. Intervention and Translational Research					✓
6. Health and Well-Being Across Diverse Community Institutions					✓
D. Public Health Education and Promotion					
1. Public Health Education Research					✓
E. Human Genomics and Public Health					
1. Genomics Bridging Preventive Medicine and Public Health Research					✓
2. Human Genomics, Public Health Surveillance Systems, and Research Studies					✓
3. Models for Incorporating Education and Community Engagement into Population-Based Genomics Research					✓
4. The Genomic Evidence Base in Public Health Practice					✓
5. Human-Pathogen Genomics					✓
F. Mental Health and Well-Being					
1. Mental Health					✓
2. Substance Abuse Treatment and Prevention					✓

Themes	Overarching Health Protection Goals				Cross Cutting
	People	Places	Preparedness	Global	
G. Law, Policy and Ethics					
1. Public Health Policy and Law					✓
2. Ethics in Public Health					✓
H. Social Determinants of Health and Health Disparities					
1. Burden of Disease					✓
2. Social Determinants of Health					✓
3. Health Disparities Prevention and Elimination					✓

III. Prevent and Control Infectious Diseases

Infectious diseases are an ever-present threat to the well-being of all people around the globe, regardless of nationality, age, sex, lifestyle, ethnic background, or socioeconomic status. Although all populations are at risk for certain infectious diseases, the degree to which some populations are impacted by them can vary. Persons who are very young or old, hospitalized patients, and persons whose immune systems are compromised are particularly at risk for the negative health effects associated with infectious diseases. The individual characteristics of each person within a population also can make some persons more vulnerable to infectious diseases than others.

With advances in public health and medical research, including improvements in sanitation and the development of antimicrobial agents and vaccines, many diseases causing fear, illness, and death within communities now pose only minimal threat. However, despite modern advances, many infectious diseases continue to inflict unnecessary suffering and death. Diseases once thought to be controlled can re-emerge in new forms that do not respond to antimicrobial drugs or other existing interventions; novel infectious diseases for which no interventions have been developed also continue to emerge, challenging the ability of public health and other responders to stop them from spreading. Thus, despite significant achievements, public health professionals must continue to strive to control infectious diseases that cause significant harm and threaten the social and economic fabric of society.

Public health research is crucial to ensuring adequate public health response to known and emerging infectious agents, prevention of infection-associated chronic illnesses, and increased understanding of the underlying reasons for infectious disease-associated health disparities. Infectious disease research will help protect all people, especially those at high risk, from all types of infectious threats, including those that occur naturally and those used in intentional acts of terror. In addition, it will further CDC's efforts to reach several Health Protection Goals for the 21st century, including preparing persons in all communities for emerging health threats, helping persons achieve optimal health in every stage of life, and ensuring that persons in all communities live, work, learn and play in environments that support their health, safety, and well-being. Research categories in this chapter include:

- A. Emerging and Re-emerging Infectious Diseases**
- B. Pandemic and Annual Influenza**
- C. Infectious Disease Surveillance and Response**
- D. Vaccines and Immunization Programs**
- E. Behavioral, Social, and Economic Research in Infectious Diseases**
- F. Host- Agent Interactions**
- G. Special Populations and Infectious Diseases**

A. Emerging and Re-emerging Infectious Diseases

Infectious diseases are one of the oldest threats to human health. Improving the detection, prevention, and control of infection can better prepare and protect our nation from new and re-emerging disease threats.

Advances in science, technology, and medicine enable us to treat and prevent many diseases that historically have caused high rates of morbidity and mortality around the world. However, other advances (e.g., globalization of travel and trade) have created new opportunities for microbes to emerge and spread. In addition, health threats that were inconceivable only a few decades ago are now being recognized; people around the globe are starting to face infectious disease threats resulting from terrorist acts involving the deliberate release of pathogenic microbes with intent to cause harm. In some countries, resource problems, trade concerns, and complacent attitudes about infectious diseases contribute to inadequate reporting and control of emerging threats, which can result in excess spread of disease.

Infectious microbes have a remarkable ability to evolve and adapt to new situations, sometimes becoming more virulent or developing resistance to commonly used drugs; microbial evolution can render vaccines and therapeutic drugs ineffective. As a result, unique public health challenges and scientific questions have been associated with the recent emergence and re-emergence of infectious diseases around the globe (e.g., those caused by human immunodeficiency virus [HIV], West Nile virus, variant Creutzfeldt-Jakob disease/bovine spongiform encephalopathy [Mad Cow disease], severe acute respiratory syndrome [SARS], and community-associated methicillin-resistant *Staphylococcus aureus*).

A significant risk factor for disease emergence in the years ahead is likely to be population growth and urbanization, which will lead to the creation of megacities throughout the world. These population increases will be associated with ecological changes that allow increased contact among humans, animals, insects, and animalborne and insectborne pathogens. Improving research that focuses on the prevention and control of emerging and re-emerging infectious diseases will help ensure that people in all communities are protected from infectious threats. In addition, results of infectious disease research will lead to: a) the development of new and increased use of existing interventions known to prevent biological agents and naturally occurring infectious diseases; b) more timely and accurate communications regarding public health threats; c) a quicker public health response in identifying the causes, risk factors, and appropriate interventions for infectious diseases; and d) the prompt provision of countermeasures and health guidance to persons who are most affected by emerging and re-emerging infectious diseases.

1. Antimicrobial Resistance

Develop strategies to improve appropriate antimicrobial use, conduct clinical trials to validate use of existing drugs, and develop improved tools for conducting epidemiologic and microbiologic studies and surveillance of drug resistance.

Scope of Research: Identify methods to preserve the effectiveness of antimicrobial agents. Develop, implement, and evaluate the impact of control policies and interventions to improve the use of antimicrobial agents in human and veterinary medicine. Develop and evaluate methods for preventing the spread of antimicrobial resistant pathogens – particularly those that are multidrug-resistant – in diverse settings (e.g., the community, healthcare facilities, and farms). Conduct clinical trials of existing drugs for which no valid trial data exists regarding efficacy for antimicrobial-resistant infections (e.g., drugs used to prevent and treat certain infections for which efficacy is unproved). Conduct clinical trials, ideally in collaboration with industry, to determine the efficacy and safety of new drugs and biologics that can be used to treat and control drug-resistant infections. Develop methods of surveillance that employ standardized and accurate laboratory methods and linked microbiology, drug-use, and health-outcomes data to provide comprehensive, cost-effective strategies that will improve empiric therapy for infections both in and outside of healthcare facilities. Develop tools for the rapid detection of the genetic determinants of antimicrobial resistance in microbes located within environmental and clinical samples. Determine the optimal methods of preventing the spread of drug-resistant infections in healthcare facilities and other settings or cohorts where outbreaks have been described, and evaluate the efficacy of relevant vaccines to decrease infections.

2. Bioterrorism-related Environmental Microbiology

Develop methods to establish the presence of microbial pathogens in the environment, estimate the risk of infection to human populations, and develop strategies to implement proven risk-reduction strategies for infectious disease transmission in contaminated environments.

Scope of Research: Develop effective sampling strategies for and sensitive methods of obtaining specimens and identifying infectious agents in the environment. Develop sensitive and specific methods to test for a range of priority agents (Category A agents, microbial agents in Categories B & C [<http://www.bt.cdc.gov/agent/agentlist-category.asp>], other microbial agents, and toxins produced by

microbial agents) in a variety of environmental media (e.g., water, air, surface, and bulk materials). Develop techniques to classify organisms with maximal specificity using genomic, proteomic, and atomic characteristics. Conduct studies on efficiency of dose and exposure routes through different environmental media (water, air, surface, and bulk materials) for delivering infectious pathogens. Conduct studies on the durability of infectious pathogens in environmental media (including areas involved in personal decontamination, such as skin, hair, and clothes) and under different conditions (e.g., temperature, humidity, pH, and light level). Develop technologies and procedures for reducing human exposure and removing or inactivating pathogens in contaminated environments.

3. Emerging Infections

Improve rapid histopathologic and immunopathologic detection of infectious agents; develop methods for rapid detection of all known families of bacteria, viruses, parasites, and fungi; improve prevention of zoonotic diseases; detect illness among donors and recipients of blood, organs and other tissues; and improve healthcare preparedness.

Scope of Research: Develop new methods of histopathologic and immunopathologic detection of infectious agents. Develop surveillance and laboratory tools to identify new and emerging pathogens. Conduct research on human, microbial, and environmental factors that contribute to the emergence of infectious agents. Develop a comprehensive set of microbial DNA microarrays that contains phylogenetic sequences from all known families of bacteria, viruses, parasites, and fungi and can be used to rapidly determine the cause of an outbreak of unknown etiology. Develop methods to prevent transmission of infectious diseases through blood, organs, and other tissues. Develop strategies for monitoring infection in donors and recipients of blood, organs, and other tissues. Develop animal models for transmission of infectious agents to improve understanding of the pathogenesis of emerging infections transmitted through biologic tissue. Establish best practices for effective responses to emerging or intentional infectious agent exposure events in healthcare settings to prevent transmission to other patients, healthcare workers, and the community. Conduct modeling studies to assess healthcare utilization and surge capacity (e.g., beds, staff, antiviral drugs, and ventilators) for different scenarios. Develop and assess the impact of effective criteria and tools for screening patients, visitors, and healthcare workers who are or may be infected with epidemic strains of infectious agents; examine the use of these criteria and tools during various stages of disease activity at the local level.

Measure the effectiveness of infection-control interventions on limiting dissemination of respiratory infections in various healthcare settings. Assess the effectiveness of syndromic surveillance, triage, and other early-detection systems in identifying and isolating patients with pandemic influenza or other emerging infectious diseases in healthcare settings.

4. Healthcare-associated Infections and Patient Safety

Create novel strategies for preventing healthcare-associated infections, including those occurring among recipients of blood, organs, and other tissues.

Scope of Research: Evaluate the use of enhanced electronic reporting systems and surrogate markers to detect and prevent adverse events associated with invasive devices, invasive procedures, biologic products, and medication. Develop improved methods for identifying and preventing healthcare acquired infections and for determining relatedness of pathogen strains. Develop strategies to prevent unsafe injections in healthcare settings. Develop methods to decrease errors associated with the identification and antimicrobial susceptibility testing of healthcare-associated infections. Develop methods for promptly and accurately communicating and integrating information from all points in the process of procuring, donating, and transfusing or transplanting blood, organs, and other tissues (e.g., blood collection centers, organ and tissue procurement organizations, public health authorities, and adverse-event surveillance systems). Conduct studies aimed at decreasing infections transmitted from cadaveric organs and allograft tissues through a) improving donor screening; b) tracking allograft tissues; c) standardizing methods for maintaining quality in the processing and storage of tissues; and d) detecting allograft-associated infections. Determine the efficacy of masks and respirators in preventing the transmission of various microorganisms between patients and healthcare workers. Determine the contribution of fit-testing in ensuring that respirators provide protection to healthcare workers and emergency responders. Evaluate the most effective personal respiratory protection programs, and quantify the relative importance of respirators in preventing infectious disease transmission compared with other control measures. Determine factors that facilitate healthcare provider infection-control practices.

5. Zoonotic and Vectorborne Diseases (ZVBDs)

Develop new methods of detection, control, and prevention of existing and emerging ZVBDs in humans and animal populations.

Scope of Research: Characterize newly identified pathogens in domestic and wildlife species of animals that can infect humans. Develop reliable laboratory assays for ZVBDs. Determine new targets and tools for diagnostic applications, and develop new and improved diagnostic assays. Conduct studies to improve diagnostics for the early detection and surveillance of ZVBDs in animals that precede human infection. Develop surveillance methods for the emergence of ZVBDs globally. Create models to assess factors that predict the risk of, contribute to the spread of, and may limit efforts to control ZVBDs by integrating climatic, environmental, veterinary, ecologic, entomologic, and epidemiologic data. Conduct research on the human host, microbial, environmental, and behavioral risk factors that contribute to the emergence of ZVBDs. Identify intervention and control measures for ZVBDs. Assess the impact of intervention and control measures on ZVBDs through surveillance. Collaborate with animal-health experts to develop strategies from wildlife, agricultural, aquatic, companion animal, and captive exotic species sectors to address ZVBDs. Determine the actual imported zoonoses risks at U.S. ports-of-entry via animals and animal products.

B. Pandemic and Annual Influenza

We can better protect Americans against the catastrophic impact of an influenza pandemic by learning more about how influenza spreads, who is most at risk, and how best to prevent infection.

Both pandemic (a worldwide epidemic resulting from efficient transmission of a novel influenza A virus to which there is little or no pre-existing human immunity) and interpandemic (“annual”) influenza pose tremendous threats to the health and life of persons living in the United States. In particular, pandemic influenza has the potential to overwhelm the U.S. healthcare delivery system’s capacity to adequately respond to a sudden and enormous demand. An annual epidemic occurs predictably every winter in the United States, resulting in about 36,000 deaths and 200,000 hospitalizations, mostly among the elderly. By contrast, an influenza pandemic has the capacity for catastrophic global impact. Such a disease event would likely cause extensive morbidity and mortality, social disruption, and economic loss. Some signs indicate that the world is on the verge of a pandemic influenza outbreak, likely caused by the H5N1 strain of avian Influenza A. Although both types of influenza have the potential to impact all populations, some groups (e.g., young children, the elderly, persons with certain pre-existing health conditions, and those whose immune systems are compromised) might be more susceptible to infection, severe disease, and death. The health of certain people (e.g., those who are economically disadvantaged, are elderly, and have disabilities) may be disproportionately impacted because of limited access to already scarce, life-saving healthcare resources. Steps can be taken now to substantially reduce the health, social, and economic impacts that both pandemic and annual influenza epidemics will

have on the general population and those at high risk. Research in influenza prevention and control will prepare the nation to better protect people in all communities from this infectious threat.

1. Influenza Pandemic and Interpandemic (Annual)

Determine the pathogenesis, transmission, and immune response of highly pathogenic avian and other influenza viruses with pandemic potential to develop improved preventive and therapeutic measures.

Scope of Research: Examine the pathogenesis and transmission of highly pathogenic avian influenza viruses (HPAIs) in mammalian models. Improve reliability of diagnostic methods for influenza, focusing on strains with pandemic potential. Assess the degree of existing immunity to HPAI and determine the risk factors (i.e., viral, host, and environmental) for transmission of HPAI from birds to humans and from person to person. Examine the evolution and antigenic variation of HPAI. Develop vaccine candidates for potential pandemic viruses by using traditional and reverse-genetics approaches. Develop, evaluate, and compare approaches for faster and increased vaccine production using various technologies (e.g., egg-based and cell-culture based techniques). Evaluate the effectiveness of alternative delivery and antigen-sparing immunization practices. Evaluate the immune response to HPAI and vaccines in high-risk populations. Evaluate immunologic correlates of protection among persons with severe illness in various stages of life. Model the effectiveness of vaccination strategies in cases of limited vaccine availability. Assess the utility of immunization registries and vaccine tracking systems for pandemic and non-pandemic influenza vaccines. Develop and test materials and methods to rapidly monitor vaccine-associated adverse events during a pandemic. Evaluate the effectiveness and safety of antiviral drugs against influenza strains with pandemic potential and the field effectiveness for containing localized outbreaks. Improve diagnostic methods for influenza and develop streamlined screening approaches for monitoring the emergence of drug-resistant strains during a pandemic. Assess the impact of age and other host-specific factors on hospitalizations and death. Evaluate the effectiveness of immunization and therapeutic approaches in high-risk populations. Evaluate and field-test communication messages, and determine the efficacy of “low-tech” intervention measures (e.g., hand hygiene and face masks). Investigate the most effective ways to relate uncertainty to the public.

C. Infectious Disease Surveillance and Response

We can better protect the health of our nation with improved disease tracking, faster diagnosis, and rapid response to disease outbreaks.

Rapid, inexpensive, sensitive, and specific etiologic diagnostic tests, which are key to the treatment and control of infectious diseases, are often lacking. Additional prevention research relevant to virtually all infectious disease is needed in light of diminishing new vaccine and antimicrobial development. Many infectious diseases disproportionately affect certain populations (e.g., minorities, children, adolescents, and persons who are economically disadvantaged and foreign born), resulting in health disparities. Evaluating various prevention methods to identify which methods are most effective for high-risk populations and in settings where rates of specific infections are higher would help reduce these disparities. Development of new diagnostic methods would prevent many infections, ensure appropriate therapy, and inform the design of control strategies (e.g., vaccination). New methods of prevention and control are likely to be applicable to multiple infectious diseases. Accurate and rapid diagnostic testing is crucial for determining appropriate therapy, controlling institutional and community outbreaks, describing disease burden, and responding effectively to a pandemic or potential bioterrorism event. Research in the prevention of infectious diseases supports the basic public health objective of ensuring that people in all communities are protected from infectious disease-related threats.

1. Infectious Disease Diagnostic Methods

Develop rapid, inexpensive, cost-effective, sensitive, and specific etiologic diagnostic tests for a variety of infectious disease agents.

Scope of Research: Develop improved methods of diagnosing respiratory illnesses of public health importance to expedite implementation of appropriate control measures. Develop accurate, rapid, and affordable diagnostic tests capable of detecting multiple agents (e.g., viral, bacterial, and fungal) from a single sample (which enables clinicians and public health workers to deliver treatment, prevention, and control strategies more rapidly). Develop reliable laboratory assays for viral and rickettsial diseases of public health importance. Expand the capacity for diagnosis and molecular typing to discover new targets and tools for diagnostic applications. Develop molecular and immunologic tools for the surveillance and diagnosis of microbes that cause known or potential vaccine-preventable diseases. Develop diagnostics for viral, bacterial, and fungal pathogens that are a threat to organ, blood, and other tissue transplant/transfusion recipients.

2. Infectious Disease Surveillance and Response

Improve infectious disease surveillance and the timeliness of response for pathogens that affect U.S. and international populations.

Scope of Research: Develop more advanced, practical disease surveillance systems by combining laboratory subtyping (i.e., "fingerprinting") with epidemiologic data. Develop more efficient tools for outbreak detection, investigation, and reporting that integrate clinical, epidemiologic, and laboratory data obtained from various sources (e.g., healthcare providers and national public health institutions). Enhance capabilities to recognize novel, previously unidentified pathogens by the genes they carry; improve our abilities to detect, characterize, and fingerprint known pathogens rapidly and with high accuracy using cutting-edge methods (e.g., DNA and protein sequencing and mass spectrometry); and learn more about the prevalence and ecology of these pathogens. Conduct research to optimize the use of electronic health records (EHRs) for public health surveillance purposes in the context of privacy protection (e.g., the Health Insurance Portability and Accountability Act [HIPAA]). Evaluate the effectiveness of new sources of real-time or near real-time disease detection and the monitoring of healthcare delivery practices. Evaluate proposed and existing information systems and linkages between them for their usefulness in the detection of infectious disease epidemics; examine their potential for detection of the major biothreat agents, their ability to monitor the spread of epidemics, and their cost-effectiveness for prevention. Enhance methods used by international networks that identify the spread of pathogens across borders. Develop new tools and strategies for controlling neglected diseases causing significant burden in areas where treatments do not exist, are inadequate, or are unavailable to the affected populations (e.g., persons in developing countries). Develop strategies to increase access to and improve effectiveness of currently available control interventions for neglected diseases.

3. Infectious Disease Elimination

Develop methods to eliminate or eradicate identified priority infectious diseases.

Scope of Research: Assess disease burdens, define and evaluate strategies and implementation targets for diseases with potential for elimination (e.g., those that are vaccine preventable). Develop new tools for diagnosis, treatment, program monitoring, and surveillance to achieve elimination goals. Evaluate novel approaches to improve the implementation of program

interventions and to enhance population coverage for those interventions. Conduct demonstration projects to determine the feasibility of disease elimination, and analyze the public health impact of disease elimination efforts. Evaluate and develop social mobilization and communication methods. Define opportunities to sustain disease elimination efforts through collaboration and integration with other disease-control programs and activities. Investigate the economic impact of priority disease elimination and the cost-effectiveness of selected prevention and control strategies. Develop optimal strategies for surveillance, and validate criteria for certification of the elimination of priority diseases.

D. Vaccines and Immunization Programs

Our nation can have the highest level of disease protection by ensuring that all Americans have access to a safe and abundant vaccine supply.

