MEASURING PERFORMANCE AMONG STATE DOTS: SHARING GOOD PRACTICES -- SERIOUS CRASH INJURY

Prepared for:

American Association of State Highway and Transportation Officials/ Standing Committee on Performance Management

Prepared by:

Cambridge Systematics, Inc.
115 South LaSalle Street, Suite 2200
Chicago, IL 60603

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Table of Contents

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List of Tables

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List of Figures

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Executive Summary

To reach the national goal of eliminating highway fatalities and significantly reducing serious injury crashes, states must refocus on consistently and comprehensively measuring serious injuries. In 2011, an estimated 2.22 million people were injured in motor vehicle crashes across the U.S. Despite a recent uptick, the nation's fatality rate has continued to trend downward. However, the vehicle crash injury rate rose 1.3 percent between 2010 and 2011. As the nation's passenger vehicle fleet continues to turn over, safety technologies become standardized in new vehicles and states deploy proven countermeasures to target problem areas, highway fatalities are increasingly less common. But while the likelihood of fatal crashes is declining, life-changing, serious injuries may be increasing. Serious injuries are often disabling or debilitating and represent a significant loss to society. According to the Centers for Disease Control and Prevention (CDC) the total cost of direct medical care and economic productivity losses associated with injuries from motor vehicle crashes is estimated in excess of $99 billion annually.

To counter these trends, transportation and health practitioners must more accurately measure performance and direct resources toward identifying and resolving safety challenges on the nation's highways. Both fatality and serious injury performance measures are included in the most recent surface transportation reauthorization bill Moving Ahead for Progress in the 21st Century (MAP-21). As a precursor, the National Highway Traffic Safety Administration (NHTSA), in collaboration with the Governors Highway Safety Association (GHSA) and others, developed 11 outcome safety performance measures that include the number of serious injuries. All states began reporting in 2010. MAP-21 requires these performance measures as a minimum for developing State performance measures and targets. Both NHTSA and GHSA recognize serious injury reporting is inconsistent and the data are incomplete.

Serious injuries are often underreported or misreported, recorded subjectively and inconsistently at the crash scene, may be misrepresented in state crash or health datasets; and not collected, reported, recorded, tracked, or utilized consistently across states.

Many issues exist for consistently measuring serious injury crashes on a nationwide basis. Challenges first arise when injuries are determined at the crash scene. Most states rely on injury severity data recorded at the scene by law enforcement. Classification systems are not consistent within and across states and injury coding varies considerably depending on the reporting officer, injury visibility, crash severity, response of emergency personnel, and many other factors. Injury severity data collected through crash reports are deemed unreliable for many uses, require substantial resources to process and link to other records, and are not adequate for use in national level performance reporting. Most importantly, the first responders' responsibility should be concern for crash survivors and public safety rather than data gathering.

Additional issues with data quality, compatibility, and portability arise at many points through the law enforcement and public health systems. Analysts from many different agencies are involved in crash data and in emergency, hospital, trauma, or vital records databases. In some states, these data systems are coordinated through a single agency, while in others databases are spread across multiple agencies. Sharing this data for the purposes of better reporting and tracking serious injury crash data is often stymied by privacy concerns, state regulations, inadequate funding for analysis, and siloed agency responsibilities.

Other challenges are encountered during processing and linking data, which occurs well after and far removed from the initial incident. Data from crash reports may be linked with public health records; however, this process is not currently viable for many states. Data linkages efforts have been successful in some cases (largely where coordination and champions exist in both transportation and public health agencies) but are not likely to be scaled up to meet the needs of a national performance framework.

The goal of NCHRP 20-24(37)K: Measuring Performance among State DOTs: Sharing Good Practices -- Serious Crash Injury is to chart a path forward on collecting serious injury crash data for state DOT performance measurement and management. Projects like this one are helping build the capacity of state DOTs and other agencies for expected performance management requirements embedded in MAP-21 and are being pursued by both individual states and national organizations.

This report provides a starting point for NCHRP 17-57: Development of a Comprehensive Approach for Serious Traffic Crash Injury Measurement and Reporting Systems, which seeks to develop a roadmap to assist states in developing and implementing an interim system to measure and report injury severity. The research team surveyed current state practices, reviewed existing approaches and pilot programs, described possible implementation options, and sought feedback directly from safety and health practitioners to assess feasibility of the options.

The option to count serious injury crash statistics based on hospital discharge data is the most viable and productive. Solutions are needed to address data privacy concerns and resources must be devoted to establishing State programs. However, the insights and information gathered could yield consistent injury counts and provide state practitioners with valuable information. Implementing this option would require significant lead time – two to five years – following enabling legislation or a Federal mandate. Full implementation at the state level would progress faster in those states with active and engaged partners and current efforts to compile and analyze health datasets. Implementation could be led by state health departments with support from Federal agencies.

Measuring serious injuries using health data would address national performance measurement needs, but would not provide full information to states for surveillance and prevention efforts. This option must be pursued in concert with sustained commitment to directly link state health and crash data or dedicated funding for further advancing probabilistic linkage programs. Aggregate counts of serious injuries not linked to traffic records do not equip traffic safety professionals with the information needed to identify crash patterns and implement interventions. Quality data are needed from both the traffic safety and health perspective to actively reduce the severity and frequency of serious injury crashes.

1.0 Introduction

This report presents research conducted under NCHRP Project 20-24(37)K: "Measuring Performance among State DOTs: Sharing Good Practices -- Serious Crash Injury".

NCHRP Project 20-24(37) activities are undertaken to support state departments of transportation (DOT) in assessing system and agency performance, identifying, validating, and sharing management practices that support high performance. These projects study specific aspects of performance management. In general, they gather data and document state practices.

1.1 Study Overview

The objectives of Project 20-24(37)K include: 1) review and assess current state practices for quantifying serious injuries from motor vehicle crashes, 2) describe issues to be addressed in adapting CODES or other available databases to provide a basis for comparative analysis of DOT performance regarding serious crash injuries, and 3) describe feasible options for addressing these issues and assess their relative merits.

The following research tasks were performed for this study.

Task 1: Coordinate with the NCHRP project panel to affirm the project's technical scope.

Task 2: Scan the current literature assessing the quality of state serious injury data systems and published efforts to determine serious injury measures based on existing and possible linkages.

Task 3: Survey state DOTs, state highway safety offices, and state public health agencies to determine common practices, identify state data systems related to injury severity and determine injury definitions, types of data collected, severity indicators, completeness of data, and existing linkages.

Task 4: Describe feasible options for measuring and reporting serious injury data and their relative advantages and disadvantages.

Task 5: Identify and present states that may serve as examples for how more favorable options could be implemented. Discuss next steps to achieving options for linking data systems and standardizing measurement and reporting processes outlined in Task 4.

Task 6: Document the research findings and prepare a final report.

1.2 REPORT ORGANIZATION

The final report presents the results of research performed under this project.

Chapter 2 discusses the study's goals and objectives, reviews background information on recent safety performance measurement initiatives, and presents current issues surrounding the collection and reporting of serious injury data.

Chapter 3 reports the results of a survey of state transportation and public health agencies. Findings from this survey illuminate current state practices to define serious injuries and to link safety and health databases. Critical challenges and barriers to further linking these data also are reported.

Chapter 4 presents a range of potential options to advance ongoing national dialogue and support continuing research to improve collection and compilation of serious injury crash data at the state level. This discussion does not include specific recommendations, but identifies possible future directions and associated advantages and disadvantages to inform the development of a national framework for reporting serious injury data.

Chapter 5 synthesizes input from interviews with several states to share best practices and report initial feedback on implementation options identified in Task 4.

2.0 Measuring Safety Performance

Momentum for a nationwide performance-based transportation program has grown significantly. This trend reflects increasing pressure for public agencies to demonstrate accountability and measure the relationship between resource allocation decisions and resulting performance. An investment and decision process centered around the principles of performance management provides practitioners with a rational, defensible, and accountable basis for improving the delivery of transportations services. Performance management is a continuous process of improvement driven by assessing, reporting, and acting on the performance of the system and the impact of investments.

To this end, the National Cooperative Highway Research Program (NCHRP) sponsors a variety of efforts to help transportation practitioners identify and discuss opportunities and challenges associated with performance-based programs. NCHRP 20-24(37) is intended to lay a foundation and provide direction for continuing work to produce practical and effective performance measures.

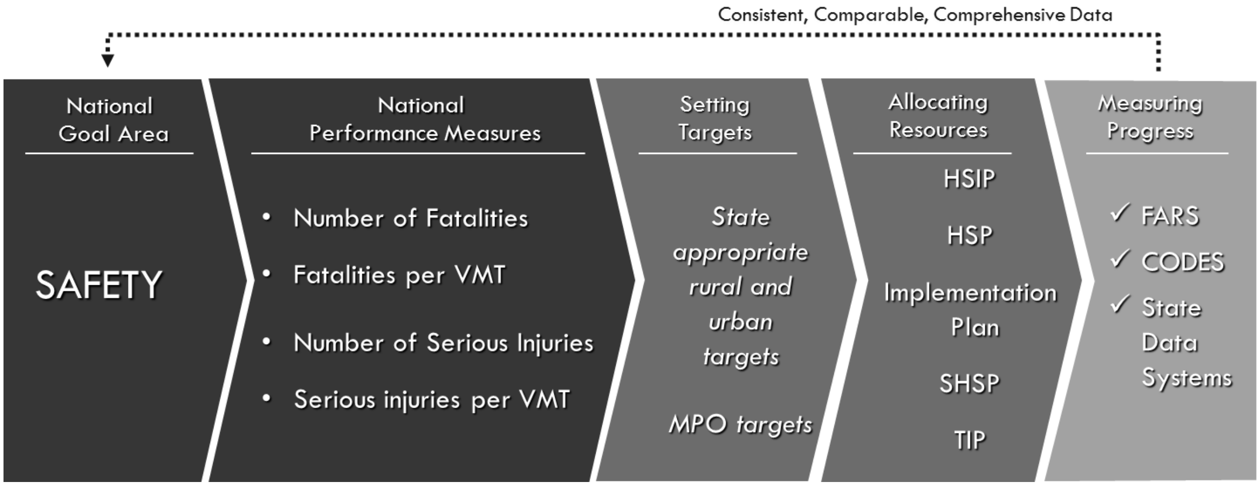
2.1 A National Serious Injury Standard

Highway safety remains an area where the desire to better measure performance related to serious injury exceeds current capability to produce reliable performance measures. Currently, broad consensus exists among practitioners on the safety performance measures, which could be reported nationally and tracked by states. Consensus is lacking on how to best record and report these measures.