Vaccines have been hailed as one of the 10 most important public health contributions of the 20th century. Vaccines currently are used to protect people of all ages from many infectious diseases (e.g., measles, polio, and influenza), and new vaccines are being developed to protect against acute and chronic diseases (e.g., certain types of cancer and acquired immunodeficiency syndrome [AIDS]) and against diseases with pandemic potential. To achieve maximum infectious disease protection for all children, adolescents, and adults living in the United States, the following vaccine-associated research efforts must be undertaken: a) the identification and development of suitable vaccine-delivery mechanisms that will reduce health disparities by ensuring the provision of vaccine to all U.S. residents, regardless of socioeconomic status; b) the assurance of intrinsically safe vaccines that are free from adverse effects; c) the conduct of epidemiologic studies to identify populations most in need of vaccine (based on disease burden, risk and vaccination coverage in a population); d) the assessment of the relative contribution of different modes of disease transmission; e) the determination of vaccination effectiveness in adults and children; f) the development of strategies to ensure full supply and distribution of vaccines to all persons wanting to be vaccinated; and g) the evaluation of the impact of programs created to prevent hospitalization and death in vulnerable populations (e.g., young children and the elderly).

1. Immunization Services Delivery Research

Develop, evaluate, implement, and disseminate effective strategies to encourage all persons living in the United States to seek recommended vaccination, and optimize immunization delivery.

Scope of Research: Develop, evaluate, and monitor effective vaccination programs, especially for new vaccines and those involving new populations of people to be vaccinated (e.g., adolescents and high-risk groups). Develop programs that reduce health disparities in vaccine coverage. Research the efficacy and effectiveness of evidence-based strategies as outlined in the *Guide to Community Preventive Services* [<http://www.thecommunityguide.org/>]. Conduct health economics research of vaccine programs. Identify strategies to match vaccine supply and demand. Determine the potential usefulness of tailored interventions. Assess the accuracy and usefulness of vaccine registries. Examine the effect of vaccine-associated communication with various audiences (e.g., the public, policymakers, healthcare providers, and healthcare organizations) on immunization coverage rates. Test the potential usefulness of alternative settings for vaccine administration (e.g., emergency departments).

2. Vaccine Epidemiology and Surveillance

Enhance epidemiologic research and improve surveillance to better define the burden of vaccine-preventable diseases (VPDs) and to develop more efficient coverage strategies for both new and existing vaccines.

Scope of Research: Determine the burden of disease in special populations and at-risk groups and develop new surveillance methods to accomplish this task. Determine whether diseases in specific populations are best prevented by vaccinating those at greatest risk or vaccinating everyone. Determine the optimal timing of revaccination for persons with waning immunity (e.g., adolescents). Determine the potential risk and benefits of universal vaccination recommendations for specific vaccines. Develop and evaluate novel methods of monitoring and controlling VPDs. Explore indirect infection-control strategies (e.g., vaccinating people not considered to be at high risk). Determine the relative effectiveness of mass vaccination against emerging diseases. Determine the risk and benefit of live virus vaccines; for example, determine the potential of varicella (chicken pox) vaccination to reduce Herpes zoster (shingles) among the elderly or to increase Herpes zoster risk in vaccinated children. Develop rapid, inexpensive testing for serologic types of VPD strains to measure potential for diminished effectiveness of vaccine control.

3. Vaccine Safety

Develop, implement, and evaluate methods for ensuring safe vaccines and vaccine administration and effective communication of the benefits and risks of vaccines.

Scope of Research: Develop, implement, and evaluate methods to improve detection and assess causality of adverse events following immunizations (e.g., through improved vaccine-safety surveillance and epidemiologic studies). Conduct clinical and population based research on pathophysiology and risk factors, including individual genetic variation, that influence vaccine-related adverse effects in order to inform immunization decisions. Develop, implement, and evaluate international standards in vaccine safety research for use in surveillance systems, clinical trials, and epidemiologic studies to enable data comparability. Evaluate current healthcare provider practices regarding prevention, identification, and reporting of vaccine-associated adverse events. Determine behavioral and social factors that impact vaccination acceptance rates among subpopulations, and develop evidence-based methods of addressing potential concerns. Identify and evaluate methods of effectively communicating vaccine benefits and risks to different audiences (e.g., the public and healthcare providers). Develop and test promising technologies to enhance vaccine administration safety. Determine and implement cost-effective methods and partnerships to monitor, evaluate, and improve vaccine safety.

4. Vaccine Supply

Develop strategies to ensure sufficient supply and appropriate distribution of vaccines.

Scope of Research: Develop and evaluate strategies to enhance the demand for vaccines, particularly for adults, adolescents, and underserved racial/ethnic groups. Develop a prioritization system for new vaccines based on disease burden, economic analysis of existing markets, and new product availability. Develop and evaluate regulatory strategies for streamlining the review and approval of new vaccines without compromising vaccine safety or efficacy. Collaborate with the National Institutes of Health (NIH) to develop more efficient means of vaccine production. Develop, evaluate, and implement strategies to more efficiently track vaccine supply from manufacturer to provider. Devise and test strategies to encourage industry interest in manufacturing vaccines. Devise and test strategies to maintain redundant vaccine suppliers to ensure sufficient vaccine inventory. Evaluate the effectiveness of antigen-sparing strategies.

The choices we make can be harmful to our health. We can provide better protection from infectious diseases by understanding how our behaviors put us at risk.

E. Behavioral, Social, and Economic Research in Infectious Diseases

Infectious diseases can significantly impact quality of life, society, and all levels of the economy (i.e., local, regional, national, and global). Human behavior plays a critical role in the emergence, spread, and control of almost all infectious diseases. However, to reduce the infectious disease burden in the United States, research is needed to further understand the interplay between human behavior, health-associated economics, and the control of infectious diseases. Because the incidence of infectious disease varies between populations and sub-populations, additional population-specific research focusing on the behavioral, social, and economic factors that contribute to U.S. health disparities is needed. Such research could help identify specific strategies for effective interventions, particularly in populations that are disproportionately impacted by infectious diseases. The conduct of these types of research will help elucidate the causes of health disparities and help guide policymakers in effectively using limited health resources to narrow gaps in health status between populations. New types of research have been identified that show promise for: a) identifying effective interventions to prevent the emergence and spread of infectious diseases; b) improving life expectancy and quality of life; and c) improving the economies of societies, communities, groups, and individuals. This research can accelerate health improvements for persons at high risk for illness and help ensure that the greatest numbers of people are protected from infectious threats.

1. Behavioral and Prevention Research to Promote Health

Develop, evaluate, and implement existing and emerging infectious disease-specific behavioral and social science interventions, public health education programs, and health communication research.

Scope of Research: Identify and characterize behaviors and specific determinants (e.g., sex, health-related stigma, poverty, and access to healthcare) that put people at risk for routine infectious diseases and those associated with large outbreaks. Examine the physical, social, and cultural factors at the individual, community, and institutional level that directly or indirectly influence a person's risk for infection and for transmitting disease. Engage in community-based participatory research (CBPR) (i.e., a collaborative research process between researchers and community representatives) to improve the effectiveness of behavioral, communication, and health interventions to reduce risks of

infection. Identify, understand, and characterize healthcare provider behavior and institutional policy associated with: a) the containment, spread, and treatment of disease in healthcare settings; and b) the implementation of effective strategies to prevent disease transmission and improve health outcomes. Study the effectiveness and practice of culturally competent services and infection-control measures (e.g., hand washing and safe needle use and disposal). Evaluate the effectiveness of: a) behavioral, health promotion, communication, and prevention programs; and b) interventions for specific populations at various levels (e.g., individual, community, and institutional). Evaluate methods for the dissemination and application of research outcomes, model programs, and interventions that have been demonstrated to work.

2. Economic Analyses of Infectious Diseases

Measure the economic burden caused by infectious diseases and the costs and cost-effectiveness associated with new and existing prevention interventions.

Scope of Research: Improve understanding of the economics of controlling and preventing infectious diseases through enhanced information and analysis of the economic burden imposed by these diseases. Measure the costs of delivering existing prevention interventions (e.g., vaccines). Conduct cost-effectiveness analyses of existing and novel interventions to allow for direct comparison among interventions. Integrate existing mortality and morbidity estimates and other data to estimate the economic burden caused by all infectious diseases each year in the United States. Each year, sample the population to determine estimates of the number of persons who become infected with specific diseases (e.g., influenza) and the burden imposed by these illnesses; these data will improve efforts to target disease-control interventions (particularly during supply shortages and naturally occurring catastrophes). Measure the cost efficiency of vaccinating or treating different segments of the population (e.g., children and the elderly) in different settings (e.g., physician offices and community mass immunization locations). Apply standardized methodology to evaluate the cost-effectiveness of existing and proposed public health interventions to allow policymakers to make direct comparisons of intervention options. Use econometric analysis to assess the demand for and the supply of infectious diseases interventions.

F. Host-Agent Interactions

Our genes determine not only the color of our eyes but how our bodies will respond to infection. Learning more about the relationship between genes, the immune system, and infection can lead to better treatments, faster recovery, and longer healthier lives for all Americans.

Infectious diseases are among the leading causes of death worldwide; in 1998, deaths from infectious diseases were estimated at 13.3 million, or 25% of all deaths. This number likely is an underestimate, however, because deaths from cancer, cardiovascular disease, and respiratory/digestive illness can also be caused by infections (<http://www.who.int/infectious-disease-report/pages/graph1.html>). Understanding host immune, genetic, genomic, and other factors (e.g., cellular events and immune response mechanisms) is critical to the prevention of illness, disability, and death caused by infectious disease. The identification of genetic and immunologic characteristics that predispose persons to adverse vaccine or drug reactions and the knowledge that numerous chronic diseases are actually caused by preventable or treatable infections also can further efforts to develop new and improved prevention and control modalities. Genetics, race/ethnicity, culture, socioeconomics, sex, education, and behavior influence the outcomes of infection and its associated chronic illnesses. Persons in racial and ethnic minority groups and those who are disadvantaged or undereducated are often most vulnerable to these diseases, which results in substantial health disparities.

Infection that occurs at an earlier age can determine later chronic health outcomes, including the chronic disease outcomes of offspring. Additional research in the field of host-agent interactions could eventually enable persons to enjoy additional years of healthy life by delaying death and the onset of illness and disability caused by infectious diseases and any associated chronic conditions.

1. Applied Genomics in Infectious Diseases

Investigate genetic and immunologic features of human-pathogen interactions to understand and prevent infectious causes of acute and chronic diseases.

Scope of Research: Investigate the relationship between human and pathogen genetic and immunologic factors in disease susceptibility, transmission, and natural history; amenability to prophylaxis; response to treatment; priority groups for intervention (i.e., those at high risk); side effects of drugs and vaccines; adverse long-term sequelae; and drug resistance.

2. Infectious Disease and Chronic Disease Associations

Develop improved methods to determine, measure, monitor, treat and/or prevent chronic diseases attributable to infectious agents in general and specific populations.

Scope of Research: Investigate, define, and quantify chronic diseases attributable to infectious agents, particularly those with modifiable, confirmed, and still unproven etiologies. Define the epidemiology of infections and chronic diseases in the presence and absence of infection and other cofactors. Enhance laboratory capacity to detect and monitor biomarkers of infection and of progression to infection-related chronic diseases. Identify populations at risk for infection and chronic health outcomes, and identify factors that increase risk (e.g., socioeconomic, culture, genetics, non-infectious environmental exposures, and micronutrient status). Develop appropriate interventions that will be readily accepted and used by at-risk populations. Monitor and demonstrate the evolving impact of intervention strategies on infections and their chronic outcomes, including chronic illness and disability. Monitor the indirect effects of interventions on other human-microbe interactions (e.g., antimicrobial resistance, reduced beneficial effects of microbes, and imbalances between microbes and probiotics). Determine when and how modifiable infections influence chronic conditions characterized by inflammation (e.g., cardiovascular and respiratory diseases).

G. Special Populations and Infectious Diseases

Some U.S. populations (e.g., males who have sex with males, persons who are elderly, and those who are homeless) are at increased risk for being adversely affected by some infectious diseases, which leads to health disparity. These vulnerable populations are heavily dependent on public health programs and services for their well-being. Although each vulnerable subpopulation can be small in size, as a group these subpopulations represent a substantial number of persons who need assistance from public health programs. Pregnant women comprise one such vulnerable group. Infection is a leading cause of hospitalization during pregnancy, preterm delivery, and postpartum complications. Maternal infection can lead to life-threatening bloodstream infections, prematurity, low birth weight, long-term disability, chronic respiratory and liver disease, and neonatal death. In addition, infectious diseases that emerge within these populations can eventually spread to the general population. Fortunately, solutions to some of the health problems that affect one group often can be used to manage different diseases in other at-risk populations. Research focusing on ameliorating adverse health effects experienced by vulnerable populations not only would better

Protecting the health of our nation by ensuring that our most vulnerable populations—victims of disasters, pregnant women, the very young and the very old—are well protected from infectious diseases.

the health of those who are most vulnerable, but also persons in other populations, including those that are not considered to be high-risk. In the long run, this research would enable all persons, regardless of risk level, to enjoy additional years of healthy life by delaying death and onset of illness and disability.

1. Health Disparities and Infectious Diseases

Develop, evaluate, and implement strategies to reduce and eliminate health disparities associated with infectious diseases.

Scope of Research: Develop, evaluate, and implement strategies to reduce and eliminate disparities associated with infectious diseases that affect certain groups of persons (e.g., those of a certain age, sex, and race/ethnicity; those with a lower education and income level; those who engage in certain cultural practices; and those who have certain religious beliefs, disabilities, sexual orientations, geographic locations, occupations, and languages). Investigate the protective and risk factors for infectious diseases for these and other subgroups of the larger population (e.g., popular cultural customs). Investigate the relative efficacy of new diagnostic and screening approaches to detect infectious diseases across populations. Develop and evaluate new tools and materials for reducing rates of infectious disease based on segmented cultural approaches, education, communication, and prevention.

2. Infectious Diseases Among High-risk Populations

Develop, evaluate, and implement strategies to assess the risks associated with infectious diseases, and better monitor infectious disease rates to reduce the impact of these diseases in populations at high risk.

Scope of Research: Identify and evaluate prevention and control interventions in the following four situations: a) adverse environments; b) highly susceptible hosts; c) special risk-factor groups; and d) high-density populations. Specific environments that should be further studied include war and disaster zones, jails, and rural and low population frontier areas. Particularly susceptible hosts include recent immigrants, international travelers, regular or occasional drug and alcohol users (particularly those that use methamphetamines), persons with immunodeficiencies, and persons who have undergone solid-organ transplants. Evaluate changes in infectious disease risk across the lifespan, with special emphasis on the very young and elderly populations.

3. Perinatal and Neonatal Infectious Diseases

Develop point-of-care diagnostic methods, characterize strategies for preventing perinatal infections, and assess the health impact of existing prevention tools.

Scope of Research: Identify, characterize, and assess effective strategies to prevent and control perinatal infections to: a) ensure healthy pregnancies for both mothers and infants; and b) prevent premature births, birth defects, and other morbidity and mortality that can affect the fetus, infant, and older child. Examine the relationship between particular maternal and infant infections, and determine the long-term outcomes for infected infants. Through interdisciplinary research, examine infectious processes, inflammatory responses, reproductive health, and genomics to identify novel strategies to prevent premature births. Develop point-of-care diagnostic methods for use in prenatal and obstetric healthcare settings for various infections. Identify and evaluate effective primary prevention strategies through health services research (e.g., maternal and infant screening, education, and treatment).

IV. Promote Preparedness to Protect Health

September 11, 2001 marked a tragic day in the lives of Americans and served as a wake-up call for all public health professionals nationwide. As recently as September 2005, two Hurricanes -- Katrina and Rita -- have pounded America's Gulf Coast killing hundreds of people, destroying homes and property, and decimating the healthcare and public health infrastructure. Extreme events, including acts of terrorism, natural disasters, and infectious disease outbreaks, pose challenges for all communities. Public health threats worldwide are growing in complexity and severity. Further, current research suggests that ethnic minorities may suffer more adverse psychological consequences after disaster and mass violence than do white Americans [1]. In 2003, when six state and local health departments and three provincial governments were asked how prepared their respective states were to respond to bioterrorism or other emergency threats, they responded that although the states are off to a good start, more work must be done [2]. The public health response efforts regarding emergency threats should include the development of an infrastructure that improves the capacity of local public health agencies to respond to any type of emergency [3]. Public health systems must be able to anticipate, recognize, and respond to large-scale disturbances, whether they are intentional acts of terrorism or naturally occurring events.

Although emergency public health has always been a public health activity, it must be made a priority; focus must be given to preparation for such events, including planning, tracking, and response [3]. Research on community preparedness and response is needed to minimize the impact of extreme events on affected communities and to promote health. Research on detection and diagnosis, health communication, and public-health workforce training will contribute to existing public health efforts to maintain safe and healthy communities in the face of a wide range of extreme events. Such research will help CDC achieve its goals of protecting the health of individuals and communities into the 21st century, particularly those that are disproportionately affected by injury and illness. Research categories in this chapter include:

- A. Vulnerable Communities and Populations**
- B. Infrastructure and Prevention**
- C. Public Health Workforce Preparation and Front-line Prevention and Response**
- D. Detection and Diagnosis of Hazards and Medical Consequences Associated with Emergency Events**
- E. Communications**

A. Vulnerable Communities and Populations

Communities isolated by poverty, language, and geography suffer most when disaster strikes. Identifying those at greatest risk will ensure that all Americans are better prepared and protected.

Extreme events (e.g., catastrophic events such as acts of terrorism, natural disasters, and infectious disease outbreaks) pose challenges for all communities. However, they extract an even greater toll on persons in vulnerable populations (i.e., those at increased likelihood of experiencing negative outcomes because of social, health, psychosocial, or economic status). Vulnerable communities must be able to maximize their preparedness to ensure recovery from and resilience to extreme events. Reducing or mitigating threats among diverse populations is challenging, because the responses, interpretations, judgments, and self-protective behaviors of persons in vulnerable groups are influenced by different cultural, social, and environmental forces; the characteristics associated with the extreme events themselves (e.g., breakdown of social order) also affect these behaviors. Standardized and reproducible measurements and methods must be developed to describe and quantify the vulnerability of communities. Advances in knowledge regarding which demographic, behavioral, and health risk factors make communities more vulnerable will enable the identification of strategies and interventions to reduce communities' susceptibilities across a broad range of hazards. Research focusing on the populations most likely to be negatively impacted by catastrophic events will further existing public health efforts to keep communities protected from environmental, occupational, infectious, and terrorist threats. This research should be conducted in collaboration with community stakeholders and academic, private, tribal, and government researchers.

1. Determinants of Community Vulnerability to Extreme Events

Identify, measure, and understand the factors and dynamic processes that influence the vulnerability of defined community populations.

Scope of Research: Develop reliable, valid tools and strategies to profile the vulnerability of communities along multiple sociocultural and community dimensions, including the mechanisms responsible for health disparities. Explore approaches to effectively intervene upon the mechanisms or pathways that link sociocultural, physical, psychological, pre-existing health, and economic characteristics to community vulnerabilities during extreme events to reduce negative outcomes. Evaluate the cumulative effect of exposure to multiple adverse events over time on the vulnerability of communities and the variability in their ability to adaptively respond and recover. Develop both rapid assessment and more detailed and enduring evaluation tools to measure community vulnerability.

2. Risk Appraisal and Adaptive Behavior During an Extreme Event

Explore how local influences, cultural factors, and past experiences affect the perception of risk among individuals and their communities and shape their behavioral responses.

Scope of Research: Identify the influence of social, cultural, and historical factors on perceptions of risk and adaptive responses associated with public health emergencies and extreme events, especially among vulnerable, high-risk populations. Determine possible sociocultural barriers to and facilitators of healthy adaptive response patterns among individuals and communities. Evaluate the way in which perception and appraisal of risks influences individual and group interpretations of that risk and their subsequent behaviors, and determine the effectiveness of communications from public health professionals concerning ways to reduce these risks. Determine the influence of ethnicity and culture in a community's request for help and the availability of help. Evaluate the benefit and impact of providing funding opportunities and technical assistance to tribal and minority communities.

3. Predictive Strategies for Risk and Recovery in Vulnerable Populations After an Extreme Event

Identify, evaluate, and model the components of risk, including hazards, vulnerabilities, and resources.

Scope of Research: Understand how ongoing and multiple risk or protective factors and dynamic processes interact to affect vulnerability and/or resilience before, during, and after extreme public health events. Identify models to incorporate pre-existing dynamics, exposures, and other conditions within vulnerable communities that influence the probability and severity of negative outcomes during a single risk event.

4. Assessment Strategies for Populations Affected by Extreme Events

Identify, develop, and evaluate strategies and policies to prevent, mitigate, and treat adverse health effects.