The National Highway Traffic Safety Administration (NHTSA), working with the Governors Highway Safety Association (GHSA) and others, developed a series of performance measures that include fatalities and serious non-fatal injuries. The American Association of State Highway and Transportation Officials (AASHTO) also has identified fatalities and serious injuries as specific measures.

The general performance management framework supported by Federal agencies and other national organizations is presented in Figure 2.1 along with initial safety goal and performance measures required by MAP-21.

Figure 2.1 Performance Management Framework



MAP-21 incorporates several performance management elements into the safety program consistent with this framework, including:

- Performance reporting is a critical step in identifying the scale and scope of challenges and providing a means to track progress over time. Data reporting has long been a core focus of federal and state programs, and MAP-21 continues that emphasis.
- Target setting is the link between decision making and reporting. States are required under MAP-21 to set targets for fatality and injury reductions to assess safety on all public roads. Metropolitan Planning Organizations (MPOs) are also required to set targets for their planning areas. States failing to meet targets within two years must develop implementation plans to achieve the targets.
- Performance-based planning and programming guides investment decisions. MAP-21 more fully integrates performance-based goals, programs, and decision making within state Highway Safety Improvement Programs (HSIP), Highway Safety Plans (HSP), Strategic Highway Safety Plans (SHSP) and implementation plans, and MPO Transportation Improvement Plans (TIP).

With the renewed emphasis on performance-based decision making within MAP-21 and given that serious injuries are identified as a core performance measure, a national approach to defining and reporting serious injuries must be developed. AASHTO has identified serious non-fatal injuries as a specific measure that must be further developed and refined to become a useful management tool To move serious injuries from a conceptual, state-specific indicator to a true performance measure across all states requires investigating how best to record and report serious injuries.

NCHRP Project 20-24(37)K and other related national and international efforts are being developed in recognition of the value of serious injury crash data as a reliable and powerful performance measure. This project is also intended to inform research conducted under NCHRP 17-57: "Development of a Comprehensive Approach for Serious Traffic Crash Injury Measurement and Reporting Systems."

To continue this national dialogue and further ongoing efforts, the objectives of NCHRP 20-24(37)K are to: 1) review and assess current state practices for quantifying serious injuries; 2) describe issues apparent in adapting available data and state systems to comparatively measure performance based on serious crash injuries; And, 3) describe and assess the relative merits o feasible options for addressing these issues.

2.2 THE SERIOUS INJURY DATA CHALLENGE

To reduce serious injury crashes, states must be able to identify trends and problem areas and direct limited resources appropriately. Serious injuries are often underreported or misreported, recorded subjectively and inconsistently at the crash scene, may be misrepresented in state crash or health datasets; and not collected, reported, recorded, tracked, or utilized consistently across states.

Significant issues with real consequences exist, and recent efforts are seeking solutions, including:

- Globally, the International Traffic Safety Data and Analysis Group (IRTAD) released a report providing specific recommendations to enhance crash injury data among member nations. The group's recommendations include actions to complement crash records with hospital data, to systematically assess injuries using a common scale, and for assessments to be completed by medical professionals.
- Nationally, NCHRP 17-57: "Development of a Comprehensive Approach for Serious Traffic Crash Injury Measurement and Reporting Systems" was launched to develop a roadmap to assist states in measuring and reporting injury severity. This project is intended to enable year-to-year performance assessments of states using a standard measure for serious injuries. The roadmap will include systems for using accepted injury scoring systems and document processes for linking statewide crash and hospital discharge data.

  Additionally, coordinated efforts are underway to improve state crash data collection. NHTSA recently revised the Model Minimum Uniform Crash Criteria (MMUCC) guidelines in 2012 to encourage better collection of serious injury data. Included in changes to the MMUCC 4th edition is a revision to the often used KABCO severity scale with clear definitions for each category. Other voluntary state-based efforts such as the Crash Outcome Data Evaluation System (CODES) or the National EMS Information System (NEMSIS) provide models for national coordination and consistent data reporting.
- Locally, an increasing number of state safety offices, public health departments, and departments of transportation are researching and experimenting with advanced crash-injury data analysis. These efforts are often short-term research or pilot programs geared toward improving data quality, expanding data linkages, or coordinating data reporting. Some of these practices may be scaled up or may help inform a national solution.

These initiatives and other efforts are leading the way toward establishing a consistent, coordinated, and comparable system for reporting serious injury data across the states. Yet, the complexity involved in state data systems, the lack of a nationally accepted injury classification system, the resources needed to implement a national system, and the legal, financial, and institutional barriers facing states present formidable challenges.

Reporting Serious Injuries

Two basic challenges exist for reporting serious injury crash data as a nationally accepted performance measure: 1) variation across the states in standards and approaches to data collection; and 2) variation within individual states in administering the approaches.

States utilize various reporting procedures, injury classification systems, police accident report forms, crash and health data systems, and statistical analysis techniques. The survey administered for this project found the greatest number of states define serious injuries using language similar to American National Standards Institute, Manual on Classification of Motor Vehicle Traffic Accidents (ANSI D.16). The KABCO scale is also popular among states though the exact descriptors of an 'A' or 'incapacitating injury' vary. Other states employ MMUCC guidelines, both older versions and the newer 4th edition descriptions. This widespread variation in classifications and the even more varied level of data quality across states makes nationally comparable data impossible.

This latter challenge of variation within states may be more significant because currently states rely on crash reports completed at the crash scene by responding police officers. Officers often employ the KABCO injury scale or a comparable rating system to classify injuries based on visual evidence. However, what an officer observes at a crash scene can differ substantially from evaluations performed later by medical personnel. Training and education of officers can make a difference and help improve the quality of injury severity reports. However, the benefits that can be achieved from sourcing injury data from trained medical personnel is substantial and will increase statistical reliability of injury data.

Alternate data sources, such as ambulance run reports, hospital outcome data, or data from trauma centers, are available and do provide greater data accuracy, but reliably linking police crash records with hospital trauma data presents unique challenges. NHTSA facilitated the development of CODES to enable states to conduct a probabilistic matching of statewide health records with crash reports, but a limited number of states are participating in the system, and the technical process is complex and requires substantial financial resources.

Overview of Crash Outcome Data Evaluation System

CODES is a component of the NHTSA State Data Program that evolved from a congressional mandate to report the benefits of safety belt and motorcycle helmet use in terms of medical and financial outcomes. This system allows electronic tracking of crash victims from the scene of an incident through the health care system using a database created by linking different sources of traffic and health records. With privacy concerns related to the data collected from both traffic and health record sources, unique identifiers (e.g. a victim's name) are not available in the data, and as a result, CODES uses probabilistic linkage methodology which generates an estimate that a matched pair is a valid match.

The CODES program was initiated in 1992, and six states were awarded grants to develop CODES. By 2001, 27 states were funded and the number increased to 30 by 2005. By 2011, the number of states funded for the CODES program had fallen to 16. These states are required to have an administrative structure to promote collaboration among the agencies involved and share authority. Person-specific files must be generated by linking the data, and applications must also be designed to use these data to enhance traffic safety decision making. The final responsibility of CODES states is to institutionalize the program throughout the state.

Although CODES is a national-level program, each state using the program can customize features to different preferences. In general, NHTSA sponsors cooperative agreements that provide software access, technical assistance, and some program assistance to CODES states through various means that include an annual national meeting. Generally, CODES data are governed by a Board of Directors who control access to the data based on state privacy legislation. Users include highway safety offices, public health and injury prevention departments, emergency medical services agencies, DOTs, and other agencies. The linked data are used to identify trends in crash rates and injury trends by vehicle safety features; support traffic safety decision making and legislation; to educate the public on the links and trends between traffic safety, injury severity, and other health outcomes; and in a variety of other ways.

CODES data are useful; however, several challenges are associated with its use. The data are collected by different parties at different points throughout the victim's journey from the incident scene through the medical system. At the scene, law enforcement record crash data and details pertaining to the vehicle, traffic, and roadway conditions. En route to the hospital, data are collected by the transporting agency. In the case where multiple units are used in transporting the victim (e.g. ambulance to helicopter) multiple records are recorded by all EMS units involved which can result in records duplication. The final leg of the data is collected throughout the health agencies from arrival to admission, discharge, or time of death. Overall, the data collected by each agency are designed to meet the specific agency's data collection needs. As a result most data by itself is rarely sufficiently comprehensive to support injury control efforts. For a CODES program to be useful on all levels, data must be accessible, high quality, automated, and linkable, as described in the 1996 NHTSA Technical Report on CODES. The types of data included are either related to a person or a crash and can include age, gender, vehicle seating position, admission as hospital inpatient, date and time of crash, crash location, type of crash, etc.

Linking Crash Data and Hospital Records

The success of record linkage is highly dependent on the quality of the data in the databases. For example, if the police officer fails to complete all fields in the crash report, it may be more difficult to link the crash with records from other databases if the necessary information is missing.

Quality and completeness issues with hospital data must also be considered. A recent IRTAD report, *"Reporting on Serious Road Traffic Casualties – Combining and Using Different Data Sources to Improve Understanding of Non-Fatal Road Traffic Crashes"* identified the following issues associated with the quality and completeness of data collected for medical purposes and hospital administration:

- Hospital practices change over time according to the administrative needs of each hospital (e.g., billing patients or insurance companies or claiming costs from elsewhere);
- Practices may vary between states according to practices set by the state government;
- Data may be collected mainly for financial purposes, with little requirement for fields indicating road traffic crashes;

- Data systems may differ from hospital to hospital (and even within different hospital departments);
- Medical staff do not always treat data entry as a high priority; and
- EMS data may provide additional medical information on injuries when available. However, data are often only available locally and may not specifically identify motor vehicle crashes.

Due to the limitations of using a single data source to measure serious injury, it is advantageous to link complementary data sources to enhance the quality of serious injury data.

Three main methods exist for linking two databases: manual, deterministic, and probabilistic. Manual linkage is only practical for databases that contain few records and little information. The deterministic approach links records with an exact match based on a unique identifier or combination of variables common to both databases. The deterministic approach is, therefore, subject to the accuracy of the identification variables. Data availability restrictions (i.e., social security number, names) can limit the use of the deterministic method. Finally, the probabilistic approach links records based on the highest probability of the records belonging to the same individual. The success of record linkage is highly dependent on the quality of the data records being linked.

CODES states primarily use probabilistic weight-based linkage using variables that include date of birth, gender, zip code, date and hour of collision and hospitalization, place of collision, and hospital reference area. Some states also use names and surnames; however these are commonly limited due to privacy protection restrictions.

NHTSA identified several challenges related to administrative functions and data linkages. Some of the administrative challenges identified include:

- Communication among different parties;
- Supporting a collaborative source of authority (conflicting goals/priorities);
- Problem of "turf" or data ownership;
- Issues related to confidentiality and release of CODES data;
- Organizational and fiscal management (bureaucratic red tape);
- Staffing difficulties; and
- Institutionalization (insufficient dedicated, long-term funding).

Collaboration and communication among the data owners are critical to successful administration of CODES and may help overcome many of these challenges. The data owners must share the decision making authority for linking the state crash and injury data, developing policies for confidentiality and release of the linked data, and institutionalizing CODES to support highway traffic safety and injury control.

Many of the linkage challenges NHTSA identified relate back to issues already described, such as difficulties in accessing databases due to privacy restrictions, data quality (completeness, multiple records, person identifiers), and data consistency (formats, definitions) among sources. These challenges can be managed through communication among stakeholders, stakeholder education, and manipulation of datasets to facilitate linkage.

Another issue in linking data is the use of hospital discharge data or emergency department data for injury surveillance may result in duplicate reporting. A potential solution to address this issue is to pre-process hospital discharge data to remove or link readmissions and transfers to the first admission.

A link between crash data and hospital outcome data provides a promising opportunity to promote the use of non-fatal, serious crash injuries as a national safety performance metric. CODES states have achieved a level of success in linking state databases, and other states can benefit from the lessons learned. Understanding these past approaches and current practices can help chart the way forward toward a uniform system for assessing serious injury crash performance at the national level.

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3.0 State Practices

To fulfill the objectives of NCHRP 20-24(37)K, the research team surveyed states to determine existing data systems, definitions, reporting standards, data linkages, and current barriers to better traffic safety data integration. The survey results provided the research team a baseline assessment of states' efforts to identify, utilize, and link injury severity data. The following sections present tabulated survey responses.

3.1 Survey Methodology

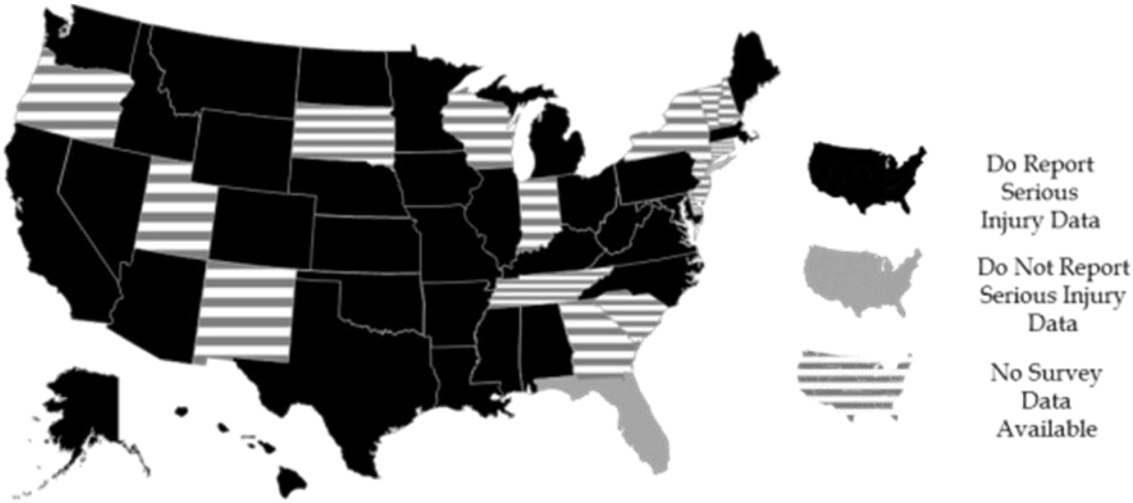
The NCHRP Serious Injury Survey Questionnaire was designed with input from the University of Michigan's Transportation Research Institute because the results will also be used to support NCHRP 17-57 research.

Invitations to complete the survey were emailed to Traffic Records Coordinators in all states and territories. The survey was available online for a two month period in late fall of 2012. A reminder notice and individual follow-up notices were sent to increase participation. The survey was held open for longer than initially planned to accommodate requests from several Traffic Records Coordinators for additional time due their attendance at the 38th International Forum on Traffic Records & Highway Information Systems which conflicted with the survey submission deadline.

A total of 50 respondents completed the survey, representing 36 states and one territory. Respondents primarily represented Traffic Records Coordinators in State Highway Safety Offices (SHSO) or highway safety program managers in state DOTs. Survey responses also were received from representatives from state Departments of Public Health, Public Safety, and State Police, academia, and safety consultants. The map in Figure 3.1 shows the responding states.

Of the 37 states responding to the survey, 36 (97 percent) indicated they currently measure and report on serious injuries as part of transportation safety improvement efforts. Florida was the only state to report it does not currently utilize serious injury data.

Figure 3.1 States Reporting Serious Injury Data



NCHRP 20-24 37K. Task 3 Survey, 2013. Survey sample includes data from 37 states.

3.2 SURVEY FINDINGS

Currently states use a variety of definitions to classify serious injuries on PAR (PAR) and in crash databases. The majority of states responding to the survey classify injury severity using a numeric or alphanumeric scale of three to six values. The most common terms used to describe serious injuries include 'incapacitating' or 'disabling'.

Defining Serious Injuries

At least 18 states define serious injuries using language similar to ANSI D.16. The KABCO injury scale is used by at least six states with the standard description of an 'A' or 'incapacitating injury' similar to that found in ANSI D.16. Several states have adopted serious injury definitions from MMUCC guidelines. Two states currently use a description similar to the 2012 MMUCC, which updated prior injury classifications and uses a revised definition for 'suspected serious injury.'

Survey respondents provided information on serious injury definitions which were verified, to the extent possible, and grouped by the research team. States may abridge or revise standard national definitions in uniform crash report code manuals, or adopt variations of standard injury scales (e.g. KABCD or KABC PDO). The research team grouped states based on similarity to existing definitions, except in the cases noted in Table 3.1 where states use entirely unique descriptions of injury severity.

Table 3.1 State Serious Injury Definitions

State Definitions		Responding States
States using standard injury classifications	***27***	
Scale using similar description to ANSI D16.1 definition of "Incapacitating Injury" or frequently "Disabling Injury"	18	AZ, AR, CO, HI, IA, ID, KS, LA, MA, MD, MI, MO, MT, ND, OH, OK, WA, WY
KABCO injury scale, or similar, using ANSI D.16 definition for 'A' or "Incapacitating Injury"	6	IL, ME, MN, NC, NV, TX
Definition of "Suspected Serious Injury" similar to 2012 4th edition MMUCC Guideline	2	AK, CA
Definition of "Incapacitating Injury" similar to 2008 3rd edition, or older, of MMUCC Guideline	1	DE
States using unique injury classifications	***8***	
Incapacitating. This means the victim must be carried or otherwise helped from the scene. If the victim needs no help, then either a code 3 or 4 applies even though medical assistance may have been administered at the scene.		AL
KABCD scale, with dissimilar values (K=Killed, A=Life Threatening, B=Moderate, C=Minor and D=No Injury)		MS
Disabling Injury. Cannot leave scene without assistance (broken bones, severe cuts, prolonged unconsciousness, etc.)		NE
Major injury. Incapacitating injury, including bleeding wounds and distorted members (amputations or broken bones), and requires transport of the patient from the scene.		PA
Injury resulting of a car accident which involves lacerations, severe hemorrhage, or bone fractures and requires hospitalization.		PR
The definition of "Incapacitating Injury" is not identified, prompting officers to use their own discretion.		RI
Visible signs of injury, such as bleeding wound, distorted member or had to be carried from the scene		VA
Incapacitating Injury. Injury severe enough to require individual to be immediately transported from the scene. Injuries include bleeding wounds, distorted members, etc.		WV

Utilizing Injury Data

All states measuring injury severity utilize data to generate reports. The majority of respondents also use data for planning, policy, research activities, and measuring performance. Note: the percentages reflect the number of reporting states. In some cases, states did not complete all the information on the survey.

Table 3.2 State Use of Injury Data

Utilization of Data		State(s)
Generating reports	36 (97%)	AK, AL, AR, AZ, CA, CO, DE, HI, IA, ID, IL, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NV, OH, OK, PA, PR, RI, TX, VA, WA, WV, WY
Safety/program planning and management	35 (95%)	AK, AL, AR, AZ, CA, CO, DE, HI, IA, ID, IL, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NV, OH, PA, PR, RI, TX, VA, WA, WV, WY
Evaluating and refining existing policy and regulation	33 (89%)	AK, AL, AR, AZ, CA, DE, HI, IA, ID, IL, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NV, OH, OK, PA, PR, VA, WA, WV, WY
Research	32 (86%)	AK, AL, AR, CA, DE, HI, IA, ID, IL, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NV, OH, OK, PA, TX, VA, WA, WV, WY
Is not used	1 (3%)	FL
Other	7 (19%)	CO, ID, IL, MA, ME, MN, MO

Verbatim Responses	
CO	All levels of severities (PDOs, injuries, and fatalities) are considered for all safety studies.
ID	Performance measure as required by DOT HS 811 025
ID	Economic cost of crashes
MA	Data quality improvement
MA	Highway Safety Improvement Program (HSIP) eligibility, e.g. must be in top 5 percent of crashes based on EPDO (weighted by injury severity)
ME	State Highway Safety Plan
MN	Performance measurement and goal setting
MO	Performance measures

Linking Health and Crash Data

Nearly all states responding to the survey indicate motor vehicle crash data records are linked with roadway inventory systems. Fewer states are currently, or are planning to, link crash data with health records. Approximately two-thirds of respondents indicate EMS patient care, trauma registry, and hospital discharge records may be linked, while less than half report emergency department and vital records may be linked.