Scope of Research: Evaluate methods of assisting every segment within a community in establishing unique plans and policies that will assess and prioritize each segment's needs and outline available resources to be relied upon in times of crisis.

5. Extreme Event Response Strategies

Develop strategies to adapt the public health response system to accommodate heterogeneous social and physical contexts.

Scope of Research: Develop, examine, and evaluate procedures and policies for identifying the elements that distinguish one subgroup from another to facilitate the development of community-based plans for provision of services to each of these groups. Develop methods to comprehensively assess the needs of each population group, understand how best to satisfy those needs, and modify response strategies accordingly.

6. Extreme Event Management Strategies

Identify, develop, and assess comprehensive risk-management strategies for heterogeneous populations.

Scope of Research: Identify potential causes of adverse physical and psychological health effects and the segments of the population likely to be affected by natural or man-made disaster events. Determine the means for categorizing stressors (both real and perceived) and rectifying the effects of each stressor for specific populations. Prior to an extreme event, study ways to identify and select risk-control activities and methods of assigning responsibility to ensure that all aspects of the response are directed toward the populations that are most in need.

B. Infrastructure and Prevention

U.S. public health systems must be prepared to anticipate, recognize, and respond to large-scale natural catastrophes, intentional acts of terrorism, or unintentional man-made disasters. In national forums, Congressional testimonies, and in their communities, local public health officials have stated that strengthening overall local public health practice is the best way to address the public health consequences of bioterrorism [2]. The National Association for County and City Health Officials has encouraged the use of community-wide surveillance systems capable of detecting bioterrorist events and other health emergencies [2]. Efforts to strengthen the public health infrastructure will enable the U.S. public health system to be more resilient and better prepared to detect and respond quickly to potential or actual health emergencies. Specifically, operational and applied research is needed to promote and evaluate integrated systems of care and risk management, incident management, and communication between health and safety authorities and residents. Research also is needed to identify the contextual, incident management, and infrastructural variables that lead to model integration practices, community response systems, and best practices for health-related government and public information exchange. Finally, research must include assessment of populations who may be disproportionately impacted by emergency events because of certain factors (e.g., limited access to care, geographic barriers, poor health status, and socioeconomic disadvantages). This research should be conducted in collaboration with community stakeholders and academic, private, and government researchers.

Our nation's emergency response system depends on faster, more accurate information about where people go, how they cope, and about what people need so that help arrives where and when they need it most.

1. Critical Environmental Infrastructure Systems and Processes

Assess and prioritize methods and practices to better protect environmental public health systems, which are critical for maintaining healthy populations.

Scope of Research: Identify the critical environmental public health systems that are frequently disrupted during public health emergencies (e.g., food and water supply, waste management, vector control, and veterinary services). Create or strengthen guidelines, practices, and collaborations that will ensure that health-sustaining public health systems and preventive practices (e.g., having back-up supply sources and adequate numbers of qualified environmental health personnel) are protected by rapid vulnerability assessment.

2. Public Health, Mental Health, and Medical Response Systems

Assess and identify strategies and model practices for the integration of public health, mental health, and medical response systems to respond to public health emergencies.

Scope of Research: Assess healthcare utilization and surge capacity (e.g., the availability of beds, staff, operations, logistics, decontamination, antiviral drugs, ventilators, diagnostic imaging technology, operating rooms, and medical supplies) for different scenarios (e.g., conventional weapon terrorism, hurricanes, tornadoes, earthquakes, tsunamis, airplane or railway crashes, seasonal and pandemic influenza outbreaks, and vaccine shortages). Develop and test screening and triage strategies to: a) assist resource allocation efforts; b) inform medical triage decisions; and c) ensure comprehensive care and follow-up associated with mass casualty events at the local level. Determine whether systems integration can: a) reduce the impact of surge capacity on already fragile, overburdened systems of trauma and emergency care; and b) influence the efficacy of infection control interventions (e.g., respiratory hygiene and universal masks) in limiting dissemination of respiratory infections in various settings (e.g., hospitals, emergency departments, outpatient clinics, and long-term care facilities). Assess the efficiency and effectiveness of syndromic surveillance, field triage, and other early detection systems in: a) improving survival and outcomes of persons sustaining trauma; and b) identifying and isolating patients with pandemic influenza or other emerging infectious diseases in healthcare settings. Evaluate community-based mental-healthcare aimed to assist people in coping with the consequences of various public health emergencies. Identify and evaluate alternative partners (e.g., community health centers, tribal health centers, and school-based health services) that can be relied upon to help coordinate public health functions and reach minority populations and communities.

3. Human Migration and Mobility Issues Associated with Extreme Events

Assess and evaluate the role of human migration in the public health response to extreme events occurring around the world.

Scope of Research: Identify risk and protective factors and evaluate interventions designed to control the spread of disease, social deterioration, injury, disability, and death associated with human migration and global mobility. Carry out operational research to improve standards, guidelines and practices to prevent

disease, injury, and disability among displaced populations in temporary shelters, long-term evacuation centers, or new permanent living spaces. Collaborate with governments, agencies, and partner organizations to improve both the national and international communities' understanding of and response to complex and humanitarian emergencies; such research should also focus on: a) the diverse health issues experienced by refugees, evacuees, and other displaced populations; and b) the public health impact of armed conflict on civilian populations.

4. Community Actions in Extreme Events

Describe and explain how diverse communities detect, interpret, respond to, and communicate perceived and actual public health threats.

Scope of Research: Examine critical social processes and reporting relationships that are relied upon by communities and population groups to enhance hazard awareness and trigger prevention or mitigation efforts. Evaluate the health risks and unique needs of immigrant populations and those with limited English proficiency during and after adverse events. Evaluate community and faith-based organizational capacity to respond and provide emergency support during crisis events.

5. Local and Regional Operational Strategies for Managing Extreme Events

Optimize local and regional operational strategies for information exchange, decision-making, and command and control, and define the optimal roles and functions for persons involved in managing public health emergencies.

Scope of Research: Evaluate systems currently used to promote effective information exchange and to establish lines of authority, responsibility, and accountability across multiple agencies and jurisdictions to ensure public health and safety.

C. Public Health Workforce Preparation and Front-line Prevention and Response

We need highly skilled, well equipped public health professionals working together to keep our communities healthy and strong in times of crisis.

The public health workforce, comprised of approximately 450,000 professionals and other front-line responders [4], must be adequately prepared for prevention and response in the event of a large-scale extreme event (i.e., catastrophic events such as acts of terrorism, natural disasters, and infectious disease outbreaks). Public health professionals must be able to rapidly assess the health of populations in affected areas; implement surveillance systems to monitor the health status of populations following an event; produce and distribute health education materials to medical providers, affected populations, and others; control disease outbreaks and identify and mitigate any resulting environmental health hazards; and provide for the needs of special populations (e.g., the disabled and elderly) during and after a disaster event [5]. All front-line public health practitioners should have the skills and abilities to recognize a time of crisis or emergency and to intervene by helping to prevent disease, disability, and injury. Research to understand the importance and uses of cultural competency training and the recruitment of professionals representative of the population will be valuable. Determining the proficiencies required during emergency response and recovery may require identifying specific skill sets, competencies, or cross-training needed to ensure that public health professionals can adapt to rapidly changing community health needs during the evolution of an emergency. Research focusing on public health preparedness and response should be conducted in collaboration with community stakeholders and academic, private, and government researchers.

1. Community and Regional Response during Extreme Events

Ensure scientific rigor of drill and exercise design, implementation, and evaluation.

Scope of Research: Assess and evaluate strategies for modeling community- and regional-level response to test system capacity and the ability of the system to rapidly and effectively recover essential infrastructure functions (e.g., communications and power supply).

2. Support for Front-line Personnel Involved in Health Protection Functions During Extreme Events

Improve and evaluate the countermeasures, personal protective equipment, and health policy guidelines that support members of the public health workforce and maximize safety, personal resilience, self-confidence, and performance for these workers.

Scope of Research: Develop appropriate medical screening and monitoring programs for workers involved in rescue and recovery at scenes of chemical, biological, radiological, and nuclear threats. Gather information and recommendations on the performance, availability, and appropriateness of personal protective equipment (PPE). Develop recommendations for management processes and worker training to prevent injury and illness to first responders and recovery workers at the local, state, and federal levels. Assess technologies designed for better protecting emergency responders and other relief or recovery workers. Develop guidelines for emergency responders on the selection, use, and maintenance of respirators and other PPE in disaster situations.

3. Proficiency of the Public Health Workforce in the Event of Disaster

Define and assess the knowledge, attitudes, and proficiencies needed by the public health workforce to successfully ensure the safety and well-being of the community.

Scope of Research: Develop ways to ensure the timely and continual updating of the standards and competencies necessary for an effective, efficient health workforce. Develop methods for ongoing assessment of the training and development needs of the public health workforce. Evaluate strategies for recruitment and retention in maintaining the workforce, particularly health workers belonging to minority groups.

D. Detection and Diagnosis of Hazards and Medical Consequences Associated with Emergency Events

Advanced information systems provide real-time information to support real-time responses to public health threats.

Detection and diagnosis are essential components of the public health and medical response needed to mitigate the impact of an extreme event (i.e., catastrophic events such as acts of terrorism, natural disasters, and infectious disease outbreaks) on the community. Research that focuses on enhancing the ability of responders to rapidly detect and accurately diagnose the etiology of adverse health events is needed. Specific research areas include: a) the evaluation and integration of public health and medical surveillance and reporting systems; b) the exploration and leveraging of rapid identification advancements in the fields of medical diagnostics and environmental detection; and c) the evaluation and development of strategies and methods for immediate impact assessment (e.g., exposure modeling, environmental contamination and decontamination assessment methods) and long-term community impact evaluation (e.g., health registries for long-term health status follow-up and full community impact assessment). Systems must be evaluated for their flexibility in collecting and compiling health data of all types and for reaching communities who may disproportionately experience the affects of public health emergencies. This research should be conducted in collaboration with community stakeholders and academic, private, and government researchers.

1. Public Health and Medical Surveillance Systems Involved in Extreme Events

Develop and integrate systems to detect, report, and investigate illness and injury associated with intentional and unintentional emergent health threats.

Scope of Research: Identify and assess potential health-indicator data sources. Validate, standardize, and integrate public health and medical surveillance systems to improve capabilities for the detection of natural and man-made threats to public health.

2. Post-Emergency Rapid Clinical Diagnostic Capabilities

Develop or enhance rapid clinical diagnostic capabilities to identify significant exposures to potentially hazardous agents.

Scope of Research: Explore and evaluate modern techniques for and advancements in the rapid clinical diagnosis and identification of significant etiologic agents, and examine ways to leverage these diagnostic capabilities within public health and medical laboratory systems.

3. Post-Emergency Environmental Detection and Decontamination

Develop or enhance methods of rapidly detecting, identifying, and decontaminating persons and environments that may be adversely impacted by an emergency event and could potentially pose a threat to others.

Scope of Research: Explore and evaluate: a) modern techniques and advancements used for rapid identification of environmental health threats and for interpretation of data to assist public health decision-making and accurate health guidance; b) methods for assessing environmental contamination; and c) strategies and methods for evaluating the effectiveness of decontaminating or cleaning up impacted environments or persons to reduce the probability of exposure to health threats.

4. Exposure and Impact Data Generated from Extreme Events

Identify and evaluate model strategies for rapidly assessing exposure impacts and resource needs during adverse health events that impact a community, and evaluate the tools needed to support these strategies for resource allocation and health-status tracking.

Scope of Research: Develop practical strategies and increase capacity for rapid collection of appropriate exposure and impact data during (or promptly after) an emergency event to be used for needs assessment, resource allocation, and long-term health status tracking (e.g., health registries). Evaluate data collection practices for ethical approaches immediately following any extreme event.

Assess the way in which these practices could yield long-term benefits for other scientific and public health disciplines.

E. Communications

Communication is essential to community preparedness and response associated with any extreme event (i.e., catastrophic events such as acts of terrorism, natural disasters, and infectious disease outbreaks). Effective communication during a public health emergency requires the delivery of clear health-related messages and close involvement of the affected community [6]. Diverse populations may require tailored approaches to ensure that messages are delivered and accepted appropriately, particularly those that face barriers to traditional modes of communication [6]. Research must focus on communication between the public health system and communities, within the public health system, and between the public health system and emergency responders.

We must help all Americans better prepare for emergencies with clear and effective health and safety information.

1. Risk Communication and Information Dissemination

Identify and develop effective communication strategies, tools, and mechanisms to facilitate rapid and accurate communications regarding risk information and public health recommendations to affected populations.

Scope of Research: Work with the news media and other organizations and agencies from which people obtain information (e.g., community centers, churches, and schools) to evaluate the effectiveness and impact of various forms of messaging and communication strategies (e.g., content, timing, dissemination, and monitoring of reactions). Review scientific validation, approval, and clearance procedures used by the public health community to assure that timely and valid information is communicated and disseminated. Evaluate existing practices to minimize the dissemination of incomplete, incorrect, or potentially harmful misinformation. Ensure that adequate processes are in place to translate health guidance into effective preventive interventions for a diverse population. Understand the role of and how to incorporate the effective and appropriate use of culture and language in relaying risk-related information and response recommendations.

2. Post-Emergency Response Communications

Optimize strategic communications technology to allow for efficient event response across multiple jurisdictions.

Scope of Research: Develop and test technology and evaluate communication strategies (e.g., use of common language and terminology, interoperability, and redundancy) in ensuring optimal communication within and among responders during an extreme event.

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V. Promote Health to Reduce the Burden of Chronic Diseases and Disability

Many non-infectious conditions, including developmental and other types of disabilities, birth defects, and chronic diseases, continue to negatively impact the health and well-being of Americans throughout all stages of life. Approximately 17% of U.S. children have a developmental disorder, and 54 million Americans of all ages have some type of disability, nearly half of whom face severe and chronic disabling conditions. In addition, one in every 33 babies in the United States is born with one or more disabling birth defects, which can take a lifelong toll on the emotional, medical, financial, and social well-being of patients and their families. Chronic conditions remain the leading cause of illness, disability, and death in the United States: 31% of children have a chronic health condition, and nearly 45% of the overall U.S. population has a least one chronic condition, leading to suboptimal quality of life and economic burden.

To improve the health of our nation, efforts to promote the health of persons of all ages living in the United States must focus on the prevention and control of these conditions. Research is needed to: a) promote health and reduce the burden of chronic diseases through effective interventions; b) develop interventions to promote healthy behaviors among women before conception and during pregnancy and among all persons in every stage of life; c) develop and evaluate strategies to ensure optimal child and adolescent development and to identify developmental disabilities early in life; d) reduce the burden and disparity of chronic disease in adults and older adults; and e) promote health and prevent illness among persons with disabilities across the lifespan. Such research will foster health and well-being in persons with disabilities, birth defects, and chronic conditions and will help reduce the national prevalence of these often preventable conditions. Research areas in this chapter include:

- A. Health Across the Lifespan**
- B. Infant and Maternal Health**
- C. Health and Development of Children and Adolescents**
- D. Adult and Older Adult Health**
- E. Health Among Persons with Disabilities**

A. Health Across the Lifespan

Almost half of all Americans suffer from a chronic illness. Prevention research holds the promise that people, especially those at risk of health disparities, will achieve their optimal lifespan with the best possible quality of health in every stage of life.

Chronic conditions are the leading cause of illness, disability, and death in the United States [7]. Chronic diseases, including cardiovascular disease, cancer, and diabetes, are among the most prevalent, costly, and preventable of all health problems. In the United States, almost 125 million persons (45% of the population) have at least one chronic condition [8], and the medical costs for persons with chronic conditions account for almost 75% of the \$1 trillion spent on healthcare each year in the United States [9]. People with chronic conditions spend six times more per year on healthcare than do those who are not chronically ill, and those who have a chronic condition that results in limitations in day-to-day functioning spend 16 times more than persons who have no chronic illness [8]. Tobacco use and other risk behaviors continue to be the leading contributors to preventable illnesses and causes of death in the United States [10]. In 2000, the leading causes of death were tobacco, poor diet and physical inactivity, and alcohol consumption. [10]. However, the prevalence of persons who are overweight and obese, characteristics that have been associated with increased prevalence of and morbidity from type 2 diabetes, hypertension, arthritis, and some cancers, has more than doubled during the last 40 years [7]. Sustainable strategies to establish appropriate health habits and behaviors during and across all stages of life are needed to promote lifelong mental and physical health and reduce the risk of the leading causes of morbidity and mortality, including chronic diseases (e.g., arthritis, heart disease, stroke, cancer, and type 2 diabetes), injury, violence, tuberculosis (TB), human immunodeficiency virus (HIV) infections, and other sexually transmitted diseases (STDs). Profound disparities exist in health behaviors, risk factors (e.g., tobacco use, poor diet, and physical inactivity), insurance coverage, access to healthcare, health outcomes, and disease burden of persons in all stages of life. Understanding the determinants of these disparities is necessary to ensuring that effective interventions that address economic, structural, cultural, and individual barriers to optimal health are developed and implemented for diverse population groups and communities. The dissemination of effective, sustainable interventions to protect and improve health throughout the lifespan will enhance health and quality of life. These interventions also can be used to discourage the risky behaviors that contribute to excess morbidity and mortality. Research focusing on health maintenance for persons in every stage of life is needed to promote optimal lifespan and ensure the best possible quality of life. This research will ultimately be used to help support people in all communities in their efforts to achieve healthy and productive lives.

1. Implement Effective Health Promotion Strategies

Develop and evaluate strategies that enable families, employers, and communities to establish and sustain healthy behaviors all across the life span.

Scope of Research: Conduct dissemination research to achieve widespread adoption and implementation of proven family-, school-, worksite-, and community-based interventions to sustain active lifestyles, healthy eating, tobacco cessation, and mental health. Develop and implement approaches to prevent or delay the onset of chronic diseases and conditions. Conduct research on the prevention of obesity and maintenance of optimal weight throughout the lifespan. Conduct economic research to identify the most promising interventions. Support high priority research identified through the systematic review process of the *Guide to Community Preventive Services* [11].

2. Reduce the Burden of Chronic Diseases

Develop and evaluate strategies that enable families, employers, and communities to control and prevent the burden of chronic diseases and to reduce the preventable physical and emotional adverse health effects associated with these diseases and conditions.

Scope of Research: Conduct research to estimate the current and future burden of chronic diseases, and identify the risk factors that contribute to the burden, including health behaviors, literacy, education, socioeconomic status, insurance coverage, access to healthcare, quality of care, self-care and preventive-care practices, and health-systems structure. Develop, implement, and evaluate strategies that enable families, employers, and communities to control and prevent chronic diseases (e.g., heart disease, stroke, type 2 diabetes, cancer, and arthritis) to reduce the preventable physical and emotional adverse health effects associated with these diseases and conditions. Examine linkages within the clinical care system to improve access to and quality of healthcare. Conduct community-based participatory research (CBPR) to develop and implement strategies that can be used to establish and maintain healthy behaviors throughout the lifespan (i.e., those that protect and sustain health, reduce the risk of chronic disease and disability, and maintain and enhance quality of life); these strategies should be particularly targeted to adults, including those who are elderly.

3. Reduce Disparity in Chronic Disease Burden and Risk Factors

Understand the determinants of disparities in chronic disease burden and risk factors, and implement effective interventions that address economic, structural, cultural, and individual barriers to optimal health, particularly among populations in which health disparities persist.

Scope of Research: Conduct research to estimate the extent and depth of disparities in health behaviors, risk factors (e.g., tobacco use, poor diet, and physical inactivity), insurance coverage, access to healthcare, health outcomes, and disease burden that exist at all stages of life. Identify and understand the causal factors (e.g., health behaviors, literacy, education, socioeconomic status, insurance coverage, access to healthcare, quality of care, self-care and preventive-care practices, and health systems structure) that contribute to the significant disparity in chronic disease burden experienced by racial, ethnic, and other population groups. Develop and implement interventions that work across diverse communities and population groups to ensure that all persons, particularly those at high risk for chronic disease, achieve an optimal lifespan and maintain the highest possible quality of life at any age.

B. Infant and Maternal Health

Every child deserves a healthy, strong start in life. Research that supports healthy mothers, healthy pregnancies, and healthy babies can ensure that our smallest citizens have the brightest futures possible.