Table 3.3 States with Linked Crash Data

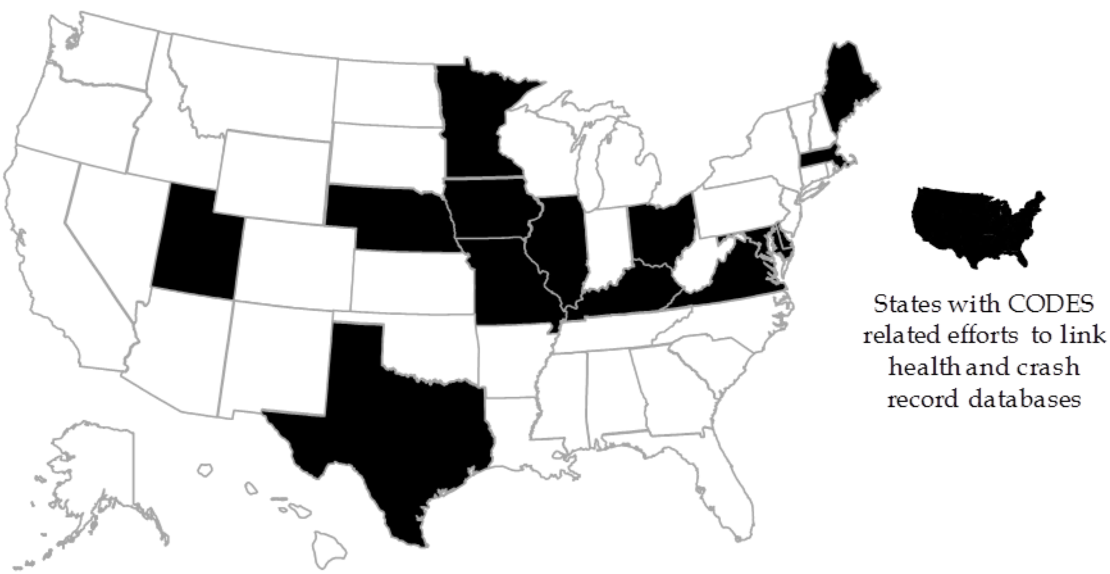
Linkage with Crash Data?	Yes		No	
EMS Patient Care Data	23 (62%)	AK, AL, DE, FL, HI, IA, ID, KS, LA, MA, MI, MN, MO, MS, MT, NC, NE, OH, OK, TX, VA, WA, WV	11 (30%)	AR, AZ, CO, KY, ME, ND, NV, PA, PR, RI, WY
Emergency Department Data	15 (41%)	CA, DE, HI, KY, LA, MA, MD, MI, MN, MS, NC, NE, OH, TX, WA	17 (46%)	AL, AR, AZ, CO, FL, ID, KS, ME, MT, ND, NV, OK, PA, PR, RI, VA, WY
Hospital Discharge Data	22 (59%)	AK, AL, AR, CA, DE, HI, IL, KY, LA, MA, MD, ME, MI, MN, MO, NC, NE, OH, OK, TX, VA, WA	12 (32%)	AZ, CO, FL, ID, KS, MT, ND, NV, PA, PR, RI, WY
Trauma Registry Data	22 (59%)	AK, AL, HI, IA, ID, IL, KS, KY, LA, MA, MD, MI, MN, MS, MT, NC, NV, OH, TX, VA, WA, WV	14 (38%)	AR, AZ, CO, DE, FL, ME, MO, ND, NE, OK, PA, PR, RI, WY
Vital Records	17 (46%)	CA, CO, HI, ID, LA, MA, MN, MO, MS, NC, NE, OH, OK, TX, VA, WA, WV	16 (43%)	AK, AL, AR, AZ, DE, FL, KS, KY, MD, ME, ND, NV, PA, PR, RI, WY
Roadway Inventory	33 (89%)	AK, AL, AR, CO, DE, FL, HI, IA, ID, IL, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NV, OH, OK, PA, RI, TX, VA, WA, WV, WY	3 (8%)	AZ, NE, PR

The following maps group states based on efforts to comprehensively link all available health databases and crash records, continue CODES related efforts, and that have developed systems to probabilistically link health and crash databases.

Figure 3.2 States with Comprehensive Health and Crash Data Linkages

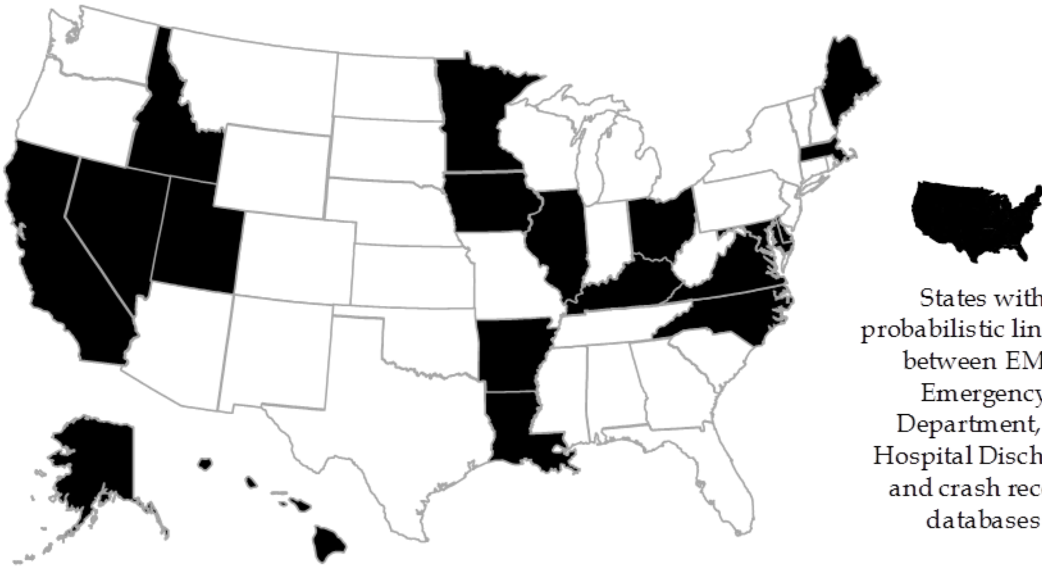
NCHRP 20-24 37K Task 3 Survey, 2013. Survey sample includes data from 37 states.

Figure 3.3 States with CODES Related Data Linkage Efforts



NCHRP 20-24 37K Task 3 Survey, 2013. Survey sample includes data from 37 states.

Figure 3.4 States with Probabilistic Data Linkage Systems



NCHRP 20-24 37K Task 3 Survey, 2013. Survey sample includes data from 37 states.

Detailed Data Linkages

For each of the health datasets described above, respondents were asked to identify whether data linkages were deterministic or probabilistic. Deterministic linkage is based on the number of individual identifiers that can be matched among the combined data sets. When using a deterministic record linkage procedure, two records are considered to match if all or some identifiers above a certain statistical threshold are identical. Probabilistic linkage involves a wider range of potential identifiers and computing weights for each identifier based on its estimated ability to correctly identify a match or a non-match. The weights are used to calculate the probability that two given records refer to the same entity. Pairs with probabilities above a certain statistical threshold are considered matches, pairs with probabilities below another threshold are considered non-matches; and those in between the two thresholds are considered "possible matches".

States were also asked if their EMS patient care, emergency department, hospital discharge, trauma registry, vital records, and/or roadway inventory data linkage is direct to the crash data system or indirect through another data system and if the linkage efforts were related to a CODES project.

Tables 3.4 through 3.9 present details for each health dataset linked with motor vehicle crash data. Note, not all states provided detailed information on linkages.

Table 3.4 Detailed EMS Patient Care Data Linkages

States with Crash Data Linked to EMS Patient Care Data						
Type of Linkage?		**Direct or Indirect?**		**CODES Related?**		
Deterministic	**Probabilistic**	**Direct**	**Indirect**	**Yes**	**No**	**Unknown**
12 (48%) AK, AL, AZ, FL, KS, MA, MI, MO, MS, MT, OH, OK, WY	13 (52%) DE, HI, IA, ID, LA, MD, MN, NC, NE, PR, TX, VA, WA	13 (52%) AK, AL, DE, FL, IA, MA, MD, MN, MS, NC, NE, OH, OK, WY	12 (48%) AZ, HI, ID, KS, LA, MI, MO, PR, TX, VA, WA, WV	10 (32%) DE, IA, MA, MD, MN, MO, NE, OH, TX, VA	18 (58%) AK, AL, AR, AZ, FL, ID, KS, LA, MI, MS, NC, ND, OK, PR, RI, WA, WV, WY	3 (10%) CA, HI, MT

Table 3.5 Emergency Department Data Linkages

States with Crash Data Linked to Emergency Department Data						
Type of Linkage?		**Direct or Indirect?**		**CODES Related?**		
Deterministic	**Probabilistic**	**Direct**	**Indirect**	**Yes**	**No**	**Unknown**
5 (29%) AZ, MI, MS, OH, WY	12 (71%) CA, DE, HI, KY, LA, MA, MD, MN, NC, NE, PR, TX, WA	8 (47%) DE, MA, MD, MN, MS, NC, NE, OH, WY	9 (53%) AZ, CA, HI, LA, MI, PR, TX, WA, WV	7 (26%) KY, MA, MD, MN, NE, OH, TX	18 (67%) AL, AR, AZ, CA, DE, ID, KS, LA, MI, MS, NC, ND, PR, RI, VA, WA, WV, WY	2 (7%) HI, IA

Table 3.6 Hospital Discharge Data Linkages

States with Crash Data Linked to Hospital Discharge Data						
Type of Linkage?		Direct or Indirect?		CODES Related?		
Deterministic	Probabilistic	Direct	Indirect	Yes	No	Unknown
6 (25%)	18 (75%)	11 (46%)	13 (54%)	12 (38%)	16 (50%)	4 (13%)
AL, AZ, MI, MO, OK, WY	AK, AR, CA, DE, HI, IL, KY, LA, MA, MD, ME, MN, NC, NE, OH, PR, TX, VA, WA	AK, AL, DE, MA, MD, MN, MO, NC, NE, OH, OK, WA	AR, AZ, CA, HI, IL, LA, ME, MI, PR, TX, VA, WV, WY	DE, IL, KY, MA, MD, ME, MN, MO, NE, OH, TX, VA	AL, AR, AZ, CA, ID, KS, LA, MI, NC, ND, OK, PR, RI, WA, WV, WY	AK, HI, IA, NV

Table 3.7 Trauma Registry Data Linkages

States with Crash Data Linked to Trauma Registry Data						
Type of Linkage?		Direct or Indirect?		CODES Related?		
Deterministic	Probabilistic	Direct	Indirect	Yes	No	Unknown
8 (38%)	13 (62%)	10 (45%)	12 (55%)	8 (27%)	18 (60%)	4 (13%)
AK, AL, AZ, KS, MA, MI, MS, NV, WY	HI, IA, ID, IL, LA, MD, MN, NC, OH, PR, TX, VA, WA	AK, AL, IA, KS, MA, MD, MN, MS, NC, OH, WA	AZ, HI, ID, IL, LA, MI, NV, PR, TX, VA, WV, WY	IA, IL, MA, MD, MN, OH, TX, VA	AK, AL, AR, AZ, DE, ID, KS, LA, MI, MS, NC, ND, NE, PR, RI, WA, WV, WY	CA, HI, MT, NV

Table 3.8 Vital Records Linkages

States with Crash Data Linked to Vital Records						
Type of Linkage?		**Direct or Indirect?**		**CODES Related?**		
Deterministic	**Probabilistic**	**Direct**	**Indirect**	**Yes**	**No**	**Unknown**
8 (47%) AZ, MA, MI, MO, MS, NC, OH, OK, TX	9 (53%) CA, HI, ID, LA, MN, NE, PR, VA, WA	8 (44%) MA, MN, MO, MS, NC, NE, OH, OK, WA	10 (56%) AZ, CA, HI, ID, LA, MI, PR, TX, VA, WV	7 (25%) MA, MD, MN, MO, NE, OH, VA	19 (68%) AL, AR, AZ, CA, DE, ID, KS, LA, MI, MS, NC, ND, OK, PR, RI, TX, WA, WV, WY	2 (7%) HI, MT

Table 3.9 Roadway Inventory Data Linkages

States with Crash Data Linked to Roadway Inventory Data						
Type of Linkage?		**Direct or Indirect?**		**CODES Related?**		
Deterministic	**Probabilistic**	**Direct**	**Indirect**	**Yes**	**No**	**Unknown**
32 (100%) AK, AL, AR, AZ, CO, DE, FL, IA, ID, IL, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NV, OH, OK, PA, PR, RI, TX, VA, WA, WY	0 (0%)	24 (73%) AK, AL, AZ, CO, DE, FL, IA, IL, KS, LA, MA, MD, ME, MN, MO, MS, NC, ND, OH, OK, TX, VA, WA, WV, WY	9 (27%) AR, HI, ID, MI, MT, NV, PA, PR, RI	4 (11%) MA, MD, ME, MN	28 (80%) AK, AL, AR, AZ, CO, DE, FL, IA, ID, KS, KY, LA, MI, MO, MS, MT, NC, ND, NE, OK, PA, PR, RI, TX, VA, WA, WV, WY	3 (9%) CA, HI, OH

Direct Linkage Identifiers

States with direct linkages between health and crash datasets were asked to indicate the identifiers associated with linkages. Verbatim responses are reported in Tables 3.10 through 3.15.

Table 3.10 EMS Patient Care Direct Linkage Identifiers

State	Verbatim Responses
AL	Time of Crash | Crash Location
AK	This has yet to be built but we are planning to use the Alaska Public Safety Information Network (APSIN) ID as a unique identifier across databases
DE	Last Name |First Name| Gender | Age | Crash Date and Time| ALS/BLS Agency Latitude and Longitude
FL	Sex | Date of Birth |Zip code | Incident Date
ID	Name | Date of Birth | Gender | Date of Incident | Hospital
IA	A variety per CODES.
KS	Indirect link with FARS database. Yet to be determined though likely to include event date, person ID, local case number, etc.
MD	Time of Day | Day of Week | County of Crash | Age | Gender | Mechanism of Injury | Person Type (Driver, Passenger, Pedestrian)
MA	Vehicular Injury Indicators | Area of the Vehicle Impacted by the Collision | Seat Row Location of Patient in Vehicle | Position of Patient in the Seat of the Vehicle | Use of Occupant Safety Equipment | Airbag Deployment | Barriers to Patient Care | Alcohol/Drug Use Indicators | Incident/Patient Disposition | Transport Mode from Scene PSAP Call Date/Time | Unit Arrived on Scene Date/Time | Destination Type | Patient Arrived at Destination Date/Time | Patient's Home Address | Patient's Home City | Patient's Home State | Patient's Home Zip Code | Gender | Race | Ethnicity | Date of Birth | Number of Patients at Scene | Mass Casualty Incident | Incident Location | Type | Incident Address | City | Possible Injury | Cause of Injury
MN	Last Name| First Name | Gender | DOB | Crash Date | Location
MS	EMS Agency |Hospital |Person Name
MO	Name | DOB | Date of Crash | Crash Number | Crash Date | County
NE	Patient First Name, Last Name | Gender | Date of Birth |Occurrence Date
NC	Date | County | Time of Day | Sex | Ethnicity |Date of Birth | Person Type |Name (If Driver)
OK	First, Last Name | DOB | Age | Sex | Last 4 Digits of SSN | Incident Date | Soundex

Table 3.11 Emergency Department Direct Linkage Identifiers

State	Verbatim Responses
IL	Age | Gender | Date of Birth | County | City | Date of Crash | Date of Admission
KY	Admit Date | Occupant Date of Birth | Gender | Resident Zip Code | Distance From Crash Location To Hospital Location | Vehicle Type | Person Type | Crash Type
MD	Time of Day | Day of Week | County of Crash | Age | Gender | Mechanism of Injury | Person Type (Driver, Passenger, Pedestrian)
MA	Encrypted SSN | Gender| DOB | Ecode | Org ID | Date | Time | Diagnosis | Status | Patient City | Patient Zip
MI	Not yet linked
MN	Hospital Zip | Home Zip | Injured (Y/N) | Fatal (Y/N) | Gender | DOB | Admit Hour | Crash Date | Position | Age | Vehicle Type
MS	Person Name
NE	Patient Date of Birth | Age | Gender | Occurrence Date | Occurrence County
NC	Date |County | Time of Day | Sex | Ethnicity | Date of Birth | Person Type | Name (If Driver)

Table 3.12 Hospital Discharge Direct Linkage Identifiers

State	Verbatim Responses
AL	Patient Identifier Code
AK	Names and dates on both the crash data and the hospital discharge data
AR	Name and other fields
DE	Patient's Last Name | First Name | Gender| Age| Position (Driver, Passenger, Etc.) | Crash Date| Hospital Location
IL	Age| Gender| Date of Birth| County| City| Date of Crash| Date of Admission
KY	Admit Date| Occupant Date of Birth| Gender| Resident Zip Code| Distance From Crash Location To Hospital Location| Vehicle Type| Person Type| Crash Type
MD	Time of Day| Day of Week| County of Crash| Age| DOB| Gender| Mechanism of Injury| Person Type (Driver, Passenger, Pedestrian)
MA	Encrypted SSN| Gender| DOB| Ecode| Org ID| Date| Time| Diagnosis| Status| Patient City| Patient Zip
MN	Hospital Zip| Home Zip| Injured (Y/N) | Fatal (Y/N) | Gender| DOB| Admit Hour| Crash Date| Position| Age| Vehicle Type
MO	Crash Number| Crash Date| County| Name| DOB
NE	Patient Date of Birth| Age| Gender| Occurrence Date| Occurrence County
NC	Date| County| Time of Day| Sex| Ethnicity| Date of Birth| Person Type| Driver
OK	First and Last Name| DOB| Age| Sex| Last 4 Digits of SSN|Incident Date| Soundex
WA	First, Middle, and Last Name| Date of Birth| Date of Incident| Zip Code| Gender

Table 3.13 Trauma Registry Direct Linkage Identifiers

State	Verbatim Responses
AL	Patient Identifier Code
AK	This has yet to be built but we are planning to use the APSIN ID as a unique identifier across databases
ID	Trauma Registry is responsible for the data linkage
IL	Age | Gender | Date of Birth | Date of Birth | County | City | Date of Crash | Date of Admission
IA	A variety per CODES.
KS	Yet to be determined. Likely to include event date, person ID, local case number, etc.
MD	Time of Day | Day of Week | County of Crash | Age | DOB | Gender | Mechanism of Injury | Person Type (Driver, Passenger, Pedestrian)
MA	Protective Devices/Child Specific Restraint | Airbag Deployment | Alcohol Use/Drug Use Indicators | Diagnosis Code | Transport Mode | Injury Incident Date | Injury Incident Time | Site OrgID | ED/Hospital Admission Time | Patient Street Address | Patient City | Patient Zip Code | Gender | Date of Birth | Location ECode | Incident City | Primary ECode | Encrypted SSN
MN	Last Name | First Name | Hospital Zip | Home Zip | Injured (Y/N) | Fatal (Y/N) | Gender | DOB | Admit Hour | Crash Date | Position | Age | Vehicle Type
MS	Person Name
NV	Patient Name | Birthdate | Incident Date
NC	Date | County | Time of Day | Sex | Ethnicity | Date of Birth | Person Type | Name (If Driver)
WA	First, Middle, and Last Name | Date of Birth | Date of Incident | Zip Code | Gender