One in every 33 babies born in the United States has one or more severe birth defects [12], and 17% of children <18 years old have a developmental disability [7]; the substantial medical, financial, and social consequences of adverse birth outcomes are lifelong for patients and their families. Approaches to enhance safe motherhood and promote infant and maternal health can significantly improve pregnancy and birth outcomes and help to stop the life-long effects of poor birth outcomes on affected infants and their families. Profound and persistent health disparities exist in maternal and infant health, pregnancy outcomes, and risk behaviors among women of reproductive age [13]. Eliminating health disparities for mothers and their children is a public health priority; several Healthy People 2010 objectives directly address the need to reduce these health disparities [14]. Research focusing on identifying and implementing promising approaches towards reducing these disparities is needed. In addition, effective interventions that promote pregnancy planning, preconception care, and safe motherhood and improve the health of all women and their infants also must be developed, implemented, and evaluated. Such interventions will prevent unintended pregnancy, teen pregnancy, and pre-term delivery; increase access and quality of care before, during, and after pregnancy; and increase breastfeeding rates.

Promoting healthy pregnancy and birth outcomes through the prevention and control of disability across the lifespan is critical to ensuring that infants and toddlers grow into healthy children and adults.

1. Pregnancy Planning and Pre-conception Care

Develop and evaluate strategies of promoting pregnancy planning and preconception care to improve birth outcomes and reduce the life-long effects of poor birth outcomes.

Scope of Research: Initiate and assess research-to-practice initiatives to promote pregnancy planning and preconception care through a broad range of healthcare programs and services. Initiatives should include assessment of maternal and paternal health history and behaviors before, during, and after pregnancy; delivery of vaccinations; screening for disease and genetic disorders; promotion of folic acid use; management of existing illnesses (e.g., diabetes); and provision of health services to address risky behaviors (e.g., smoking, alcohol use, and obesity).

2. Genetic Causes of Birth Defects and Blood Disorders

Identify and evaluate genetic factors in birth defects and blood disorders that can lead to effective interventions to improve health.

Scope of Research: Assess genetic factors in the causation, course, prevalence, and burden of secondary physical, social, emotional, and mental health conditions that affect persons with birth defects and hereditary blood disorders. Identify interventions to maximize the health and well-being of such persons.

3. Healthy Birth Outcomes

Identify and assess the impact of factors that lead to birth defects and developmental disabilities, and identify and evaluate interventions to prevent such adverse events and promote healthy birth outcomes.

Scope of Research: Identify and assess interventions that can improve birth outcomes by preventing risk of unintended pregnancy, teen pregnancy, and pre-term delivery. Identify and assess the impact of factors that contribute to adverse birth outcomes (e.g., birth defects and developmental disabilities), including those associated with genetics, maternal and paternal environmental exposures, cultural practices, and social status. Identify new risk factors for birth defects and other adverse birth outcomes during

pregnancy planning, pre-conception, pregnancy, or in the newborn period. Conduct studies to identify potential interventions to address adverse birth outcomes.

4. Promote Safe Motherhood and Infant Health

Develop and evaluate strategies to promote safe motherhood and promote maternal and infant health.

Scope of Research: Develop and evaluate strategies to enhance infant and maternal health by increasing access to and quality of care before, during, and after pregnancy. The implementation of these strategies will prevent unintended pregnancy, teen pregnancy, and pre-term delivery. Understand the determinants of infant feeding behavior, including breastfeeding initiation and continuation. Conduct clinical trials of drugs and nutritional supplements to prevent mother-to-child transmission of human immunodeficiency virus (HIV) and other diseases. Identify the role of fetal development and infant care, including increasing breastfeeding practices, on reducing chronic disease and disabilities in subsequent life stages.

C. Health and Development of Children and Adolescents

Approximately 17% of children in the United States have some type of developmental disorder [7], and an estimated 31% of all children and adolescents have some type of chronic health condition [15,16], placing them at increased risk for poor health and educational outcomes. In addition, over the past 30 years, rates of obesity, a condition that has been associated with early onset of type 2 diabetes and decreased cardiovascular health [17], have increased by two- to three-fold among children and adolescents. Health issues that begin *in utero* and early in life can have life-long consequences. Therefore, the development and dissemination of effective interventions that ensure early access to appropriate services likely would significantly reduce excess morbidity and mortality among children, adolescents, and adults and would result in improved health and educational outcomes. Substantial disparities in health behaviors, health outcomes, educational, and social outcomes exist among children and adolescents of varying racial and ethnic groups. The determinants of these disparities must be better elucidated to ensure the development and implementation of effective, population-specific interventions that can be used to: a) break down the financial, structural, and personal barriers to optimal health and development; and b) increase access to needed care. Research is needed regarding the

Too many children suffer from health conditions that can be prevented. Finding better ways to promote lifelong health will give all children a chance to grow safe and strong.

development and implementation of effective approaches that will enable families, healthcare providers, schools, and communities to improve the health and development of children and adolescents. Effective interventions are critical to the physical and emotional well-being of children of all ages and ultimately will help young persons grow into healthy, independent, and productive members of society.

1. Optimal Child Development

Develop and evaluate strategies to improve the health and fitness levels of U.S. children and to establish health behaviors that promote lifelong health by reducing the leading causes of morbidity, mortality, and disability across the lifespan.

Scope of Research: Study the prevalence of risk factors, health status, and rates of disability among children. Develop broad research-to-practice initiatives to promote optimal child development (e.g., improving access to diagnosis, referral, and intervention for developmental disabilities and other adverse conditions of childhood with significant morbidity or mortality). Identify factors that promote or hinder early identification, diagnosis, and treatment of developmental disabilities and other cognitive, social, emotional, or behavioral health problems emerging in childhood and early adolescence. Evaluate coordinated developmental screening and other services for children with developmental disabilities. Assess current fitness levels among children, and examine the relationship between physical fitness and: a) school policies and programs (e.g., health education, physical education, and food services); b) family knowledge, attitudes, and behaviors; and c) community-based sources of support. Translate research to increase the dissemination of effective interventions (e.g., the delivery of oral health services in school settings). Conduct economic research to identify and implement interventions that would yield the greatest health impact per dollar invested.

2. Optimal Adolescent Development

Develop and evaluate strategies to improve health and fitness levels of U.S. adolescents, and establish health behaviors that promote lifelong health and reduce the leading causes of morbidity, mortality, and disability among youth and adults.

Scope of Research: Study the prevalence of risk factors, health status, and rates of disability among adolescents. Conduct dissemination research to achieve widespread adoption and

implementation of proven school-, family-, and community-based interventions for promoting optimal health and development among adolescents with physical, emotional, social, and physical disabilities. Identify interventions to prevent physical inactivity, poor diet, tobacco use, alcohol use, risky sexual behaviors, and other factors that contribute to obesity, heart disease, type 2 diabetes, cancer, injury, violence, human immunodeficiency virus (HIV) and other sexually transmitted diseases (STDs), and unintended pregnancy. Assess fitness levels among adolescents, and determine the relationship between physical activity and academic performance. Evaluate the impact of interventions directed to parents of adolescents that are intended to increase parental influence on risky health-related behaviors. Conduct economic research to identify and implement interventions that would yield the greatest health impact per dollar invested.

D. Adult and Older Adult Health

By 2015, the baby boomer population will represent almost one third of the U.S. population. The health challenges facing this adult population are different than those that affected past generations of adults. Because rates of overweight and obesity have more than doubled among adults during the past 30 years, this segment of the population is beginning to face the adverse health effects associated with increased weight, including type 2 diabetes, hypertension, cardiovascular disease, arthritis, and some cancers. In addition to chronic diseases, many adults are also at risk for HIV and other sexually transmitted infections. Older adults continue to face other challenges associated with the aging process. As persons age, they increase their risk for certain injuries, which can result in disability and death [18]. Research to enable individuals, families, health systems, employers, and communities to address these health challenges will greatly improve health among adults of all ages and is critical to achieving CDC's ambitious Health Protection Goals.

We must help more Americans live better and longer by preventing disease and injury and promoting healthier, safer choices.

Profound racial and ethnic disparities persist among adults and older adults. These disparities can be seen in health behaviors, chronic disease burden, insurance status, access to healthcare, health outcomes, and educational and social status. Understanding the causes of these disparities is a crucial step towards developing and implementing the most effective interventions for promoting health in all adult populations. Research to develop and disseminate the most effective adult interventions can help reduce the risky behaviors that contribute to excess illness, disability, and death in adults and older adults and can enhance health and quality of life during the most productive years of life.

1. Reduce the Burden of, Disparities in, and Risk Factors for Chronic Diseases Among Adults

Develop, implement, and evaluate strategies to establish health behaviors during adulthood that promote lifelong health and reduce the risk of the leading causes of morbidity and mortality, including tobacco use, obesity, heart disease, type 2 diabetes, cancer, injury, violence, HIV and other sexually transmitted diseases.

Scope of research: Evaluate strategies for dissemination and widespread adoption and implementation of proven community-based interventions that: a) promote active living, healthy diets, and tobacco cessation; and b) discourage the excessive use of alcohol and risky sexual behaviors. Develop, implement, and evaluate approaches to prevent or delay the onset of related chronic diseases. Evaluate interventions to enhance access and quality of healthcare, especially preventive services. Examine the burden and current and emerging risk factors for chronic conditions. Evaluate the effectiveness of policy and environmental interventions. Examine the impact of chronic diseases on mental health in the adult population. Conduct economics-based methodological research to advance health, and conduct behavioral risk surveillance.

2. Reduce the Burden of, Disparities in, and Risk Factors for Chronic Diseases Among Older Adults

Develop, implement, and evaluate strategies to establish and maintain behaviors during older adulthood that sustain health, reduce the risk of chronic disease and disability, maintain quality of life, and decrease healthcare costs.

Scope of research: Assess the burden and risk factors for certain chronic diseases and conditions, including Alzheimer's disease, arthritis, depression, psychiatric disorders, osteoporosis, Parkinson's disease, and urinary incontinence; develop effective public health interventions to prevent or delay the onset of these conditions. Develop and evaluate interventions for the prevention and control of complications and disabilities that result from arthritis, cancer, cardiovascular disease, diabetes, and other major chronic diseases. Develop, implement, and evaluate interventions to maintain overall quality of life, including the mental and physical aspects of health.

E. Health Among Persons with Disabilities

Scientific advances have helped more people with disabilities live longer lives. More information is needed to prevent disease, treat illness, and promote health so that people with disabilities can have the best health, in every stage of life.

Disabilities impose an enormous personal and social burden on persons living in the United States. Each year, one of every 33 babies is born with a severe birth defect. Approximately 17% of children <18 years of age have a developmental disability [7], and 2% of those who are school-aged have a developmental disability that has been defined as being severe [19]. Of all persons living in the United States, approximately 54 million are living with a disability at an annual cost of \$300 billion [20,21]. An estimated 24 million persons suffer from severe disabilities, including cerebral palsy, rheumatoid arthritis, spina bifida, developmental disorders, inherited blood disorders, and spinal cord injury [22]. Information is lacking regarding the course of these disabling conditions and related secondary conditions as persons move through different stages of life; the 24 million persons currently affected by severe disabilities represent the first generation of such persons to have lived into middle or old age. Understanding and preventing poor health in this population will have a significant impact on healthcare resources. Knowledge of the course and impact of illness on disabled populations will help in the development of health promotion interventions and the reduction of health disparities. In addition, research on the adverse health effects experienced by persons with disabilities, particularly those in populations most affected by health disparities, will help persons with disabilities achieve an optimal lifespan and experience the best possible quality of health in every stage of life.

1. Health Across the Lifespan Among Persons with Disabilities

Determine how illness affects persons with disabilities across the lifespan to identify promising interventions to promote health and prevent illness.

Scope of Research: Study the course, prevalence, and burden of secondary physical, social, emotional, and mental health conditions across the lifespan of persons with developmental or physical disabilities, congenital disabilities, and chronic or hereditary conditions. Determine methods of identifying and treating common chronic illnesses (e.g., heart disease and diabetes) among persons with disabilities. Identify promising interventions to maximize the health and well-being of persons with hereditary blood disorders.

2. Early Identification of Developmental Disabilities

Develop and evaluate early identification and intervention strategies among children with developmental disabilities to improve academic achievement; social, emotional, and behavioral health; and physical health throughout childhood and the lifespan.

Scope of Research: Design and evaluate measures for effectively tracking the development of infants, children, and adolescents with mental retardation, autism, and other developmental disabilities to identify opportunities for intervention as they emerge. Design and evaluate targeted measures to identify the specific, unique needs of children with developmental disabilities. Implement a research-to-practice initiative that identifies and implements the most effective and cost-effective interventions to maximize growth and development during childhood and adolescence.

3. Health Among Infants, Children, and Adolescents with Disabilities

Determine how children with disabilities are affected by associated health and social conditions and how best to intervene to ensure their health and well-being.

Scope of Research: Assess the course, prevalence, and burden of secondary physical, social, emotional, and mental health conditions that affect children of all ages who have birth defects and developmental disabilities. Identify promising interventions to maximize the health and well-being of these children.

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VI. Create Safe Places to Live, Work, Learn, and Play

When people interact with their environment, many preventable threats to health exist including injuries, violence, and diseases. Injuries and violence are the leading causes of death among persons aged 1-44 years and represent the leading causes of potential years of life lost. In addition, work-related injuries and diseases continue to take a toll on the health of the U.S. workforce and on the economy, and environmental exposures likely are the cause of a substantial percentage of the global burden of disease.

Research to understand and address risk factors and to promote health and quality of life by preventing or controlling injuries, diseases, and deaths associated with the environment, workplace, and other settings is critical to CDC's mission. Such research will help CDC reach its Health Protection Goals for the 21st century by ensuring that the places where people live, work, learn, and play support and promote the health, safety, and overall well-being of all persons, particularly those who are at greater risk for health disparities.

To reduce the burden of environmental and occupational health threats, CDC must engage in a broad spectrum of research, including surveillance and problem identification, risk-factor analysis, intervention development, and translation and dissemination of scientific information. Accomplishing this wide range of activities requires the collaboration and coordination of researchers representing many different disciplines, including behavioral and social science, medicine, ergonomics, epidemiology, biological sciences, engineering, health education, industrial hygiene, toxicology and environmental health science, and work organization. Research areas in this chapter include:

A. Environmental Health

B. Occupational Safety and Health

C. Injury and Violence

A. Environmental Health

Where we live is just as important to our health as how we live. Research that uncovers environmental hazards will protect the quality and safety of our air, food, and water.

The environment is everything around us — the air we breathe, the water we drink and use, and the food we consume. It is also the chemicals, radiation, microbes, and physical forces with which we come into contact. An estimated 7.5%-33% of the global burden of disease can be attributed to environmental exposures [23]. Populations that are particularly vulnerable to certain environmental hazards include children, the elderly, and people with disabilities. The distribution and severity of environmental exposures must be understood for different subpopulations, especially persons who are economically disadvantaged who often have the greatest risk for exposure to hazardous environmental conditions. A better understanding of the varying susceptibility of people to environmental exposures as influenced by age, nutrition, pre-existing disease, and stage of life also must be obtained, because this type of information is useful in identifying those populations at highest risk for adverse health effects and in greatest need of intervention. Examining the relationship between people, the environment, and health can help elucidate ways to prevent illness, injury, disability, and death. To maximize health impact, research focusing on the prevention of disease and injury resulting from the interaction of people and their environment should be conducted in collaboration with community stakeholders and with academic, private, and government researchers.

1. Environmental Risk Factors

Establish the major environmental causes of disease and disability, and identify related risk factors.

Scope of Research: Investigate the relationship between health and the environment using a broad approach that accounts for the biological, physical, chemical, genetic, economic, and psychosocial factors that can influence health throughout all stages of life. Identify the major environmental causes of disease among high-risk populations (e.g., children, pregnant women, and the elderly), and obtain nationally representative prevalence and incidence data. Conduct research to assess exposure to, identify risk factors for, and assess attributable risks associated with emerging environmental contaminants (e.g., endocrine disruptors, aquatic toxicants, nanotechnology, and pharmaceuticals).

2. Complex Environmental Exposures

Develop, evaluate, and apply new and innovative methods for assessing the toxic action and health impact of multiple environmental exposures.

Scope of Research: Develop cross-cutting biomedical and modeling tools to better understand the ways in which exposures to chemical mixtures and other environmental agents impact health. Examine the cumulative effect of multiple environmental exposures in relation to individual genetic and biological predisposition, especially among persons in vulnerable, high-risk populations.

3. Environmental Bio-monitoring Methods and Tools

Evaluate the use of bio-monitoring technology to measure chemicals and other markers in humans to assess exposures and health outcomes in environmental and work settings.

Scope of Research: Develop and evaluate methods and modeling tools to better understand how bio-monitoring can be used to protect people from illness, birth defects, disabilities, cancer, and death caused by hazardous environmental exposures.

4. Environmental Health Interventions

Identify, develop, and evaluate the effectiveness of interventions, and elucidate best practices to prevent environmental health threats and promote health.

Scope of Research: Design, implement, and evaluate environmental health interventions (including engineering controls) and health promotion activities that address complex environmental health issues, especially in susceptible populations (e.g., the elderly, children, persons who are disabled, and persons who are economically disadvantaged). Develop risk communication strategies, multicultural outreach initiatives, and community participatory research to reduce exposure to environmental hazards, and conduct intervention evaluation research that assesses behavior change in response to these public health efforts.

5. Lead Exposure and Health

Develop and evaluate policy interventions to eliminate elevated blood lead levels in the United States.

Scope of Research: Design, implement, and evaluate policy interventions in communities most likely to be exposed to lead (e.g., communities with substantial numbers of racial and ethnic minorities and those comprised of persons who have recently immigrated to the United States).

6. Environmental Data and Information Systems

Develop methods and tools to link available environmental hazards and health-outcome databases to support environmental public health tracking.

Scope of Research: Develop epidemiologic, statistical, and programmatic methods and tools that can be used to link available information and further the knowledge base for topics related to environmental hazards and health outcomes. Assess and demonstrate the value of developing partnerships with organizations (e.g., Kaiser, the Veterans Administration, and Medicaid) that collect health systems data to facilitate the linkage of environmental and health data regarding a wide variety of health outcomes, including chronic diseases. Develop strategies to make data, methods, and tools for linking environmental and health data widely accessible and available to researchers from academic, private, state and local health department, and federal settings.

Research that supports healthy workplaces keeps our workforce healthy and our economy strong.

B. Occupational Safety and Health

Work-related injuries and diseases take a significant toll on human health and the U.S. economy. Each day in the United States, nearly 11,000 workers are treated in emergency departments, and approximately 200 of these workers are hospitalized [24]. An estimated 6,300 private-sector workers require time away from their jobs each day as a result of workplace injury [25], and 15 workers die from their injuries [26]. An average of 134 Americans die of work-related diseases every day [27]. Annually, these losses account for nearly \$73 billion in workers' compensation claims [28] and total costs to the economy of \$155 billion [29].

Research in occupational safety and health is needed to improve the ability of employers, workers, and others to establish and maintain safe and healthful workplaces and working conditions for the 150 million civilians employed in the United States. This includes research to identify emerging hazards associated with new industrial processes, new ways of organizing work, and new chemicals, materials, machinery, and tools. It is well recognized in public health that workers typically are exposed “first and worst” to toxicants that also become general environmental hazards, such as lead, asbestos, PCBs, and dioxin. Research is needed to produce better protections for many longstanding hazards as well, such as work at heights, physically and psychologically stressful working conditions, work with and around heavy machinery and motor vehicle traffic, work-noise levels damaging to hearing, and work in environments and processes involving ionizing radiation and toxic materials and contaminants. In addition, research is needed with a special focus on protecting worker populations that have high risks of occupational injury or disease due to special susceptibilities (e.g., gender, age, genetic, socioeconomic, and educational) or demographically distinct populations (e.g., low-wage workers, undocumented workers, minority workers) that have disproportionate exposure to hazardous work.

To accomplish the wide range of research activities that are needed to further understand and prevent workplace injury and disease, broad and diverse scientific disciplines must become involved. Expertise is needed from researchers who work in the fields of medicine, ergonomics, epidemiology, biological sciences, engineering, health education, industrial hygiene, intervention evaluation and translation, and work organization. Research in occupational safety and health will help accomplish the basic public health objectives of promoting and protecting the health and safety of members of the U.S. workforce; research findings will help guide the development of comprehensive programs and policies for the prevention and control of workplace-related illnesses, injuries, and ultimately deaths. This U.S. research also serves a global audience and promotes its efforts to improve the safety and health of all working people in every nation.

A general framework for occupational safety and health research is provided below. More detailed priorities for research are being developed in establishing the second decade of the National Occupational Research Agenda or NORA (see <http://www.cdc.gov/niosh/nora/>).

1. Fatal and Nonfatal Injuries at the Workplace

Identify specific risk factors associated with fatal and nonfatal injuries, and develop and evaluate interventions for reducing such injuries.

Scope of Research: Improve surveillance methods to monitor health among members of the workforce and to detect and investigate health problems. Direct research efforts towards reducing health disparities among different worker subpopulations that are disproportionately affected by workplace injuries. Enhance surveillance methods and activities by exploring new sources of data, identifying ways to improve identification of work-related injuries in existing databases, linking data from various existing sources, and developing better methods to assess injury exposures and intervention outcomes. Conduct analytical research to identify injury risk factors and to quantify them by industrial sectors, priority areas (e.g., deaths from motor vehicles, machines, violence, and falls and traumatic injuries caused by falls or contact with machines, materials, equipment, and tools), and high-risk group (e.g., construction workers, loggers, miners, farmers, farm workers, rural workers, adolescents, and workers aged ≥ 45 years). Develop and evaluate the effectiveness of interventions to prevent occupational injuries and evaluate factors that can influence the adoption of proven technologies and strategies for protecting workers.

2. Occupational Diseases

Improve understanding of the role and burden of workplace exposures to diseases, and determine sector-specific risk factors, mechanisms, and effective prevention strategies.

Scope of Research: Conduct research to close gaps in knowledge pertaining to the occurrence of and risk factors for occupational diseases (e.g., respiratory diseases, cardiovascular diseases, dermatitis and other skin disorders, fertility and pregnancy abnormalities, and infectious diseases). Identify high-risk occupations and exposures within industrial sectors. Evaluate workplace exposures and develop appropriate prevention and control strategies, including modification of workplace practices, engineering controls, and protective equipment.

3. Occupational Musculoskeletal Disorders (MSDs)

Improve understanding of the relationship between ergonomic stressors and MSDs, and develop and evaluate interventions.

Scope of Research: Study the causes and risk factors for musculoskeletal disorders (MSDs), and conduct basic research to define the pathophysiologic mechanisms of chronic musculoskeletal injury. Identify reliable clinical methods to diagnose MSDs before they become severe and to rehabilitate disabled workers as fully and rapidly as possible. Identify and evaluate the effectiveness of intervention strategies intended to prevent MSDs through better cost-effective tool and equipment designs, work-rest periods, or changes to the organization of work. Develop more effective methods to promote the adoption of intervention strategies in the workplace.

4. Safe Workplace Design

Identify engineering and policy approaches that encourage the design of industrial processes that minimize occupational exposures and risks.

Scope of Research: Investigate ways to enhance the prevention of work-related injuries and diseases through improvements to the designs of the physical workplace and its equipment, tools, and systems. Identify current and new engineering controls that help reduce injury and toxic exposures in the workplace, including the substitution of safe materials for those that are hazardous, design changes to equipment, and modification of work methods. Identify effective administrative policies for the design of workplaces and equipment that have the potential to reduce or eliminate hazards associated with occupational exposures, including modification of work practices, enhancement of management policies, and improvement of training programs. Evaluate existing and proposed engineering controls and administrative policies to determine their effectiveness.

5. Organization of Work

Determine the potential effects of work organization on workers' mental and physical health, and identify intervention strategies to promote better overall health through workplace programs.

Scope of Research: Conduct surveillance studies to detect and investigate health problems associated with the ways in which work is organized. Conduct etiological research to better understand how the psychological and physical health of workers is being impacted by current approaches to work organization, and determine through intervention effectiveness studies how to control adverse effects and develop and encourage the use of approaches that protect and promote the health of the workers. Conduct economics, industrial organization, and epidemiological research to examine how: a) work organization is influenced by the changing economy, industrial practices, and workforce demographics; and b) how these changes contribute to adverse and positive health outcomes.

6. Emerging Workplace Hazards

Identify emerging hazards in the workplace resulting from changes in work practices and technologies, and develop and evaluate interventions.

Scope of Research: Investigate ways to enhance prevention and to detect and investigate health problems associated with emerging workplace hazards. Enhance occupational surveillance methods to facilitate identification of new hazards and their potential to cause harm to workers. Develop and evaluate control and prevention strategies as new hazards are identified. Assess the role of control technology in preventing emerging hazards, including the potential for this type of technology to: a) reduce or eliminate hazards; and b) be properly used in the workplace. Determine the cost effectiveness of control technologies in responding to a new hazard.

C. Injury and Violence

Injuries and violence are the leading causes of death among persons aged 1-44 years, represent the leading causes of potential years of life lost, and are linked to long-term educational, occupational, physical, and mental health consequences. For persons aged 1-34 years, unintentional injuries alone claim more lives than any other cause of death. The impact of injuries resulting from all types of violence, including interpersonal violence (i.e., intimate partner violence, child maltreatment, youth violence, and sexual violence), is also substantial. Homicide is the second leading cause of death for persons 15-24 years of age and the third or fourth leading cause

Finding better ways to prevent injury and violence will help Americans live safer, longer lives.

for every other age group ≤ 34 years. Suicide is not only the eleventh leading cause of death across all ages, but ranks second for persons 25-34 years of age and third for persons aged 15-24 years. Racial, ethnic, socioeconomic and geographic factors contribute to injury disparities between populations; persons in racial and ethnic minority groups have the highest rates of unintentional injury and violence [30]. Decreasing injury rates and improving care for the injured would likely have significant and immediate effects on U.S. rates of morbidity and mortality and would improve the long-term physical, social, and behavioral functioning of persons who have experienced injuries and violence. Improvements in injury rates and post-injury care also would likely lower the cost of healthcare. Research devoted to the prevention of risk behaviors, the improvement of the environments most often associated with injury and violence, and prevention of post-injury adverse health effects is needed to reduce the burden of injuries and violence in all populations. Examining these factors for the populations that are most affected by injuries and violence (e.g., persons who are in racial and ethnic minority groups, are economically disadvantaged, and those who live in rural communities) will help narrow existing health disparities in the United States.

1. Injury and Violence Prevention Interventions

Develop and evaluate the efficacy, effectiveness, and economic efficiency of interventions to prevent and reduce the consequences of interpersonal violence, suicidal behavior, and unintentional injury.

Scope of Research: Develop and evaluate various interventions (e.g., behavioral, educational, environmental, policy, engineering, legislative, enforcement, and social/cultural) to prevent and control injuries and violence. Examine the effectiveness of programs in "real world" circumstances, and measure outcomes on injury, injury-associated risk behaviors, and costs. Evaluate the effectiveness and efficacy of interventions using risk communications and ecological approaches. Evaluate injury and disability outcomes in relation to costs, changes in social norms, changes in behavior, legislation, and engineering/technology improvements. Evaluate the effectiveness of interventions aimed at improving parenting and caregiver skills in preventing interpersonal violence, suicidal behavior, and unintentional injury in children and adolescents.

2. Risk and Protective Factors for Unintentional Injury

Identify the risk and protective factors associated with the leading causes of fatal and non-fatal unintentional injury in all stages of life.

Scope of Research: Examine risk and protective factors associated with injury and risk-taking behavior, particularly among adolescents and other populations that are most impacted by injury. Study the influence of peers, family, and the local social and physical environment on changing risks and risk-taking behaviors. Develop interventions that modify environments and behaviors to reduce the leading causes of unintentional injury in adolescents.

3. Risk and Protective Factors for Interpersonal Violence and Suicidal Behavior

Identify the risk and protective factors associated with interpersonal violence and suicidal behavior in all stages of life.

Scope of Research: Identify risk factors associated with interpersonal violence and suicidal behavior, particularly among adolescents and other populations that are at increased risk for injury resulting from such behaviors. Identify protective factors that can decrease risk (e.g., strong connections to parents, family, school, religious faith, and community programs and services).

4. Trauma Systems Research

Determine and evaluate how the components of trauma systems, including disability and rehabilitation services, improve short and long-term health outcomes and costs for the acutely injured.

Scope of Research: Identify and evaluate the specific components of trauma systems (e.g., pre-hospital settings, emergency departments, and hospital-based trauma centers) that improve outcomes for the injured in both urban and rural environments. Identify and evaluate the specific components of disability and rehabilitation services that lead to improved outcomes. Identify the costs associated with improvements in trauma care and rehabilitation.

5. Connection Between Multiple Forms of Violence

Identify the relationships between different forms of violence and other public health problems, and evaluate integrative strategies to address them.

Scope of Research: Identify populations that are at increased risk for multiple forms of violence (e.g., youth violence, intimate partner violence, sexual violence, child abuse, elder abuse, and suicidal behavior). Determine the extent to which different forms of violence and other health problems (e.g., substance abuse and mental illnesses) share common risk and protective factors. Develop and evaluate interventions designed to address these commonalities. Assess the mental-health outcomes for victims and perpetrators resulting from multiple forms of violence.

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VII. Work Together to Build a Healthy World

The United States is committed to improving the health of people living around the world, regardless of which country they call home. CDC is working to support this effort through the development of agency-wide research priorities that focus solely on global health. Current global health research must reflect the growing need to address disease threats emerging from outside the United States as a result of increasing international travel, global commerce, and other factors that lead to the worldwide circulation of diseases and other health threats. CDC has identified several cross-cutting research areas that target: a) the problems most affecting the world's population; and b) those that disproportionately affect certain populations and communities including women, children, and persons who are economically disadvantaged. The research areas target major determinants of global disease and injury and focus on the tools needed for sound and effective public health action. They also address some of the greatest causes of global disease and disability and aim to diminish the severe inequities that persist in many developing countries. The implementation of this research supports three CDC's three global health goals: sharing research capacity to benefit the health of global populations, furthering the understanding of external threats to better protect the health of persons living in the United States, and using research as an instrument of world diplomacy. Research areas in this chapter include:

- A. Supporting Goals for Global Health**
- B. Disease and Injury Prevention and Control in Global Settings**
- C. Health of Vulnerable Populations in Global Settings**
- D. Societal Determinants of Health in Global Settings**
- E. Tools for Global Public Health**

A. Supporting Goals for Global Health

Poor nutrition and disease prey on the world's most vulnerable, including the millions of children who die each year before their fifth birthdays. By reducing the spread of HIV, increasing childhood immunization, and improving nutrition we can help more children grow safe and strong.

The United States and other nations around the world are committed to achieving specific goals to improve global health. These goals include those in the President's Emergency Plan for AIDS Relief (PEPFAR) [31], as well as the Millennium Declaration [32]. They reflect a U.S. commitment to address the health concerns that are most threatening the livelihood of people worldwide. Several priority concerns have been identified. One such concern is the 40 million cases of human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) [33] that occur worldwide each year. Also concerning are the 8.3 million annual cases of tuberculosis (TB) [34] and the more than 300 million curable cases of sexually transmitted diseases (STDs) that occur each year [35], which significantly enhance HIV transmission and cause adverse pregnancy outcomes, infertility, and cervical cancer. Another priority global health problem is the millions of deaths occurring each year among children younger than 5 years of age living in 42 countries around the world [36]; although the means to prevent these deaths are well understood (e.g., through the receipt of vaccine and consumption of micronutrients), preventive measures remain unavailable to millions of affected children. Other priority health concerns include: a) the major disparities in maternal mortality that exist from country to country; and b) the lack of safe drinking water in many countries around the globe; each year, 1.6 million deaths (most of which occur among children <5 years of age) can be attributed to unsafe water, sanitation, and hygiene [36].

The achievement of these global health commitments will impact the health of persons around the world by reducing major health inequities. To be effective, however, the interventions needed to achieve global health goals in diverse settings must be guided by operational research. Such research will benefit large populations of persons living in countries of greatest need and will help CDC achieve global health goals to: a) reduce child mortality; b) increase life expectancy; and c) decrease disease and disability among persons of all ages.

1. Global Mortality Among Mothers and Young Children

Develop, implement, and evaluate interventions that increase maternal and child survival in priority countries to meet the respective goals of the Millennium Declaration.

Scope of Research: Conduct operational and evaluation research to obtain essential information needed to guide the development and implementation of programs to prevent deaths among mothers and young children. Priority topics include: a) emergency obstetric care; b) the practice of spacing and limiting births; c) breastfeeding practices; d) diseases that affect newborns; e) the major causes of child mortality (e.g., malaria, diarrheal diseases, pneumonia, and measles); f) major risk factors for mortality (e.g., malnutrition); g) critical areas of intervention (e.g., family planning and appropriate drug therapy) and; h) health system needs for providing effective interventions.

2. Immunization to Eliminate and Protect Against Global Diseases

Evaluate interventions to increase the impact of global immunization programs.

Scope of Research: Determine the field effectiveness of current and new vaccines, and assess effectiveness and economics of different strategies to increase immunization coverage. Evaluate the integration of immunization with other health interventions. Identify new technologies for vaccine-preventable disease surveillance in resource-poor international settings, including developing field-appropriate methods for detection and laboratory confirmation of measles, rubella, poliomyelitis and other vaccine-preventable diseases. Evaluate the morbidity, mortality and economic impact of diseases for which established vaccines exist and for which new vaccines are in development. Evaluate disease elimination efforts and strategies including evaluation of national immunization programs, policy, surveillance, and other strategies.

3. Global Micronutrient Malnutrition

Develop, implement, and evaluate interventions to prevent vitamin and mineral deficiencies of global importance.

Scope of Research: Improve micronutrient (e.g., iodine, iron, zinc, vitamin A, and folate) assessment methods. Investigate the efficiency of different micronutrient delivery strategies, including fortification of foods, and evaluate program effectiveness in priority settings. Develop methods to quantify the problem of micronutrient deficiencies in stable and complex humanitarian emergency (CHE) environments and identify interventions to treat and prevent such deficiencies.

4. Global Efforts for Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS), Tuberculosis (TB), and Sexually Transmitted Disease (STD)

Develop, implement, and evaluate approaches regarding the prevention and treatment of, diagnostic testing and surveillance for, and delivery of services associated with these diseases.

Scope of Research: Develop, implement, and evaluate behavioral and biomedical interventions to prevent and treat HIV infection among adults and children and to integrate reproductive services with HIV prevention. Identify behavioral interventions to promote: a) knowledge of HIV status; b) treatment adherence; and c) simpler, less costly diagnostic techniques. Develop and evaluate interventions to prevent or reduce STDs among vulnerable populations. Conduct operational research to strengthen global TB surveillance and control. Develop and evaluate new and more rapid diagnostic testing for multidrug-resistant TB.

5. Global Water Safety

Determine the burden of illness associated with water supplies from untreated sources in global settings, and investigate interventions for the prevention of diseases.

Scope of Research: Determine the burden of illness associated with water supplies from untreated sources, and identify existing risks to vulnerable populations (e.g., young children and PLWHA (people living with HIV/AIDS)). Assess the efficacy and effectiveness of interventions that have a high likelihood of being sustainable in international settings (e.g., water treatment at the household level). Identify barriers to access for appropriate technologies, evaluate the efficiency and effectiveness of innovative implementation strategies in increasing access to safe water in target populations, determine the cost effectiveness of different appropriate technologies and implementation approaches, and assess the effectiveness of different behavior-change techniques in motivating adoption of appropriate technologies. Conduct operations research to identify factors that will enhance the successful implementation of large-scale programs.

B. Disease and Injury Prevention and Control in Global Settings

Disease, injury, and violence threaten the health of all countries. CDC and its partners can work together to promote healthy people in a healthy world.

The major causes of morbidity and mortality in the world must be elucidated before disease and injury prevention and control efforts can be successful in global settings. Of the approximately 57 million deaths worldwide in 2003, an estimated 15 million (>25%) were caused by infectious diseases [37]. Although a subset of these diseases has been targeted for elimination, new infections continue to emerge, and existing diseases re-emerge in more virulent forms, making prevention and control efforts challenging. In 2003, 59% of the 57 million deaths and 46% of the global burden of disease was caused by non-communicable chronic conditions, including cardiovascular diseases, diabetes, obesity, cancer, and respiratory diseases [38].

More than 5 million people around the world die each year from injuries, with 1.2 million deaths being traffic-related [39, 40], and 1.6 million deaths resulting from acts of violence (http://www.who.int/violence_injury_prevention/violence/en/). The rates of violent death in low- to middle-income countries are more than twice as high (32.1 per 100,000) as those in high-income countries (14.4 per 100,000) [41]; in addition, most drowning deaths, traffic-related deaths, and pedestrian deaths occur among children in low- and middle-income countries [40, 42]. Substantial differences in the epidemiologic patterns and the rates of death and disability from injuries and violence can be observed between world regions and across age groups. Many countries do not have the capacity to provide prompt emergency care, including rapid movement of injured victims from the scene of injury to a healthcare facility [43], which likely contributes to global disparities in health outcomes.

Globally, 1.7 million deaths each year are caused by illness and injury associated with workplace hazards. Each year, 268 million non-fatal injuries and 160 million new cases of work related-illness are reported [44].

Public health interventions directed at the prevention and control of the diseases and injuries that cause the most morbidity and mortality are among the most effective ways to improve the health of large populations. Such public health interventions identify those populations most in need and can be employed to reduce disparities by better reaching groups that do not have access to traditional modes of care.

1. Global Infectious Diseases

Develop and evaluate functional tools to detect, diagnose, predict, and respond to endemic and emerging infectious diseases of global or regional importance.

Scope of Research: Develop and assess new tools (e.g., drugs, diagnostics, and vaccines), surveillance methods, treatment regimens, and intervention strategies for the control, prevention, and eventual elimination of infectious diseases. Priority research areas will address: a) infectious diseases that pose the greatest threat to public health; b) those targeted for elimination; c) infections associated with high fatality rates; and d) infections with substantial potential for international transmission.

2. Global Burden of Non-Communicable Diseases

Define the magnitude of global non-communicable diseases, identify the major risk factors for the disproportionately high burden of such disease in the developing world, and develop and implement interventions for disease prevention and control.

Scope of Research: Assess methods for quantification of the burden of non-communicable diseases in developing countries. Identify the individual and contextual determinants that shape health behaviors of individuals, groups, and communities, as well as the environmental determinants contributing to such disease. Develop new intervention strategies to reduce the risk factors associated with unhealthy behaviors. Priority research areas include cardiovascular disease, hypertension, cancer, diabetes, mental illness, and oral health, as well as major risk factors (e.g., tobacco and obesity).

3. Global Burden of Injuries

Identify the causes, consequences, and costs of intentional and unintentional injuries, and assess the efficacy, effectiveness, and economic efficiency of interventions to prevent injuries and mitigate consequences.

Scope of Research: Determine the relationship between various aspects of globalization (e.g., economic, environmental, and cultural factors) and violence and injury (both intentional and unintentional). Identify risk and protective factors common to

different cultures and settings. Develop primary and secondary prevention approaches that impact all populations in various settings, focusing on developing countries. Evaluate diverse international public health programs created to prevent injuries, improve injury care, and reduce adverse health outcomes.

4. Global Occupational Health

Identify, develop, and evaluate effective interventions to reduce hazardous exposures and safety risks at the workplace that contribute to the high rates of work-related disease and injury in developing nations.

Scope of Research: Evaluate interventions from developed countries to determine whether they can be adapted for use in both urban and rural work settings in developing countries. In conjunction with existing preventive measures and in light of local operational constraints, develop technologies to ensure the continuing health and well-being of persons in the workplace. Inventory, compare, and contrast intervention alternatives relative to health effects, costs, and benefits. Identify and develop user-friendly model(s) to determine the type of intervention required. Evaluate strategies to build capacity and professional collaborations in developing nations to overcome barriers and satisfy global workplace needs.

C. Health of Vulnerable Populations in Global Settings

War, disease, and natural disasters threaten the lives of millions of women and children around the world. Global efforts to prevent disease and protect health can make the world a healthier, safer place for all women and children.

The current health status of vulnerable populations around the world (e.g., refugees and internally displaced people, exploited women and children, orphans, and people with disabilities) is poorly understood, primarily because these populations are largely marginalized. An estimated 45 million people are affected by complex humanitarian emergencies resulting from war, natural disasters, and other catastrophes [45]. Most causes of death and disability among persons affected by CHE (e.g., measles, malaria, diarrhea, acute respiratory infections, maternal and neonatal mortality, land mines, and pedestrian- and cycle-related injuries) can be prevented with known interventions. In 2002, the International Labor Organization estimated that 250 million persons aged 5-17 years were involved in child labor; approximately 179 million of these children routinely engaged in severe forms of such labor (i.e., those that endanger their physical, mental, or moral well-being) [46]. According to the Standing Against Global Exploitation (SAGE) Project, an estimated 10 million women and

children are exploited through the commercial sex industry each year, which places them at risk for HIV/AIDS and other STDs as well as physical and psychological abuse (http://www.sageprojectinc.org/html/info_statistics.htm).