Table 3.14 Vital Records Direct Linkage Identifiers

State	Verbatim Responses
CO	For fatal records (crashes) only
MA	Encrypted SSN | Address | City | State | Date of Death | DOB | Cause of Injury | Location of Injury | Diagnosis
MN	Last Name | First Name | Hospital Zip | Home Zip | Injured (Y/N) | Fatal (Y/N) | Gender | DOB | Admit Hour | Crash Date | Position | Age | Vehicle Type
MS	Person Name
MO	Crash Number | Crash Date | County | Name | DOB
NE	Patient First Name | Last Name | Gender | Date of Birth | Date of Death | Occurrence County
NC	Name | Date of Birth | Sex | County of Residence
OK	First and Last Name | DOB | Age | Sex | Last 4 Digits of SSN | Incident Date | Soundex.
TX	Name
WA	First, Middle, and Last Name | Date of Birth | Date of Incident | Zip Code | Gender

Table 3.15 Roadway Inventory Direct Linkage Identifiers

State	Verbatim Responses
AL	Milepoint
AK	Crash and roadway inventory data are in the same database and are directly linked
AR	County | Route | Section | Log Mile
CO	Direct interface with all roadway data for exact location (coding) of both, on- and off-system crashes statewide
DE	Road Name | Road Number | Milepoint | Latitude and Longitude
FL	GPS location | Intersection Information
HI	Milepost | Intersection | GPS
ID	Indirect, soon to be implemented. ITD TAMS System | Segment Code | Mile Point
IL	Location Codes
IA	Direct key field match.
KS	State accident case number On Road/At Road information
LA	Lat/Long | Street Name | Primary Roadway | Secondary Roadway | Distance | Direction | Milepoint
MD	Integrated through use of GIS mapping of crashes and roadways in the state
MA	Street Name | City | Mile Point | Route | Bridges | Speed Limit | Highway District | Regional Planning Agency. Linked on Road Segment ID once crash is geocoded
MN	Route and Reference Point | Roadway System Type | County/City Identifier
MS	Linked with crash by GPS location
MO	All crash data is linked to roadway inventory files by using GIS based location referencing system: Crash Number | Location Information | County | Crash Date
NV	Route ID and/or Route Full Name
NC	Crash Location Fields: County | Route | Distance | Direction | From Road | Towards Road
ND	Roadway Location
OK	Year | County | Control Section | Subsection | Milepoint
PA	Currently we can only link state roads. Crash and roadway records both contain information: County | Route | Segment | Offset
RI	We are in the planning stages of implementing a statewide Linear Referencing System that will link crash data to roadway features/characteristics/etc. via a geographic component.
TX	Crash Latitude/Longitude Coordinates
VA	Document number per crash
WA	For state routes only: WA unique SR ID information (linear referencing system)
WV	Location
WY	Route and Milepost | Lat/Long

Defining Serious Injuries in Health Datasets

States were asked to provide definitions of serious injuries in related health datasets. Many states utilize standardized injury severity scales, including the Injury Severity Scale (ISS), Maximum or Abbreviated Injury Scale (MASI/AIS), Revised Trauma Score (RTS), International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes, or those codes included in the National EMS Information System (NEMSIS) uniform dataset. Other states assess injuries using unique prediction models, scoring systems, or definitions. A number of states indicate health datasets do not include specific definitions of serious injuries. Tables 3.16 through 3.19 present state responses for injury definitions various health datasets.

Table 3.16 EMS Patient Care Data Injury Definitions

State	Verbatim Responses
HI	Serious -- May or may not have altered level of consciousness. All vital parameters stable. Primary (and/or secondary) problem demands initiation of definitive pre-hospital treatment and transport. Pre-hospital treatment will stabilize patient’s condition.
KS	Many types of injuries are defined in the Kansas Paramedic Instructional Guidelines.
MD	Serious injury is defined by Maryland EMS protocol as a priority one patient, requiring emergent or urgent care.
MA	Fatality/Physiologic Criteria: Glasgow Coma Scale <14, Respiratory rate < 10 or > 29 or respiratory rate out of range for age, Systolic Blood Pressure < 90 mmHg or < 70-90 in pediatrics.
MN	Revised Trauma Score (RTS) of 2, 1, 0 calculated using vitals (GCS, SBP, & RR)
MT	We utilize the NEMSIS minimum data set. While we don’t have a definition of ‘serious injury’, we could implement filters to report patients with such conditions.
NE	There is no specific injury severity indicator in Nebraska’s EMS data system. It could potentially be estimated from patient’s complaint or care providers’ primary impression.
NC	No one definition is used -- depends on the research question.
OK	Injuries severe enough to cause disability or death.
WA	As part of our current multi-agency data integration efforts, we are currently in the process of defining a serious injury.
WV	The West Virginia Prehospital Electronic Patient Care Report has an element for the Provider’s Primary Impression, where the option of “Traumatic Injury” can be chosen from a given list of field values. “Traumatic Injury” has the given definition of injury-site NOS in accordance with ICD-9 code.

Table 3.17 Emergency Department Data Injury Definitions

State	Verbatim Responses
DE	We collect all injuries seen in the Emergency Department
IL	ICD-based injury severity score. Based on the ICD-9 or ICD-10 codes, we can calculate MAIS score which is based on the following Categories: 1. Minor; 2. Moderate; 3. Serious; 4. Severe; 5. Critical; 6. Maximal (currently untreatable)
KY	No official definition. We have used MAIS codes, injury severity score, Barell Matrix (TBI Type), etc.
MD	Serious injury is defined by translating the ICD9 codes from the ED discharge data into the Abbreviated Injury Scale (AIS) and then to an Injury Severity Score (ISS). An AIS of 3 (ISS of 9) reflects a serious injury.
MA	Dead on arrival Died in ED Trauma Mortality Prediction Model > 2%
MN	Injury Severity Score (ISS) >= 16
MS	NEMSIS standards
NE	Injury severity can be derived from ICD-9-CM diagnosis code, commonly known as Maximum Abbreviated Injury Scale (MAIS), where a score of 3-6 is considered a serious injury (0=not injured, 1=minor, 2=moderate, 3=serious, 4=severe, 5=critical, and 6=maximum).
NC	No one definition is used -- depends on the research question.
OH	A serious injury is defined as an injury that poses a significant loss of life; loss of limb; permanent disfigurement; or permanent disability.

Table 3.18 Hospital Discharge Data Injury Definitions

State	Verbatim Responses
AR	To ensure consistent data collection across the state, a trauma patient is defined as a patient sustaining a traumatic injury.
DE	MAIS (Maximum Abbreviated Injury Scale) is equal or greater than 3
IL	ICD-based injury severity score. Based on the ICD-9 or ICD-10 codes, we can calculate MAIS score which is based on the following Categories: 1. Minor;, 2. Moderate; 3. Serious; 4. Severe; 5. Critical; 6. Maximal (currently untreatable)
KY	No official definition. We have used MAIS codes, injury severity score, Barell Matrix (TBI Type), etc.
MD	Serious injury is defined by translating the ICD9 codes from the ED discharge data into the Abbreviated Injury Scale (AIS) and then to an Injury Severity Score (ISS). An AIS of 3 (ISS of 9) reflects a serious injury.
MA	Fatality Transferred Trauma Mortality Prediction Model > 2%
MN	ISS >= 16
NE	Injury severity can be derived from ICD-9-CM diagnosis code, commonly known as Maximum Abbreviated Injury Scale (MAIS), where a score of 3-6 is considered a serious injury (0=not injured, 1=minor, 2=moderate, 3=serious, 4=severe, 5=critical, and 6=maximum).
NC	ICD 9-CM or 10-CM Diagnosis codes are often used to define serious injury.
OK	Injuries severe enough to cause disability or death.

Table 3.19 Trauma Registry Data Injury Definitions

State	Verbatim Responses
HI	None, but Injury Severity Score is recorded.
IL	ICD-based injury severity score. Based on the ICD-9 or ICD-10 codes, we can calculate MAIS score which is based on the following Categories: 1. Minor; 2. Moderate; 3. Serious; 4. Severe; 5. Critical; 6. Maximal (currently untreatable)
MD	Serious injury is defined by translating the ICD9 codes from the ED discharge data into the Abbreviated Injury Scale (AIS) and then to an Injury Severity Score (ISS). An AIS of 3 (ISS of 9) reflects a serious injury.
MA	Fatality/Injury Severity Score> 15; Trauma Mortality Prediction Model > 2% Physiologic Criteria: Glasgow Coma Scale <14, Respiratory rate < 10 or > 29 or respiratory rate out of range for age, Systolic Blood Pressure < 90 mmHg or < 70-90 in pediatrics Anatomic Criteria: Flail Chest, Open or depressed skull fractures; Penetrating trauma to head, neck, torso, or extremities proximal to elbow and knee; Crushed, degloved or mangled extremity; Pelvic fractures (excluding simple fractures); Paralysis 2 or more proximal long bone fractures, or any open proximal long; Bone fracture; Amputations proximal to wrist or ankle; High-Risk auto crashes; Death in same passenger compartment Intrusion > 12 inches occupant site, >18 inches any site; Ejection (partial or complete) from vehicle; Vehicle telemetry data consistent with high risk of injury; Auto vs. pedestrian/bicycle thrown, run over or with significant (>20 mph) impact; Motorcycle crash > 20 mph
MN	ISS >=16 and/or Glascow Coma Scale,<= 8
MS	NEMSIS standards
MT	Serious injury can be defined in the trauma registry through various filters such as type of injury, injury severity code, ICD-9, etc.
NV	Injury Severity Score (ISS) is used to score the patient injury. An ISS/NISS of 25 and higher is considered Severe.
NC	Injury that requires an overnight stay at a trauma hospital.
WV	The American College of Surgeons National Trauma Data Standard: Data Dictionary has an element of AIS Severity. The Abbreviated Injury Scale (AIS) severity codes reflect the patient's injuries. An option of "Serious Injury" can be chosen from the given list of field values: 1 Minor Injury; 2 Moderate Injury; 3 Serious Injury; 4 Severe Injury; 5 Critical Injury; 6 Maximum Injury, Virtually Unsurvivable; 9 Not Possible to Assign.