The United Nations Children's Fund (UNICEF) estimates that by 2010, 106 million children <15 years old will lose one or both parents because of illness, violence, or injury; an estimated 25 million of these children will be orphaned as a result of HIV/AIDS alone (http://www.unicef.org/protection/index_orphans.html). Orphans and other vulnerable children are often left unprotected after loss of parents, placement in temporary shelters, or loss of contact with caregivers. They are often more vulnerable to becoming victims of violence, exploitation, human trafficking, discrimination, and other abuses. In times of conflict (e.g., war), these children experience increased risk of exposure to violence, physical abuse, and exploitation, along with an increased risk for death. These vulnerable children face disease, malnutrition, physical and psychosocial trauma, and impaired cognitive and emotional development. Girls are at especially high risk of sexual abuse, whereas boys are at high risk of being conscripted into conflict as child soldiers.

Descriptive epidemiologic research that is focused on the most effective interventions for decreasing health disparities in vulnerable populations is needed. The objective of this research must be to: a) identify interventions that can be used to modify the determinants and the progression of health problems associated with the highest disease burden; and b) promote disease prevention among vulnerable populations in global settings. Achieving a broad impact and reducing disease burden worldwide will require not only medical interventions, but also behavioral, social, and political interventions implemented by sectors other than those that traditionally focus on health.

1. International Complex Humanitarian Emergencies (CHEs)

Assess the key risk factors and the disease and injury outcomes associated with CHEs, and identify public health prevention measures to decrease illness and death.

Scope of Research: Rapidly assess the disease, injury, acute care, and disability burdens associated with CHEs (e.g., war, societal conflict, natural disasters, and displacement of populations) to help allocate resources toward resolving major health issues. Develop, standardize, and implement reproductive health indicators,

interventions, and services in emergency and post-emergency settings. Assess local, national, and international response capacities and resources. Improve training methods for the analysis and interpretation of indicators to target interventions. Develop, test, and evaluate standardized health information systems in emergency and post-emergency situations. Develop new research methods to quantify the problem of micronutrient deficiencies among populations involved in CHEs, and identify interventions to treat and prevent such deficiencies. Examine the mental health needs and coping mechanisms of persons of all ages involved in CHEs using cross-cutting tools that include ethnographic and sociological research methods. Determine the long-term physical, social, and behavioral functioning of persons experiencing CHEs.

2. Public Health Consequences of Exploitation of Women and Children in Global Settings

Examine the root causes of exploitation and the global interventions needed to prevent it.

Scope of Research: Determine the sociopolitical factors and descriptive epidemiology of exploitation, and identify the magnitude and scope of exploitation-related diseases. Examine the prevalence and trends of sexual exploitation, impact of public policy, role of the Internet in proliferation, resulting psychosocial and medical effects, cultural variations, and role of prevention education. Assess the impact and extent of sexual violence and sexual exploitation during armed conflict and other CHE situations. Identify the unique health problems of women and children who are victims of exploitation, and investigate the types of services most needed by these populations.

3. Orphans and Other Vulnerable Children in Global Settings

Develop and evaluate interventions to reduce the adverse psychological and physical health problems of orphans and other vulnerable children.

Scope of Research: Assess interventions to improve familial and community capacity to care for orphans by reducing stigma and strengthening support systems. Describe the incidence and prevalence of children with developmental delays, psychosocial conditions, disabilities, and diseases.

Assess the impact of armed conflict and other CHE situations on children and other vulnerable populations.

D. Societal Determinants of Health in Global Settings

In general, more wealth equals better health. Public health research can uncover the social and economic factors that influence health and find better ways to reduce disparities between the healthy, those at risk and the sick.

People who are socially and economically advantaged generally experience better health than those who are disadvantaged, regardless of whether they live in developing or industrialized countries [47-51]. To help reduce global health disparities, the relationship between health status and community economic characteristics must be better elucidated. Understanding how social and economic factors (e.g., education, income, employment status, and the health of the environment) affect health in various settings is the first step towards narrowing health inequity. The nature of health determinants can vary widely and operate at multiple societal levels. For example, socioeconomic status, position that a person occupies in a given society, and exposure and access to factors that can improve health (e.g., clean water, safe neighborhoods, and education) are determinants that can be observed from the more proximate levels of neighborhoods to large political units (e.g., states). Finding effective ways to address social factors could greatly improve health across a wide spectrum of populations and could help reduce health disparities. Operational research is needed to determine key risk factors and assess the impact of social and economic interventions on health, injury, and disability on a global scale.

1. Relationship Between Socioeconomic Status and Health

Evaluate the linkages between social, cultural, and economic status and health outcomes.

Scope of Research: Describe associations between different socioeconomic indicators of health (e.g., education, income, social status, and race/ethnicity) within a system framework and across different stages of life. Evaluate the links between income inequality and health within and between nation states, and examine the pathways and mediating variables through which such associations may occur.

2. Human Resources and Health Outcomes in Global Settings

Evaluate the way in which the quality and quantity of human resources in health affects the key determinants of health outcomes in global settings.

Scope of Research: Evaluate the links between healthcare associated human resources and health outcomes in various local, regional, and national settings to set resource allocation and training priorities at these different levels. Examine whether the available human resources are differentially utilized by each section of the population. Assess the: a) distribution of limited human resources (e.g., provision of healthcare in rural settings); b) most appropriate types of human resources in financially limited settings; c) quality of services provided; d) supervision and training/educating of healthcare workers; and e) involvement of traditional healers and other non-formal healthcare workers in ensuring the health of a population. Examine how working with communities and non-traditional partners can lead to alternative solutions for delivering essential health interventions.

E. Tools for Global Public Health

Produce healthier people in a healthier world, through global partnerships to develop and share public health knowledge, tools and resources.

The need for global public health action is well recognized. However, substantial variation exists in the public health infrastructure of the major regions of the world. Many countries face challenges in taking action to improve health because they lack: a) appropriate, well evaluated and researched interventions and marketing strategies; and b) thorough assessments of the scope of region-specific public health problems. Several sources of data on diseases, injuries, and health-related variables currently are available for many regions of the world; however data quality varies greatly between countries, and inconsistencies exist in the way by which indicators are measured. Lack of available data is particularly apparent in the fields of non-communicable diseases and injuries. To positively impact health outcomes around the world, the comparability of health data (i.e., information on disease, injury, death, and disability) must be improved across countries, and the contextual nature of many variables of interest (particularly in the area of personal risk factors and social determinants) must be taken into account.

Although it is a recent undertaking in the United States and other western countries, social marketing based on a sound theoretical

and practical approach is widely perceived as being an effective way to improve a population's health. However, research regarding the delivery of health messages to the public in most developing countries has been sparse. A critical need exists for evaluation of public health messages and the role they play in improving global health.

Improving global strategies for public health action can lead to the reduction and prevention of injuries, disease, and disability and help reduce health disparities among countries and populations. The following three areas of research can have broad impact on global health: a) standardizing health measures; b) improving strategies for distributing health products and methods; and c) assessing global intervention effectiveness, including cost-effectiveness.

1. Global Measurement of Health, Disease, and Injury

Further develop and enhance ways to systematically measure health, disease, and injury outcomes that allow for within- and cross-country comparisons.

Scope of Research: Determine appropriate outcome measures for within- and cross-country comparisons. Develop and evaluate harmonized survey instruments and methods for collecting data across countries. Further elucidate the socio-cultural factors that play a role in data comparability issues. Investigate state-of-the-art analytical procedures that can be used to create consistencies in data comparison across and within countries. Research the state of surveillance and infrastructure.

2. Health Marketing and Health Education in Global Settings

Improve strategies for health education and dissemination of health marketing messages and products with the objective of encouraging behaviors that will prevent disease and injury in the developing world.

Scope of Research: Determine best practices on how to adopt existing marketing approaches used in commercial industries and apply them to address health issues in developing countries. Determine how to deliver health messages (e.g., through community-based institutions and social entrepreneurs), and assess the effectiveness of communications aimed at changing behaviors. Identify cost-efficient marketing strategies for

distributing and encouraging the use of health-promoting products (e.g., vaccines, micronutrients, condoms, bed nets, cycle helmets, smoke alarms, life preservers, preventive medications, and treatments to purify home drinking water treatment) within the socio-cultural context of developing countries. Evaluate strategies for improving global health literacy.

3. Evaluation of the Effectiveness of Global Health Interventions

Assess the impact of different interventions used to address priority global health problems in developing countries.

Scope of Research: Develop a research base of effective interventions, including those aimed at reducing health disparities. Assess the cost-effectiveness for health interventions that address the substantial causes of morbidity and mortality in the developing world. Assess contextual, social, cultural and economic factors that interfere with the coverage or effective delivery of existing health interventions.

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VIII. Manage and Market Health Information

The public health needs for managing and marketing health information and for developing the tools, techniques, and strategies for this work, have never been greater. Health statistics, public health informatics, and health marketing are essential foundational and cross-cutting areas that allow public health professionals to improve and manage health information. These disciplines enable the tracking and monitoring of information and help public health professionals reach and engage individuals, communities, and entire societies. Each of these areas is rooted in long-standing, science-based disciplines that make strong and unique contributions to health protection and prevention. Research in these disciplines must be expanded. Such expansion will enable public health professionals to have a greater impact on each of the priority health areas discussed in the *Research Guide*.

Public health data serve as the basis for guidelines intended to help people live longer and healthier lives. The most accurate and reliable data are collected, managed, and analyzed by researchers, public-health practitioners, and healthcare professionals to further identify the factors that have an adverse impact on health and well-being and to develop interventions that will improve the health of all persons, particularly those affected by health disparities. The field of public health informatics plays a critical role in integrating the overall strength and importance of disease surveillance data. The development of this field and dissemination of informatics knowledge and expertise to public health professionals is the key to unlocking the potential of information systems to improve the health of the world. Health marketing is a strategic, integrated approach to health protection that involves creating, communicating, and delivering science-based health information to meet the needs of diverse customers and stakeholders, including individuals, organizations, communities, and populations. Combining the science and best-practices of marketing with the core values of public health addresses the growing need of the public health community to reach intended audiences more quickly and with more targeted and tailored messages. Research in health marketing should foster new collaborations and intellectual exchange of public health information across diverse disciplines and research communities. Research categories in this chapter include:

- A. Public Health Data**
- B. Public Health Informatics**
- C. Health Marketing**

Better health data means better decision-making—and that means better health for all Americans.

A. Public Health Data

The practice of public health involves collecting, analyzing, and sharing data that drive evidence-based decisions with the goal of improving health impact. Without robust data, public health researchers and other allied healthcare professionals cannot successfully answer different public health research questions. Public health data provide the backbone for understanding different public health research hypotheses. One of the biggest concerns facing public health is in the need to effectively manage the public health data currently being collected. Innovative data management strategies, along with statistical methodologies, address this problem by creating ways to manage and mine important public health data for use in a wide range of public health disciplines. In addition, strategies and methodologies are being developed to forge a bridge between public health data and healthcare data collected in private clinics, hospitals, and insurance companies. With the effective management and mining of public health data, gaps relating to health disparities are more easily identified and addressed. Public health data have the potential for broad impact, because such information is useful to scientists and researchers across many health disciplines. Public health data are relevant to all of CDC's Health Protection Goals and support the agency's mission of improved health and quality of life.

1. Statistical and Data Science

Identify, develop, and provide quantitative methods and software needed to ensure sound and reliable data collection, analysis, presentation, and quality assurance in support of public health science and decision-making.

Scope of Research: Develop reliable, quantitative methods for data mining while preserving individual confidentiality. Improve data collection, quality assurance, and anomaly detection. Identify epidemiologic methodologies to understand spatial analysis and trend detection.

2. Data Collection

Identify and develop efficient and effective data-collection instruments and surveys to ensure that accurate data are available for analysis by public-health practitioners and healthcare professionals.

Scope of Research: Standardize the process of collection and receipt of census data, and improve distribution methods to public health agencies (e.g., CDC). Identify the most feasible and efficient manner to capture annual population, injury, disability, and reportable-disease data. Investigate ways to establish standard protocols for data collection and analysis from multiple data sources. Develop Web-based query systems for analysis, display, and dissemination of population-based health data. Create algorithms that can be applied to different Web-based query systems. Identify public health indicators that signal events associated with notifiable diseases. Develop best practices to select appropriate sample populations; reduce respondent errors; increase response rates; improve quality checks; and ensure the use of appropriate statistical, analytical, and reporting techniques. Improve data collection to facilitate the enhancement of public health algorithms and approaches that will satisfy reportable disease and other public health data needs. Develop data-collection methodology for the integration of local and regional public health data into state and national data systems to render them more useful in meeting Public Health Information Network requirements, standards, and specifications (see <http://www.cdc.gov/phinf/>). Identify methods for consistent collection of population, disease, injury, disability, and reportable-disease data from different healthcare encounters that will enable such data to be used by public health practitioners.

3. Integrating Health and Policy Data

Identify and explore strategies to integrate policy interventions with public health data.

Scope of Research: Conduct research that enables the creation of a surveillance system that facilitates information sharing between the public health community and other professionals who operate within the healthcare data system (e.g., medical examiners and coroners). Conduct research that leads to the establishment of a foundation for direct data linkage with public health surveillance systems and other clinical care data systems. Conduct research that helps elucidate the barriers that prevent the integration of public health data and other health related data systems, and identify way to overcome those barriers.

4. Data Mining

Identify and develop best practices to aggregate, classify, analyze, and extract data to establish behavioral and disease-specific relationships and patterns from multiple data sources.

Scope of Research: Identify, aggregate, and analyze multiple data sources. Conduct research that allows public health agencies to perform automated and real-time analyses of data, and investigate the processing of data in free-text form (which will lead to the ability to investigate data from a range of sources not currently available to many public health researchers). Conduct research that allows large databases to be queried to satisfy a hypothesis, or interrogate databases to generate new hypotheses based on rigorous statistical correlations found in previously collected data.

B. Public Health Informatics

Efforts to improve our health information systems can advance the discovery of new approaches to protecting our nation's health.

Informatics and information systems are critical to the practice of public health in the 21st century. Fully operational information systems must be put into place to address emerging and routine public health needs among various U.S. populations and to help elucidate factors that contribute to health disparity in certain groups. These systems provide new and creative solutions to extend the reach of public health, allowing it to achieve more. The need for informatics development is recognized as an important asset to all public health disciplines.

The public health informatics discipline can provide new, high-impact capabilities for preventing and managing diseases and other public health threats. Within the U.S. public health system, informatics as a public health discipline is increasingly being recognized as a focus area capable of improving all aspects of public health. Informatics-related research has a potential for broad impact by helping public health professionals define and manage the architecture for national public health information systems. This kind of research identifies the capabilities necessary for these systems to work together and connect with clinical care and other health organizations.

Public health informatics can be used to reduce disparities because this discipline allows public health professionals to rapidly and consistently identify gaps in public health need. Public health informatics could have a broad impact on the health of all persons in the United States, because it can be used across all public health disciplines. Its relevance to all CDC Health Protection Goals stems

from research methodologies and strategies that focus on informatics in public health research.

1. Analytical Methods

Develop algorithms and conduct analyses for public health detection and monitoring of diseases and health conditions.

Scope of Research: Investigate ways to support disease and health-condition monitoring and outbreak detection through advancement in pattern recognition, algorithm development, and analytical methods. Develop statistical surveillance approaches, algorithms, and processes for the identification of health events and trends. Enhance the public health algorithms and approaches needed to satisfy reportable disease and other public-health data needs, which will provide the foundation for disease detection and monitoring strategies.

2. Information and Data Visualization

Explore approaches and best practices for visualizing, analyzing, and mapping public health data.

Scope of Research: Investigate ways to visualize information and data to enable greater focus on spatial and geographic relationships and context. Examine dynamic mapping practices, geographic information systems, analysis of spatial data, environmental modeling, and plume modeling for air-dispersal patterns. Develop approaches for population and other public health data collection and probabilistic, population-based representations of communities. Design cohort studies that can be used to evaluate costs, interventions, and efficiencies of different public health interventions. Create better information and data visualization tools that will lead to more real-time monitoring of systems to provide: a) the current status and reports from each system; and b) snapshots at regular intervals for trend analysis.

3. Communications and Alerting Technologies

Explore strategies and technologies to facilitate communication and collaboration between different groups focused on health protection activities.

Scope of Research: Investigate technologies and practices to enable public health professionals to communicate information and data to the appropriate persons, at the appropriate time, and in the

appropriate format. Examine the importance of coordinating “virtual team” technologies that enable geographically disparate groups to work efficiently together and share information during an emergency or crisis.

4. Decision Support

Explore technologies and methodologies that will assist decision-makers in creating public health solutions.

Scope of Research: Identify technologies and practices that can: a) assist key decision-makers, call-response personnel, public health practitioners, and subject matter experts in determining the most probable cause of a problem; and b) facilitate the creation of decision trees that outline ways to solve those problems in accurate and scientific ways. Conduct research that provides for the presentation of a detailed series of recommendations drawn from robust knowledge, management repositories, decision trees, adaptive learning tools, and fault modeling technologies. Employ consequence management technologies to evaluate the potential impact and outcomes associated with public health responses, which will assist key decision-makers in the rapid and informed determination of risks. Evaluate approaches for the presentation of community health event trends for healthcare providers. Examine approaches for evidence-based public health decision support systems and prioritization systems. Develop and evaluate public health expert systems and expert systems tools to assist key decision-makers both within and outside of healthcare environments. Develop and evaluate tools to assist public health professionals in making rapid and informed determination of risks. Improve measurement tools and data evaluation strategies regarding public health outcomes.

5. Electronic Medical Records

Explore practices and strategies for using electronic and personal health records for public health.

Scope of Research: Develop and evaluate strategies that increase the use of public health guidelines by clinical care professionals to ensure that they receive updated public health information on a variety of topics (e.g., specific diseases, health conditions, and effective interventions) to inform their decision making and practice. Improve methods for integrating public health functions into electronic medical records. Investigate approaches for integration of local/regional outbreak management and public health decision support. Explore multivariate aggregation and

analysis from disparate clinical systems. Evaluate healthcare data source availability, data translation, and data communication methods for public health use. Leverage public health functions and needs into the electronic healthcare environment while fostering public health informatics solutions that can be used in other local and regional settings. Develop methods for integrating public health functions into electronic health record systems. Investigate approaches for the integration of local and regional data into state and national systems to improve outbreak management, public health decision support, public health communications and alerting, and countermeasure and response administration capabilities. Explore approaches regarding multivariate aggregation and analysis of data from disparate healthcare systems.

6. Knowledge Management

Explore strategies and approaches to efficiently manage public health knowledge so that it can be appropriately used according to need and audience.

Scope of Research: Investigate practices and technologies that could render public health knowledge more accessible (e.g., capturing successes and lessons learned, storing and classifying information to facilitate quick retrieval, repurposing content, identifying experts in specific subjects, and providing ways for experts to share information).

C. Health Marketing

Health marketing is a dynamic and emerging area of public health that allows agencies and organizations to more effectively and efficiently exchange public health information to and from relevant audiences. It is a cross-cutting, trans-disciplinary approach to health protection that involves creating, communicating, and delivering science-based health information to meet the needs of diverse customers and stakeholders, including individuals, organizations, communities, and populations.

Health marketing research is needed to identify methods for rapidly reaching intended audiences and to help public health professionals better understand audiences, which helps ensure more appropriate and timely information dissemination. Research in health marketing also helps to reduce health disparities by identifying and emphasizing the unique qualities and needs of all public health customers, especially those at greatest risk for health disparities and adverse health outcomes. Innovative health marketing

Public health can become a competing voice against the hard sell of tobacco, alcohol, and high-fat fast food to the American public. Using the latest marketing techniques we can give people what they want and need to choose health.

research is needed to increase the applied integration of recent advances in numerous diverse disciplines (e.g., marketing, health communication, social sciences, neurobiology, informatics, business theory, information theory, mathematics, and evidence-based medicine) to ensure that the most effective, appropriate, and ethical practices are used to create, communicate, and deliver health information and improve and protect health among audiences throughout the United States and around the world.

Research and practice in health communication is particularly critical to the success of health marketing initiatives, in that the science, theories, principles, and strategies of health communication inform the development and dissemination of targeted and tailored health messages to diverse intended audiences. Research is needed to further explore how health communication can be leveraged to increase public health's impact across many topic areas and to ensure that the public has the information needed to make informed health decisions.

Health-marketing research can have a broad impact; the knowledge gained from this type of research is applicable to almost all fields of public health. Health-marketing research has great relevance to CDC's overall mission -- it cuts across all stages of life, settings, and populations, and can be used to reach health protection and promotion goals in the United States and worldwide.