Crash and Health Data Coverage

Respondents were asked to estimate the level of completeness of their states crash, roadway, and health datasets. The purpose of the question was to identify what percent of the hospitals, law enforcement jurisdictions, or emergency departments were submitting reports into the state-level database.

Crash and vital records data are most likely considered complete, followed by roadway inventories, hospital discharge, emergency department, and EMS data. Table 3.20 presents the number of states with complete, partial, or unknown datasets and provides overall responses for each dataset. Table 3.21 presents responses for each state, including estimates of partial data. States with partial datasets identified issues including: complete datasets for fatalities, but not all crashes; complete data for state roadways or primary networks, but incomplete for local roads; and, incomplete data from reporting units, including law enforcement and tribal agencies.

Table 3.20 Crash and Health Data Coverage

Dataset	State Data Coverage		
	Complete	Partial	Unknown
Crash Data	27 (75%)	92 (5%)	0 (0%)
EMS Patient Care Data	14 (39%)	12 (33%)	10 (28%)
Emergency Department Data	13 (36%)	2 (6%)	21 (58%)
Hospital Discharge Data	18 (50%)	2 (6%)	16 (44%)
Trauma Registry Data	12 (33%)	9 (25%)	15 (42%)
Roadway Inventory	18 (50%)	11 (31%)	7 (19%)
Vital Records	19 (53%)	2 (6%)	15 (42%)

Table 3.21 Data Coverage Detail by State

● = Complete ◖ = Partial ○ = Unknown NA= Not Applicable

State	Crash Data	EMS Patient Care	Emergency Dept.	Hospital Discharge	Trauma Registry	Roadway Inventory	Vital Records
AK	●	○	○	○	○	●	○
AL	●	●	○	○	○	○	○
AR	●	●	●	●	●	●	●
AZ	◖ 90%	○	○	○	○	●	○
CA	◖ 85%	○	●	●	○	○	○
CO	●	◖ *NA*	○	○	○	◖ *NA*	◖ *NA*
DE	●	●	●	●	●	●	○
FL	◖ 99%	◖ 60%	○	○	○	○	○
HI	●	●	◖ 90%	●	◖ 70%	○	●
IA	●	◖ *NA*	○	○	○	●	○
ID	●	○	○	○	◖ 50%	◖ 72%	●
IL	●	●	●	●	●	●	●
KS	●	◖ 40%	○	●	●	●	●
KY	●	○	●	●	◖ *NA*	○	●
LA	●	○	○	○	○	◖ *NA*	○
MA	◖ *NA*	◖ 89	●	●	◖ 97%	●	○
MD	●	●	●	●	●	●	●
ME	●	●	●	●	◖ *NA*	●	●
MI	●	◖ 85%	○	○	○	◖ 90%	○
MN	◖ 99%	●	●	●	●	◖ 95%	●
MO	●	◖ 86%	○	○	○	●	○
MS	◖ 95%	◖ 90%	◖ 89%	◖ 85%	◖ 90%	◖ 95%	◖ 97%
MT	◖ *NA*	◖ 99%	○	○	○	●	○
NC	●	●	○	●	◖ *NA*	◖ 80%	●
ND	●	◖ 90%	○	○	●	●	●
NE	●	●	●	●	○	○	●
NV	●	○	○	○	●	◖ 80%	○
OH	●	●	●	●	●	◖ *NA*	●
OK	●	●	○	●	○	◖ 20%	●
PA	●	●	○	●	●	●	●
PR	◖ 30%	◖ 15%	●	●	●	●	●
RI	◖ 99%	○	○	○	◖ 97%	○	●
TX	●	○	○	○	○	●	○
VA	●	●	●	●	●	●	●
WA	●	◖ 40%	○	◖ 90%	◖ 96%	◖ *NA*	●
WY	●	○	○	○	○	●	○

State Data Requirements

The majority of states do not currently have statutory requirements that set conditions for, restrict access to, or require linked datasets. Table 3.22 reports states with some level of restrictions in place.

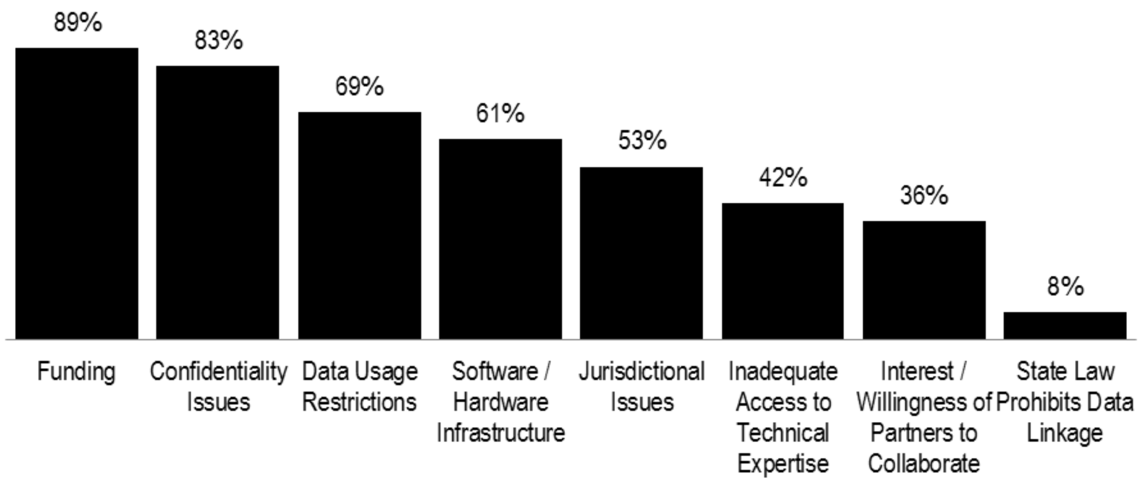
Table 3.22 State Data Requirements

Requirement	Unknown		Yes		No	
Set conditions for records linkage	5 (14%)	AZ, CO, TX, WV, WY	5 (14%)	IL, MA, NC, OH, PR	27 (73%)	AK, AL, AR, CA, DE, FL, HI, IA, ID, KS, KY, LA, MD, ME, MI, MN, MO, MS, MT, ND, NE, NV, OK, PA, RI, VA, WA
Require records linkage	6 (16%)	AZ, CO, PR, TX, WV, WY	4 (11%)	DE, MA, MI, OH	27 (73%)	AK, AL, AR, CA, FL, HI, IA, ID, IL, KS, KY, LA, MD, ME, MN, MO, MS, MT, NC, ND, NE, NV, OK, PA, RI, VA, WA
Establish access to linked data sets for research purposes	8 (22%)	AK, AZ, CA, CO, PR, TX, WV, WY	6 (16%)	AL, DE, IL, MA, NC, OH	23 (62%)	AR, FL, HI, IA, ID, KS, KY, LA, MD, ME, MI, MN, MO, MS, MT, ND, NE, NV, OK, PA, RI, VA, WA

Data Linkage Obstacles

The three most common challenges facing states in linking discrete datasets are: funding, confidentiality/data usage restrictions (e.g. legal restrictions on usage), and software/ hardware infrastructure. Over half of respondents cited jurisdictional issues as a current challenge, but fewer states identified encountering problems with inadequate access to technical expertise, lack of interest, or willingness of partners to collaborate. Other noted challenges include: issues with vendors; adequate personnel; lack of common identifiers, resources, and time; lack of mandates or champions for linking; and, lack of available data sources. Figure 3.5 reports the percentage of respondents identifying common obstacles to better linking data systems.

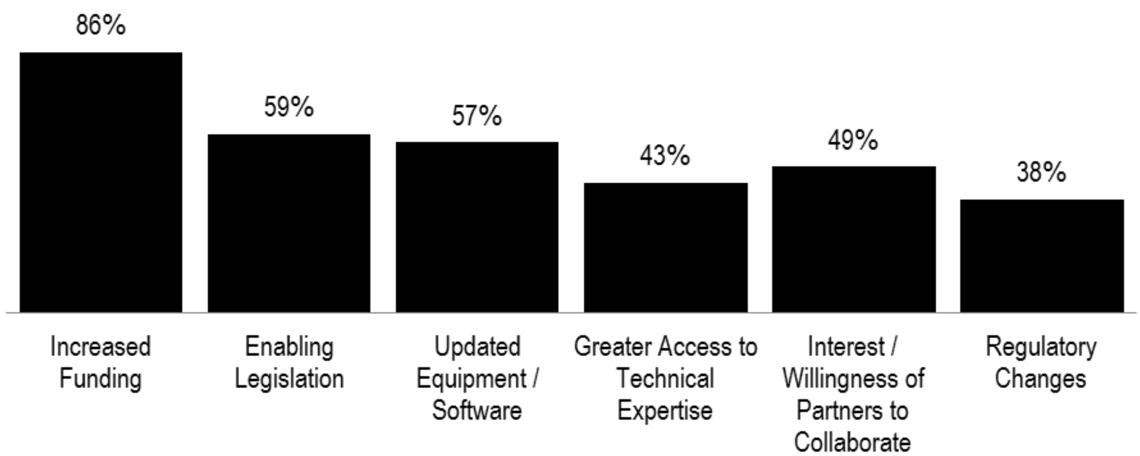
Figure 3.5 Common Obstacles to Linking Data



Solutions to Linkage Obstacles

Understandably increasing funding was most frequently identified as a possible solution to overcome the funding obstacle. Legislation, technical infrastructure and expertise, and collaboration with partners were also seen as important solutions. Figure 3.6 reports the percentage of respondents identifying common means to overcome data linkage barriers.