1. Informed Consumer Health Choices

Develop, evaluate, and implement strategies and approaches for consumers that enable them to evaluate and self-manage their health.

Scope of Research: Develop feedback and measurement tools and techniques for consumers to enable them to assess their own health. Develop effective approaches for presenting health information across racial and ethnic populations. Investigate ways in which various models of health (e.g., the medical model, public health model, and wellness model), as perceived and accepted by individuals and groups, impact health-seeking behavior and response to public health messages. Explore the impact of certain behavior models (e.g., the addiction model) on individual and group acceptance of public health interventions. Identify the practical implications (e.g., economic and social) of incorporating specific models of health into health-marketing campaigns.

2. Integrated Health Marketing Programs

Explore practices and strategies to enable public health professionals to design, create, and evaluate effective and integrated health-marketing campaigns.

Scope of Research: Develop and test approaches and strategies that will provide health professionals with the information and tools necessary for creating integrated health-marketing programs and public health initiatives. Generate new knowledge regarding the process of changing social norms, expectations, and public decision-making protocols to create healthier environments and empower individuals and groups to succeed in changing negative attitudes, activities, and behaviors. Develop and study the role of varying definitions and measures of “success” in health marketing for different partners and audience groups (e.g., consumers, caregivers, healthcare and public-health practitioners, policymakers, employers, and other stakeholders). Investigate ways to translate this information to achieve greater success in public health programs and interventions. Develop and evaluate alternative marketing and dissemination strategies for improving population health among rural, minority, economically disadvantaged, and other underserved populations.

3. Health Awareness to Health Action

Identify and develop strategies that will equip those who develop health marketing campaigns to move individuals from health awareness to health action, resulting in a more sustained health impact.

Scope of Research: Determine how the design, delivery, and reception of messages contribute to informing and instigating behavior change in various populations. Develop and evaluate health messages, and address factors for sustaining health behaviors through successful communication interventions. Generate new knowledge regarding the process of inducing voluntary changes in the attitudes and behaviors of persons regarding their own health. Generate new knowledge regarding the process of inducing voluntary change in the activities and approaches of key societal groups that impact the health of defined populations. Elucidate the theory and socioeconomic behaviors that lead to rapid acceptance of, and motivation for, change regarding health and health behaviors. Evaluate the role of regulation and the impact of various social drivers on acceptance of specified health behaviors (e.g., whether smoking bans increase the

perceived value of specified components of health, such as respiratory and cardiovascular health, or of related interventions, such as nicotine patches).

4. Niche Marketing

Identify measurable, accessible, sensitive, and sustainable target audiences to create highly targeted health messages for urgent health impact.

Scope of Research: Study “niche” marketing and its relevance to public health interventions. Investigate what level of market differentiation is necessary to maximize improvement of health outcomes among the population as a whole, with emphasis on those populations at highest risk for poor outcomes as a result of physical, environmental, cultural, or socioeconomic circumstances.

5. Public Health Brand

Explore how specific populations, particularly those that may not be familiar or comfortable with branded organizations, perceive the public health brand.

Scope of Research: Explore ways to measure and assess specific audiences' perception of the public health community, including perceptions of trust. Evaluate how various public health brands (e.g., CDC information, logos, and other visual representations of the agency) impact acceptance of information and translate into individual and group perceptions and behavior changes; elucidate which brands are most acceptable, explore the components of an acceptable brand, and investigate the time and circumstances required to create changes in brand perception.

6. Message Bundling

Explore strategies and practices to combine individual or similar health messages for common audiences.

Scope of Research: Investigate whether combining, or “bundling,” public health messages and interventions is more effective than single-issue communication for various populations and settings; determine whether, and under what conditions, such integrated approaches are more effective than single-issue approaches in producing changes in personal behavior, social norms, and environmental support. Evaluate possible strategies to effectively

bundle individual or similar health messages for common audiences. Identify the channels, messengers, and supplementary support necessary to influence hard-to-reach populations. Determine the efficiency of bundling and the effectiveness of bundled health messages. Evaluate strategies for identifying when message bundling might be an effective health communication program strategy.

7. Emergency and Risk Communication

Explore methods of communicating health information to individuals, stakeholders, and communities during an emergency or crisis situation.

Scope of Research: Evaluate key channels and strategies to enhance compliance during crises and emergencies. Assess pre-event readiness to accept and act upon specific messages through identified channels (e.g., television, radio, and Internet) and sources (e.g., government spokespersons, subject matter experts, and newscasters). Identify strategies effectively used to encourage the general public and specified groups (e.g., healthcare providers and emergency service workers) to differentiate messages from different sources and through different channels and to ultimately engage in optimal health protection behavior. Assess post-event information management and accession efforts intended to minimize secondary health, environmental, and economic damage through promotion of social consensus and specific norms.

8. Entertainment Education

Explore the use of entertainment media to promote health messages, especially for hard-to-reach audiences and for sensitive health topics.

Scope of Research: Evaluate the most effective methods for using entertainment-associated health education to reach targeted audiences. Investigate how entertainment-associated health communication messages can influence knowledge, attitudes, and health-related practices. Determine which levels and types of exposure to entertainment-based health communication are associated with the adoption of positive health practices. Investigate the way in which health issues and concerns are portrayed in entertainment programming and how they are being depicted over time. Evaluate specific theories that are most associated with developing effective entertainment-based health communication messages. Study the ways in which on-screen

We can leverage the power of the media to reach more children with messages of health and safety.

characters are portrayed as coping with health problems, and identify the methods that are most effective for modeling. Determine: a) which types of television characters are considered credible sources of health information; b) which types of media children most often seek for entertainment and the opportunities for synergy between media channels; and c) ways in which youth can be most effectively targeted through entertainment-based health communication.

9. Health Literacy and Clear Communication

Explore strategies and approaches to develop health literacy practices that can be incorporated within health marketing campaigns.

Scope of Research: Create and improve health literacy skills among non-literate, low-literate, and non-English speaking populations. Develop tools for use in health communication interventions that allow the health literacy capacity of messages to be evaluated and measured. Design methods for testing and evaluating health literacy issues within health communication messages. Identify and develop best-practices for communicating with populations that have limited health literacy.

10. Customizing Health Marketing Campaigns

Explore strategies and practices to develop effective health marketing campaigns customized to specific groups, particularly those with health disparities.

Scope of Research: Develop approaches and strategies to identify and segment populations with health disparities. Create, test, and evaluate customized public-health messages and campaigns. Evaluate strategies for identifying the most effective communication programs for reaching various segmented audiences.

IX. Cross Cutting Research

Emerging infectious diseases, avian influenza, obesity, and natural and human-made disasters are some of the many challenges facing public health in the 21st century. We face these challenges in a time of increasing demand for services and decreasing budgets. To maximize public health impact, we must work together across disciplines to harness the collective wisdom of academia, private industry, and communities and find new applications for growing fields (e.g., genomics). Interdisciplinary, cross-cutting research is essential to gaining the critical knowledge needed to ready the public health system for the future.

Cross cutting research will increase our understanding of critical infrastructure components (e.g., trauma and healthcare facilities) that are needed to advance and sustain public health. Vital to meeting new challenges is the conduct of research to identify and evaluate best practices and strategies to strengthen the public health workforce. Public health professionals must have the knowledge, skills, and abilities to improve health in diverse communities and in complex emergency situations. Research to harness public health law, policy, and ethics can provide the foundation for public health research and practice in every public health domain.

Research is needed to identify the most effective health education and health promotion strategies and interventions critical to improving health status and eliminating health disparities. Research that elucidates ways to eliminate racial and ethnic health disparities is essential and cannot be done without collective efforts across scientific disciplines and engaged partners throughout the public health community. To further advance public health efforts in increasingly diverse communities, we must examine sustainable community-level approaches to emerging health challenges. Cross cutting research supports synergy, teamwork, and builds on existing strengths. Such research supports all of CDC's Health Protection Goals. The interdisciplinary cross-cutting research described in this chapter spans the entire spectrum of priority research areas and includes:

- A. Physical Environment and Health**
- B. Public Health Systems and Professionals**
- C. Public Health Science, Policy, and Practice**
- D. Public Health Education and Promotion**
- E. Human Genomics in Public Health**
- F. Mental Health and Well-Being**
- G. Law, Policy, and Ethics**
- H. Personal, Economic, Social and Other Indicators of Health**

Learning more about the relationship between health and the places where people live, work, learn and play can better prepare us for the challenges of the 21st century.

A. Physical Environment and Health

Our rapidly changing global environment continues to create new and unique public health challenges. The environments in which people live, work, learn, and play influence our health in many ways --- from the air we breathe to the communities we design. Although environmental impacts (e.g., global climate change) can have far reaching health consequences, much is still to be learned about how these environmental changes will influence disease processes and patterns. How we use our land and design our communities (e.g., workplaces and schools) influences rates of obesity, injury, heart disease, diabetes, and many other acute and chronic diseases and conditions. Research aimed at elucidating the relationship between the built and natural environment and health allows for a comprehensive approach to solving some of public health's most challenging problems and to reducing health disparities. Ultimately, this research will help ensure that all people, especially those who experience health disparities, will achieve their optimal lifespan and experience the best possible health in every stage of life.

1. Global Climate Change

Identify and assess the potential global and domestic health impacts posed by climate variability and change.

Scope of research: Increase the understanding and awareness of the potential human health consequences resulting from climate variability and change, with a focus on waterborne, foodborne, and vectorborne disease; morbidity and mortality from extreme weather events; air pollution and respiratory health; and complex emergency response. Assess the impact of climate variability and change among vulnerable populations.

2. Natural and Built Environment and Health

Determine the relationship between land-use policy, the built environment, and human health and injury, and study how other critical infrastructure systems function to impede or improve public health.

Scope of Research: Increase the understanding of the impact that the quality and design of our homes, schools, workplaces, communities, and transportation systems have on health throughout all stages of life. Examine how land use and

transportation decisions can help or hinder the creation and maintenance of healthy and safe communities. Examine a variety of environmental hazards, including: a) substandard housing; b) indoor environmental health hazards; c) poor air and water quality, d) inadequate water and sewer infrastructure; e) noise; f) inadequate pedestrian and bicycle safety; and g) poor community walkability. Examine the role of public policy (e.g., zoning and environmental regulations) and social determinants of health and injury in land-use decisions and urban planning. Investigate the relationship between the built environment and mental health.

B. Public Health Systems and Professionals

Vital to maximizing current and future public health impact is an educated, knowledgeable workforce operating in a model public health system. A public health workforce that is effective and efficient, diverse, well-educated, and committed to reaching persons at highest risk for disease, injury, and disability is key to the success of any public health effort. The public health workforce must have expert knowledge and skills in a variety of areas, such as: a) cultural competency, health literacy, ethics, surveillance, and strategic analysis; and b) program and policy development and evaluation. In addition to attracting and maintaining a capable public health workforce, the public health system must maintain performance standards, provide the best care and services to all persons in need, and be able to anticipate and respond to evolving health issues. To achieve this ideal and meet the health challenges of the 21st century, the characteristics of high-performance health systems operating at local, state, and federal levels must be developed, and the conventional concept of the public health system must be broadened to include diverse, capable partners and sectors.

We can maximize the return on our healthcare investment by leveraging CDC's unique expertise, partnerships and networks to improve the health system.

1. Health Systems

Study how health systems can function to improve public health.

Scope of Research: Evaluate how health systems affect public health by researching the functioning of federal, state, tribal, and private health systems. Define and quantify dimensions of public health systems, including relationships between organizations. Determine how public health agency structure affects performance. Explore the relationship between health systems' performance and health outcomes. Define and characterize high-performing federal, state, tribal, and local public health agencies. Evaluate the factors

that lead to a more effective and cost-effective public health system and maximize health outcomes per dollar invested. Evaluate the economic, cultural, social, and structural determinants of access to medical care and public health services. Evaluate how regional hospitals and emergency medical services can be coordinated to better respond both to incidents widely impacting community populations and to discrete mass casualty events.

2. Workforce and Career Development

Conduct research to improve public health workforce-related recruitment, retention, and training.

Scope of Research: Define and assess the knowledge, attitudes, and skill competencies needed by the public health workforce, and identify information gaps, resources, and other areas in need of improvement. Identify strategies to create and sustain career development and entry-level supply lines to ensure the existence of a workforce pool capable of meeting the increased demands on public health. Identify best practices for workforce recruitment, retention, and training. Identify and apply new methods to describe current public health workforce needs and forecast future needs. Assess the impact of trained public health professionals on specific outcomes (e.g., improved health of people and improved public health practice or capacity). Identify best practices for workforce development. Determine the best methods of facilitating collaboration between academia and other groups (e.g., community-based organizations) and integrating efforts with public health practice. Determine the best methods for identifying, updating, and validating competencies necessary for an effective, efficient health workforce. Determine the organizational variables that support development and application of skill competencies. Determine best indicators for workforce performance. Monitor workforce trends, including size, distribution, qualifications, and tenure. Evaluate the role of labor market forces on recruitment, retention, wage, salary, benefits, and personnel-system characteristics.

Create and disseminate the knowledge and innovations people need to protect their health now and in the future.

C. Public Health Science, Policy, and Practice

CDC and its partners in public health aim to improve the health status of all persons living in the United States, reduce health disparities among subgroups of Americans, and work with nations and international agencies to extend the benefits of collaborative research and effective programs to populations around the world. Public health research and community-based participatory research (CBPR) help discover the biological, social, anthropological, cultural, and behavioral determinants of health; describe health disparities; and reveal which interventions are effective in particular settings or populations. However, the key to sustained, organized efforts to improve the health of specific populations is having knowledge beyond that of basic intervention effectiveness. More research is needed to discover how best to evaluate and measure the impact of interventions, identify the burden of disease, disseminate effective interventions beyond initial research or test settings, and adapt interventions that have been shown to work in specific places to render them effective in different populations and in diverse settings. One approach to achieving effective interventions is CBPR. CBPR, a collaborative research process between researchers and community representatives that engages community members, derives understanding and is the basis for interventions from local knowledge of health problems, and invests community members in all stages of research, including its products [52]. CBPR begins with a research topic of importance to the community and aims to combine knowledge and action for social change to improve community health and eliminate health disparities. Moving the most effective interventions from theory to practice will increase public health impact.

1. Social, Anthropological, and Behavioral Sciences in Public Health

Develop and apply social and behavioral theories and methods to assess and improve public health at individual, family, tribal, regional, state, federal, and international levels.

Scope of Research: Develop and evaluate methods for describing and analyzing social and behavioral determinants of health. Develop and evaluate indicators of baseline community health status. Establish methods and standards that employ baseline data to evaluate the effectiveness of health interventions in improving people's health. Evaluate quantitative, observational and qualitative research methods (e.g., rapid ethnography) for use in the surveillance of social, anthropological, and behavioral factors

associated with adverse health outcomes. Develop and evaluate culturally competent social, anthropological, and behavioral science interventions to prevent disease, injury, and disability and to promote health and reduce disparities. Identify individual, community, and institutional factors that result in preventive healthcare practices. Investigate methods used to change health behaviors and translate those methods into practical, sustainable programs.

2. Economics and Public Health

Develop and apply economic theories and methods to examine the supply and demand for public health services, estimate the monetary and social costs of diseases and injuries, and improve the delivery of healthcare prevention, treatment, and rehabilitation services.

Scope of Research: Develop methods to address gaps in information for various economic measures of health burden and well-being. Study the effectiveness of interventions to inform resource allocation. Develop models to illustrate how public health resources and funding can most efficiently be used to optimize the public's health. Conduct applied economic studies of factors (e.g., delayed gratification, risk perception of behaviors, preventive health interventions, and risk-taking preferences) that can affect individual and organizational choices.

3. Community-Based Participatory Research (CBPR)

Design, conduct, and interpret CBPR research to increase the relevance, acceptability, and usefulness of evidence-based scientific findings in improving the health of communities.

Scope of Research: Evaluate the influence of community-based participatory research (CBPR) on improvements in community health status and reduction of health disparities, especially in disadvantaged, minority, and hard-to-reach populations. Identify barriers to and opportunities for successful engagement of communities in research. Study and adapt evidence-based practices for use in diverse populations. Conduct CBPR to understand and evaluate interventions at the community level, especially those that focus on policy and environmental changes aimed at reducing the burden of and risk factors for chronic conditions and increasing the dissemination of effective health-promotion interventions. Evaluate comprehensive community

interventions (e.g., the *Guide to Community Preventive Services* [11]) and identify research gaps. Evaluate the effectiveness of strategies to increase community involvement (e.g., community members, partners, and stakeholders, including those with regional and urban planning expertise) in the planning, translation, and execution of health research and interventions to enable community health status to be assessed in new and comprehensive ways. Evaluate the impact of dissemination of research findings and knowledge to the community.

4. Public Health Evaluation Research

Improve evaluation methods, and conduct evaluations on the public health impact of interventions, programs, and policies.

Scope of Research: Evaluate the processes, context, impact, and outcomes associated with federal, state, tribal, and local health intervention efforts. Evaluate the relationship between adverse health outcomes and: a) health insurance coverage; and b) access to medical care, and compare the relative benefit of expanded coverage to improve the public's health. Evaluate how public health assessment, surveillance, intervention, and service delivery programs can be optimally structured to deliver the highest quality and widest array of proven activities to meet community health needs. Develop methods for evaluating the public health impact of social programs and policies not explicitly designed to address health issues (e.g., policies for housing, transportation, education, labor, early childhood development, and reduction of discrimination).

5. Intervention and Translational Research

Develop and evaluate strategies to translate, disseminate, and sustain science-based interventions, and identify best practices to promote health and quality of life by preventing and controlling disease, injury, and disability.

Scope of Research: Develop and test models for the translation, dissemination, and institutionalization of effective programs and policies to promote health and prevent disease, injury, and disability in diverse populations. Identify methods that can be used to accelerate the adoption of science-based programs, policies, laws, and behaviors at the individual, family, community, organizational, and social policy levels. Investigate means of ensuring the culturally competent delivery of interventions.

Develop effective strategies to improve “knowledge transfer” from the public to the private sector.

6. Health and Well-being Across Diverse Community Settings

Develop and implement strategies that enable individuals, families, schools, health systems, and employers in all communities to promote and sustain health for all of their residents.

Scope of Research: Identify and measure the impact of social, economic, legal, environmental, and behavioral factors (e.g., smoking and other types of substance misuse and risky sexual behavior) on the community settings that impact health. Evaluate the effectiveness of laws, policies, and incentives (e.g., water fluoridation, bike paths, immunizations, hand washing and clean air) designed to improve health. Identify, implement, and evaluate effective health promoting approaches targeted to community settings (e.g., encouraging active lifestyles, healthy eating, and tobacco cessation), and implement approaches designed to prevent or delay the onset of related chronic and infectious diseases, injuries, and disabilities. Conduct needs assessment of resources and regional planning. Conduct economic analyses of health promotion, disease control, and injury prevention activities to estimate the economic burden of disease. Identify and evaluate interventions that produce the greatest return on investment, and provide a rationale for prioritizing resources at the community level.

D. Public Health Education and Promotion

We can improve the health of our nation by enabling more Americans to make healthier, safer choices.

Public health education and health promotion play a critical and broad role in preventing illness, injury, disability, and premature mortality. These activities educate individuals, communities, organizations, and institutions about the principles, concepts, and interventions associated with public health. However, the potential of health education to influence healthy choices and changes in behavior is often under appreciated. Research on health education and promotion is needed to support evidence-based approaches to promote the health and well-being of the general U.S. and global populations, as well as specific populations at risk. Research in health education and promotion can also lead to reductions in healthcare and other societal costs. Health education and health promotion represent a combination of approaches, methods, and strategies drawn from diverse disciplines (including behavioral, social, and health sciences). Health education applies theory and

scientific evidence and incorporates the values of social justice and individual and community's perceptions of health. Health education focuses on the knowledge, attitudes, beliefs, values, and interests of people, communities, and organizations and builds on these to impact social and behavioral change at multiple levels (e.g., individual, family, community, and organizational levels). Health education requires collaboration in diverse cultural, community, and organizational settings and strives to address and reduce health disparities in diverse populations. Advocacy, policy change, and organizational change are central activities of public health education and health promotion. Health education serves as a fundamental means to achieving public health objectives and improving the success of public health interventions.

1. Public Health Education Research

Increase understanding regarding the way in which health education strategies and programs impact health and health behaviors.

Scope of Research: Identify methods to define and measure intermediate and long-term outcomes of health education programs, policies, and other activities. Assess the impact of health education that aims to change social norms, policy, and environments on health behaviors and health disparities. Identify and evaluate strategies and venues that can best be used to deliver health education interventions (e.g., electronic and Web-based education). Evaluate health education materials and messages for cultural competency and effectiveness with specific populations across the lifespan. Assess knowledge and awareness of health-related information, policies, and regulations among persons in various settings (e.g., workplaces, schools, and healthcare facilities). Increase understanding of the public health education needs of target audiences, particularly persons who are disproportionately at risk for disease, injury, and disability. Assess and understand how health and science literacy among the general public, healthcare providers, legislators, and others impacts the health of various populations. Determine best practices to improve health literacy. Assess the impact of health education on individual, organizational, and community health behavior during routine and emergency situations. Evaluate use of daily lifestyle profiles (i.e., descriptions of people's daily activities and behaviors) as indicators of health risk level for certain groups, and determine the potential of these profiles to appropriately identify interventions that are likely to be accepted and adopted within specific populations. Develop and evaluate methods to effectively communicate risk to inform individual, community, and legislative health decisions.

Develop theory- and evidence-based curricula to be used in primary, secondary, and higher education programs and in post-graduate and community education. Carefully test, refine, and disseminate health-education theories to inform innovative program development and evaluation. Evaluate the economic impact of health education policies and practice.

Discoveries in human genetics hold the promise of better health for all. Only through joint efforts of genomics research and public health can we harness the potential of the human genome to prevent illness and save lives.

E. Human Genomics In Public Health

Human genomics is the study of human genes and the way in which they interact together and with the environment. The use of human genomics in public health research will help determine why some people become ill from certain infections, environmental exposures, and behaviors while others do not. Better integration of information on inherited, environmental, and behavioral risks will help tailor intensive health promotion and disease prevention strategies to groups most in need, which ultimately will reduce health disparities [53]. Public health scientists are responsible for translating genomics research in a way that benefits individuals, families, and communities nationwide while examining the relevant ethical, legal, and social implications of this research from a public health perspective. Only through broad-based research in diverse communities can the full benefits of human genomics be realized.

1. Genomics Bridging Preventive Medicine and Public Health Research

Integrate population-level data on genotypes, environmental and social risk factors, family history, and specific disease outcomes to identify high-risk communities, families, and individuals for intensive intervention.

Scope of Research: Evaluate the validity and utility of family history and genetic testing (including newborn, family-based, and population screening) and trials of community- and family-based interventions that address both inherited and shared environmental and behavioral factors.

2. Human Genomics, Public Health Surveillance Systems, and Research Studies

Collect genomic information within surveillance systems and epidemiologic studies to examine gene-environment interactions and identify environmental targets for intervention.

Scope of Research: Demonstrate and evaluate the appropriate integration of family history and genomic markers (including genotype, gene expression, and proteomic data) into surveillance systems (e.g., cancer registries), and evaluate the benefits of collecting genomic information in epidemiologic studies.

3. Models for Incorporating Education and Community Engagement into Population-Based Genomics Research

Develop and evaluate methods for engaging communities in assessing the risks, benefits, and tradeoffs associated with research participation.

Scope of Research: Develop and evaluate methods for identifying and measuring potential risks and benefits of genomic research participation for individuals, families, and communities. Examine strategies for communicating research objectives, benefits and risks, and results. Assess trade-offs between individual and social concerns (e.g., privacy and information sharing).

4. The Genomic Evidence Base in Public Health Practice

Develop sound methods and practical tools for collecting, analyzing, and synthesizing genomic information in populations, and evaluating the public health, ethical, and legal impact of these types of data.

Scope of Research: Identify and develop effective methods and tools for collecting, analyzing, and synthesizing information on genetic variation, gene-disease associations, gene-environment interactions, and genetic tests. Identify and develop studies to examine ethical challenges, legal issues, and social implications of genomics research from a public health perspective.

5. Human-Pathogen Genomics

Investigate genetic and immunologic features of human-pathogen interactions to understand and prevent infectious causes of acute and chronic diseases.

Scope of Research: Investigate human and pathogenic genetic and immunologic factors associated with: a) susceptibility to disease transmission and natural history; b) amenability to prophylaxis; c) treatment response; d) priority groups for intervention; e) adverse long-term sequelae; f) drug resistance; and g) side effects of drugs and vaccines.

F. Mental Health and Well-Being

People who struggle with poor mental health or substance abuse are at greater risk for poor health. Finding better ways to address these issues can help more Americans live a healthy, productive and satisfying life.

Mental health plays a primary role in ensuring the overall health and well-being of all persons. Poor mental health (along with the often co-occurring substance use disorders) significantly contributes to increased rates of injuries, chronic and infectious disease, family violence, underemployment, and litigation. The *Surgeon General's Report on Mental Health* [54] indicated that although much is known about how to treat mental illness, additional knowledge is needed regarding ways to prevent mental illness and promote health. Mental health and substance abuse prevention and treatment are vital components in the elimination of health disparities. Although poor mental health and substance abuse are concerns for people in all stages of life, they disproportionately affect certain populations. For instance, persons who live in inner-city and rural settings and other persons who receive basic medical care in emergency departments often do not receive treatment for mental health and substance abuse [54]. Emergency department settings are typically overcrowded and thus limit patient access to basic care and appropriate referral services. Further, many primary care practitioners do not screen for substance use disorders or mental health problems. Stigma associated with alcohol and other drug problems, as well as mental health problems, can result in lack of identification and treatment of these problems; therefore efforts to better promote assessment and interventions for these types of disease are critical. Research that elucidates the best methods of preventing alcohol and other drug problems will help protect the health and safety of all persons within a community. Models for incorporating effective mental health and substance-use control strategies into community-based programs and medical-care settings can save lives; reduce stress; and prevent excess disability, underemployment, and litigation.

1. Mental Health

Determine the influence of mental health on overall health and well-being, and identify and evaluate best practices for prevention, assessment, and treatment of mental illness.

Scope of Research: Identify the most effective individual, family, and community level interventions to prevent, diagnose, and treat mental illness for people at all stages of life. Conduct epidemiologic studies to increase understanding of mental health in the U.S. population and to evaluate available mental health services. Evaluate the social and economic costs of mental illness, depression, violence, suicide, and post-traumatic stress on individuals, families, and communities. Evaluate strategies aimed at motivating persons to seek treatment for mental illness. Evaluate mental health assessment and treatment strategies, including the integration of mental health treatment into other medical care settings (e.g., emergency departments and primary healthcare settings). Identify strategies and interventions that help victims and first responders cope with the mental health consequences of traumatic events (e.g., war, natural disasters, rape, childhood neglect, and childhood physical or sexual abuse). Evaluate the need for and existing skills of persons working in public service (e.g., law enforcement officers, teachers, and emergency responders) who may interface with people who have mental illness.

2. Substance Abuse Treatment and Prevention

Determine the influence and impact of substance abuse on overall health and well-being for individuals and communities, and identify and evaluate best practices for prevention, assessment, and treatment of alcohol and other substance abuse.

Scope of Research: Evaluate the influence of alcohol and other drug problems on illness, injury, and mortality. Determine the societal and economic costs and the burden of disease resulting from alcohol and other drug problems, including loss of productivity, decreased family and social functioning, crime, violence, and other associated health problems. Evaluate strategies to prevent or reduce the negative consequences of alcohol misuse on health and safety, and investigate the prevention of underage drinking. Evaluate factors and strategies aimed at motivating persons to seek and complete treatment for substance abuse. Evaluate substance abuse assessment and treatment strategies,

including the integration of substance abuse treatment into medical care settings (e.g., emergency departments, mental-health clinics, and primary care settings).

G. Law, Policy, and Ethics

We must advance the cause of public health through policies, regulations, and laws that protect health, increase access, and promote ethical research and care.

Law, policy, and ethics are integral to the foundation of public health research and to the practice of public health in every domain. Law has been a critical tool throughout the history of organized public health, as it has been used to authorize and shape public health programs and services. Most public health interventions rely heavily on legal elements and tools. In fact, many public health interventions take the form of law (e.g., cigarette excise taxes, bicycle helmet laws, and niacin food supplementation requirements). Policies (both public and private sector) play an important complementary role. Research on law and policy as public health tools spans a wide spectrum of domains and priorities. Specifically, research on the role and impact that law and policy have on public health can determine how these tools can best be used to promote health and eliminate health disparities. Ethical conduct also is critical to public health efforts; ethics ensure that research and interventions achieve the highest standards of credibility, equity, and effectiveness. Research on public health ethics will improve public health research and can be used to inform efforts to translate findings into effective practice. Additional research on law, policy, and ethics is needed to strengthen CDC's public health practice, inform policy-related decisions, and ensure the conduct of sound, meaningful research.

1. Public Health Policy and Law

Determine the optimal role for law and policy as public health tools, and improve the translation of research findings for use at the community, state, national, and international levels.

Scope of Research: Evaluate the ways in which laws, regulations, and policies contribute to the prevention of morbidity and mortality and to the reduction of health disparities. Evaluate the effectiveness of laws and policies as public health interventions. Identify factors that contribute to their effectiveness, and identify their interaction with legal rights and principles. Develop the methodological basis for research on law and policy as public health tools. Identify methods to effectively translate scientific findings into information for use by public health providers and policymakers.

2. Ethics in Public Health

Determine the best methods of improving the development and promoting the adoption of ethical frameworks and practices in the conduct of public health research and programs.

Scope of Research: Develop, implement, and evaluate educational tools and trainings for incorporating ethical principles into public health research, policy, and practice. Develop and evaluate the ethical competency level and training needs for public health professionals. Evaluate the national infrastructure and resources needed for ethics education and training (e.g., ethics courses in schools of public health). Evaluate the health benefits of promoting and protecting human rights in public health research, policy, and practice. Evaluate methods to enhance the protection of privacy and confidentiality in public health programs and research, with emphasis on balancing privacy and data collection with public health goals. Develop tools for assessing and minimizing the potential impact of public health programs and research on human rights. Evaluate the ethics of conducting research in community settings, and develop methods to translate those findings to protect human rights. Identify and examine ethical considerations during preparedness response activities. Develop indicators and tools for measuring the potential health impact of ethical and human rights violations in public health research, policy and practice.

H. Social Determinants of Health and Health Disparities

For many of our nation's poor, good health is a luxury they cannot afford. Efforts to address the social and economic factors that influence health can ensure that all Americans have a fair chance at a healthy life.

Although the overall health of the U.S. population has improved over the last few decades, many segments of the population still suffer from poor health [55]. Developing methods to measure and compare the health status of various population groups and the relative burdens of specific diseases, injuries, and other adverse health conditions can facilitate appropriate implementation of health protection interventions. Reducing and preventing the greatest amount of total health burden is essential to improvement of overall health status in the United States.

Social determinants of health are those factors beyond individual behavior and genetic endowment that impact individual, community, and societal health. These factors include neighborhood conditions and resources (e.g., food supply, economic and social relationships, air and water quality,

transportation, education, and healthcare) for which distribution across populations effectively determines length and quality of life. Many of the social determinants of health exist outside of the formal health sector, even though they exert profound impacts on health status. Population and geographic distributions of the social determinants of health are not random. Structures, policies, practices, norms, and values can result in the differential allocation of resources and risks by race/ethnicity, social class, geography, sex, and other axes of population disparity.

Achieving optimal health and quality of life for all populations, locally and globally, is contingent on collective efforts to achieve the public health goal of preventing and eliminating health disparities and ensuring that all people, especially those at greater risk of health disparities, achieve their optimal lifespan and experience the best possible quality of health in every stage of life. Health disparities (i.e., differences in the quality of health and healthcare that exist between population subgroups) can be observed across a wide variety of health conditions and tend to arise between populations who differ in exposure to health-impacting resources and risks. Race/ethnicity, socioeconomic status, geography, sex, age, disability status, and sexual orientation are all risk markers associated with health disparities. Further, healthcare professionals have been identified as having biases toward other population groups other than their own [56]. To promote behavior change among health professionals and contribute to the elimination of health disparities, research activities that focus on training to reduce these biases must be supported [56].

Research to understand the determinants of health disparities, elucidate the differences in burden of disease between subpopulations, and identify evidence-based strategies to prevent and eliminate health disparities in the 21st century must be planned, overseen, and conducted through the collaborative efforts of public health experts worldwide. By encouraging and implementing aggressive research efforts that address the risk markers for health disparities, the nation can achieve better health for all of humanity [57].

1. Burden of Disease

Measure burden of diseases and risk factors for diseases to reduce or prevent the greatest amount of total health burden.

Scope of Research: Develop and improve methods to assess current and predict future trends for health burdens, including acute and chronic illnesses and conditions, death, quality of life and well-being, and economic and social costs. Develop new methods to estimate the preventable burden of disease to ensure the appropriate allocation of resources to the most effective public health interventions.

2. Social Determinants of Health

Modify and evaluate social determinants of health disparities.

Scope of Research: Identify and address the fundamental causes of adverse health outcomes and health disparities. Evaluate the social determinants of health by examining differences in the distributions of exposures, opportunities, and outcomes by race/ethnicity, socioeconomic status, geography, age, sex, disability, and sexual orientation. Develop and test measures for the collection and use of standardized data to correctly identify the social determinants of health and health disparities. Develop and evaluate surveillance methods for social class markers (e.g., racism, poverty and sex discrimination). Test and evaluate interventions that address social determinants of health disparities, including those aimed at improving high school graduation rates (e.g., after-school mentoring programs, time management skill development of adolescents, and prevention of unintended pregnancies). Conduct studies to assess and reduce the impact of social forces (e.g., racism, sexism, and homophobia) on health. Conduct epidemiologic studies on the incidence, prevalence, and modifiable social determinants and differential risk of disease, injury, and disability in disadvantaged populations. Develop assessment tools that enable determination of the impact of social determinants of health and health disparities that can be used to inform new policies and programs. Assess public health surveillance systems to evaluate how they currently capture social determinants of health and how they can be improved. Evaluate the structures, policies, practices, and norms that differentially shunt different populations into various contexts (e.g., the mechanisms of institutionalized racism). Evaluate the delivery of culturally competent programs in

communities. Implement, track, and evaluate the dissemination of public health interventions in differentially affected populations.

3. Health Disparities Prevention and Elimination

Develop, evaluate, and promote methods and interventions that have been shown by evidence-based studies to be effective in characterizing, reducing, or eliminating modifiable health disparities.

Scope of Research: Evaluate the fundamental causes of adverse health outcomes and health disparities in disadvantaged populations. Assess and increase the effectiveness, prevalence of use, opportunities for optimal use, strategies to increase use, and cost effectiveness associated with interventions to prevent and control leading causes of premature death, illness, and disability in disadvantaged populations. Examine health disparities among people with disabilities, including those associated with race/ethnicity, sex, and economic and employment status. Assess the use of cultural competency, language services, provider best practices, and community-based healthcare in underserved communities. Identify and evaluate the dissemination of successful federal, state, tribal, and local strategies that are likely to increase awareness and use of effective interventions in disadvantaged segments of the U.S. population. Identify the socioeconomic, geographic, and social barriers (e.g., stigma) that impede access to needed and quality care, and evaluate strategies aimed at improving health infrastructure to ensure equitable, population-wide access to care. Examine the role of historical urban renewal efforts in current health disparities, and determine the long-term consequences of community-level spatial reorganization on overall community health. Determine the economic and social benefits associated with reducing health disparities (e.g., assess the costs to society for continued disparities between populations with access to healthcare, and those who cannot access the current health system). Identify the social, physical, and mental health needs of incarcerated persons. Evaluate efforts to capture data for underrepresented groups; and implement targeted community interventions that can eliminate preventable disparities among such underrepresented and underserved groups and communities. Identify science-based interventions proven to be effective in population groups, and implement and evaluate their impact in different populations, particularly those who disproportionately experience health disparities. Assess the long-term mental health consequences of experiencing health disparities.

Develop research studies that evaluate cultural competency programs and training for public health professionals, healthcare providers, and students in the healthcare field.

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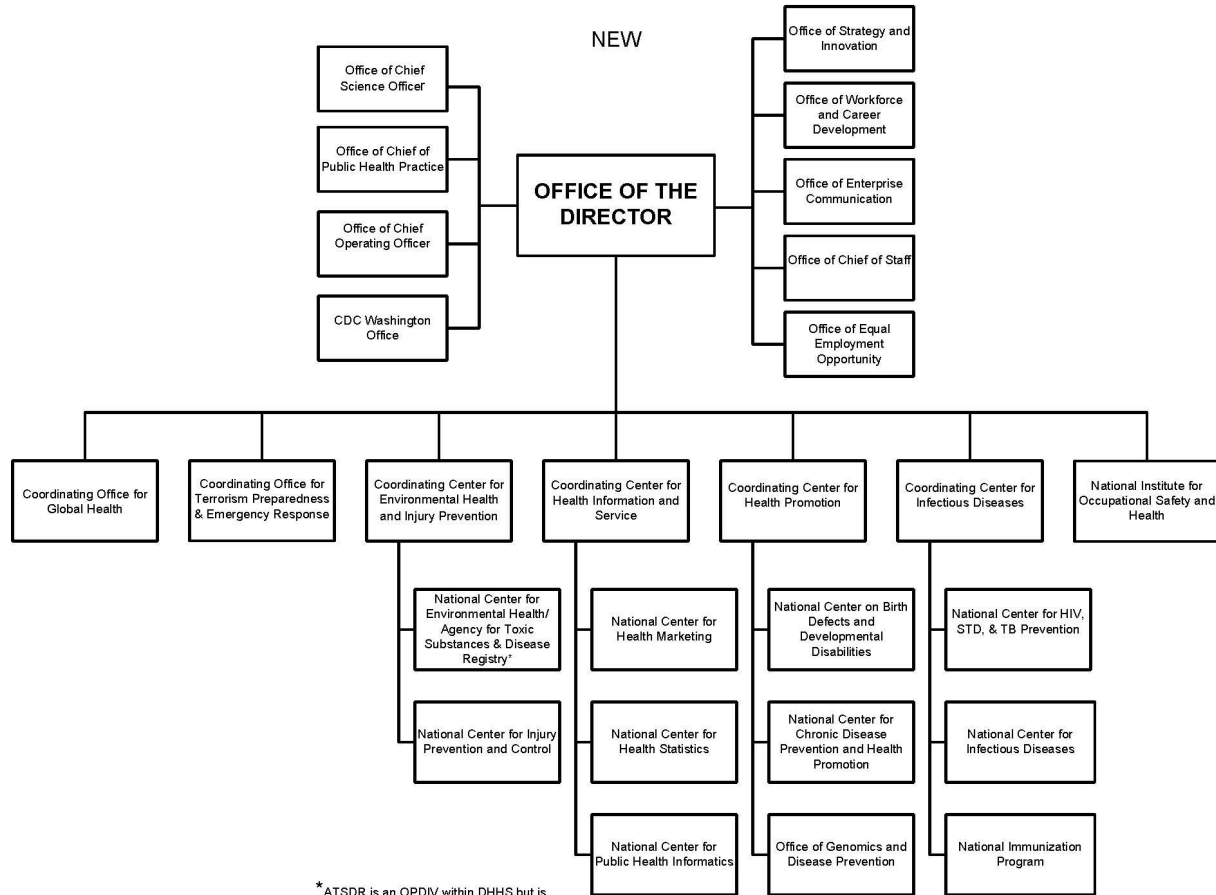
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APPENDIX II. List of Abbreviations

ACD	Advisory Committee to the Director
AIDS	Acquired Immunodeficiency Syndrome
CDC	Centers for Disease Control and Prevention
CBPR	Community-Based Participatory Research
CHEs	Complex Humanitarian Emergencies
CIOs	Centers, Institute and Offices
CVDs	cardiovascular diseases
EHRs	electronic health records
HIPAA	Health Insurance Portability and Accountability Act
HIV	Human Immunodeficiency Virus/
HPAI	Highly Pathogenic Avian Influenza
MSDs	Occupational Musculoskeletal Disorders
NIH	National Institutes of Health
NORA	National Occupational Research Agenda
PEPFAR	President's Emergency Plan for AIDS Relief
PLWHA	people living with HIV/AIDS
PPE	personal protective equipment
RFAs	Requests for Applications
SAGE	Standing Against Global Exploitation
SARS	Severe Acute Respiratory Syndrome
STD	Sexually Transmitted Disease
TB	Tuberculosis
UNICEF	The United Nations Children's Fund
VPDs	vaccine-preventable diseases
ZVBDs	Zoonotic and Vectorborne Diseases

APPENDIX III. CDC Organizational Chart

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* ATSDR is an OPDIV within DHHS but is managed by a common Ofc of the Director with NCEH

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