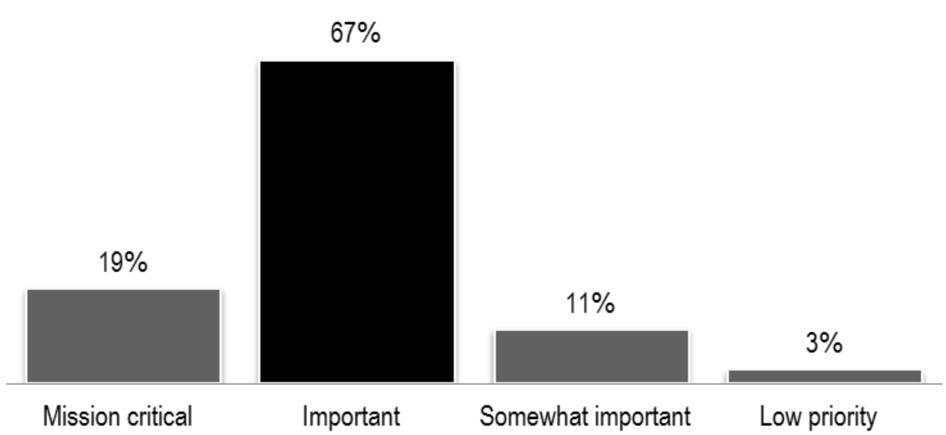
Figure 3.6 Common Solutions to Facilitate Serious Injury Data Linkage



Prioritization and Implementation

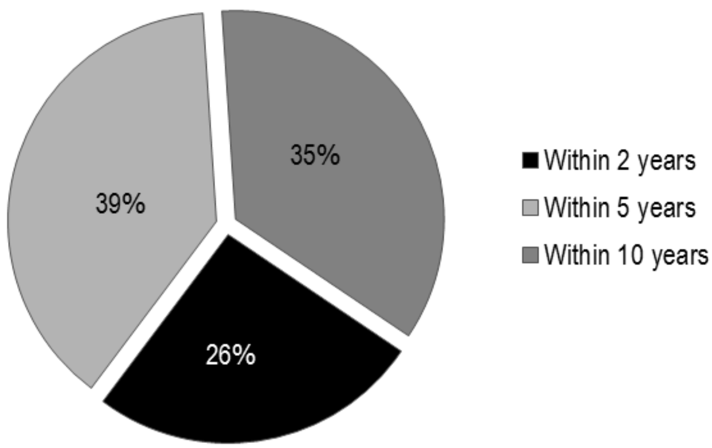
Linking data systems was considered a priority by the Governor's Highway Safety Representative/Traffic Records Coordinating Committee by two-thirds of the state respondents. Nearly one-fifth of respondents believed linking data is mission critical. Multiple responses from states are included, as some agencies perceived priority levels differently. Figure 3.7 shows the percentage of respondents who reported the priority status given to linking data in their state.

Figure 3.7 Priority Status Assigned to Linking Data Systems



Asked when they realistically foresee using serious injury data from linked data sources in place of serious injury data from PARs, respondents were equally divided in opinion. The majority of respondents felt linked data could become available within five to 10 years, and a quarter perceived access could come sooner. Figure 3.8 shows the percentage of respondents reporting implementation in a given timeframe. Multiple responses from states were allowed. Respondents, whether representing health, traffic records, transportation, or other agencies, sometimes perceived time horizons differently. For example, three respondents from a single state reported the timeframe for full implementation is achievable in two, five, or ten years.

Figure 3.8 Time Horizon for Implementation of Serious Injury Data



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4.0 Strategic Options for Collecting and Reporting Serious Injury Crash Data

This report presents a range of strategic options to advance ongoing national dialogue and support continuing research investigations focused on addressing the need to better collect and compile serious injury crash data. The intent of NCHRP 20-24(37)K is to understand current state practices in this area and to gather a broad range of interim options. NCHRP 17-57 will further develop and refine the most promising approaches. Five options are considered here ranging from relatively simple, near-term fixes to more complex, long-term solutions. The spectrum of options is:

1. Improve the source of current serious injury crash report data
2. Expand the responsibilities of the Fatal Analysis Reporting System to include serious injuries
3. Expand use of probability-based linkages among crash and health data systems
4. Determine serious injuries based on health or hospital data
5. Implement an approach to directly link data sources.

These options are not necessarily mutually exclusive, and it may make sense to develop an approach that combines aspects of several options. The following summary of options describes how each addresses current challenges, discusses potential implementation aspects, and presents advantages and disadvantages. These summaries are not intended to be exhaustive, but to provide plausible approaches that future work may continue to expand.

4.1 Improve the Source of Current Serious Injury Crash Report Data

A clear interim step toward better tracking serious injuries is to improve the data source. Currently, a consistent national definition of serious injuries is lacking. State by state definitions are subject to interpretation by law enforcement officers at the crash scene. Developing a consistent injury scale for use among the states is a necessary first step. First responders need clear information and training to ensure the serious injury data collected are more accurate, consistent, and reliably used in decision making.

The survey task completed for this effort found the majority of states surveyed (75 percent) use some variation of the KABCO serious injury scale on PARs. In this scale, "A" injuries are considered serious injuries and commonly defined as either "disabling" or "incapacitating." In an effort to address deficiencies in this approach NHTSA revised the Model Minimum Uniform Crash Criteria (MMUCC) guidelines in 2012 to more accurately account for serious injury data. Included in changes to the MMUCC 4th edition is a revised severity scale with clear definitions for each severity category. While the KABCO acronym remains "A", injuries are now denoted as "suspected serious injury", and the possible injury types associated with this category are more clearly defined for law enforcement officers.

MMUCC was created to improve crash data uniformity among and within states. While compliance is voluntary, states are increasingly conforming to the criteria, e.g., Alaska and California already have adopted the fourth edition revisions. The recent revisions to the MMUCC guidelines represent progress toward a clear national standard for defining serious injuries. This classification could be adopted by all states and eventually fully integrated into each state's PAR and crash data reporting systems. A national consensus serious injury definition will help ensure crash data are more uniform and reliable for data driven highway safety decisions.

Developing a consistent and clear scale is only a part of this interim option. Educating law enforcement officers on the importance of accurate crash data and providing training focused on assessing injuries at the scene is equally important to improve data at time of collection. Currently, officers complete the PAR at the crash scene. These reports include sections and codes for both subjective and objective crash variables. While states produce detailed handbooks to assist law enforcement officers in completing the reports, the assessment of serious injuries requires interpretation and some level of medical knowledge. Law enforcement education and training could focus on assessing injuries using common, non-medical language consistent with MMUCC 4th edition guidelines. Training on protocols could also include requirements that officers consult with emergency personnel, if at the scene, when completing accident reports, especially if the injury assessment is unclear. Providing a means for law enforcement to flag a crash survivor's injury status as 'uncertain' on police crash reports could also provide a means for data users to explicitly consider uncertainty in the data.

Implementing a national definition of serious injury and training law enforcement officers in assessment could provide a low-cost, near-term, but imperfect fix within the current system. Improving the source of crash data would enable states to better use crash records to target investments and interventions aimed at reducing serious injury crashes. However, the use of data collected by law enforcement at the scene and not linked or verified with health data records would still be subject to inaccuracies and likely vary among jurisdictions and from state to state. Thus, the use of this crash record source data in national performance measurement remains less than ideal.

Further, reaching consensus on the severity scale used to assess crash injuries, revising state crash reports, and redesigning crash databases is a serious undertaking. Retraining officers on this new system would require an upfront investment of resources. Finally, while this option does improve source data it would not completely address concerns over the accuracy of serious injury data. Police accident report data, if not paired or checked against hospital records, may continue to misrepresent the true level of serious injuries and would only partly fulfill the need for a comparable and accurate national serious injury performance measure.

Option 1 Summary – Improve the source of current serious injury crash report data		
Description	**Pros**	**Cons**
- Fully implement MMUCC 4th edition as the national standard - Develop new procedures and training materials - Conduct outreach and training	- Existing standard, starting to be adopted - Improves accuracy of PARs - Relatively low cost to begin	- Costly and time intensive to train law enforcement officers - Improves rating system but is not connected to medical evaluation

4.2 Expand the Responsibilities of Fatal Analysis Reporting System to Include Serious Injuries

The Fatal Analysis Reporting System (FARS) is a nationwide census of motor vehicle crash fatal injuries in the 50 states, District of Columbia and Puerto Rico. Currently, each of these jurisdictions have one or more FARS analysts whose job includes gathering, translating, and transmitting fatality data to NHTSA's National Center for Statistics and Analysis (NCSA). FARS analysts provide the information in a standard format and generally access hospital medical and EMS reports, among other documents, to complete FARS forms.

A potential route to improve the nation's capabilities for tracking and reporting serious injury data is to expand the roles and responsibilities of FARS analysts to include tracking and verifying serious injury records. When combined with a standardized classification of serious injuries and improved training for law enforcement, this approach could result in better confirmation of serious injury data collected at the scene and higher quality data reported through the FARS system.

FARS analysts are currently responsible for utilizing health system information and other data sources to follow up and confirm known fatalities and those injuries with significant risk of future fatalities. An expansion of the FARS mandate to include confirmation of all serious injuries, and some portion of suspected serious injuries, would result in higher quality data and more consistent national reporting. However, the primary purpose of the FARS system is to gather and report data at the national level. FARS data is used by SHSOs to implement and evaluate behavioral programs, but is not commonly used by state DOTs to identify crash locations, problem hotspots and deploy countermeasures on the roadways. So, while this approach advances the use of serious injury data for national performance measurement purposes, without linking confirmed serious injury data from FARS reports back into state crash reports, it does not fully aid states in performance management and investment decision making.

The advantages of this approach are existing NTHSA/state cooperative agreements and processes, and all states and territories have trained FARS analysts. Transitioning to a system that systematically includes confirmation of serious injuries could be efficient if instituted with a process that clearly identifies those cases where serious injuries likely occurred. FARS analysts cannot be expected to track every motor vehicle incident, so initial crash reports with suspected serious injuries would need to be sampled statistically. Adding a flag to the police accident report that indicates uncertainty on the part of the officer may be helpful for focusing the analyst's attention on records to review. However, expansion of the FARS system would potentially involve significant additional workload and implementation costs and may still encounter privacy and security barriers related to individual health records. This approach may over or undercount serious injuries, either through sampling error or because FARS analysts are not able to access or confirm every case through the myriad of available health information systems.

Option 2 Summary – Expand the responsibilities of FARS to include serious injuries		
Description	**Pros**	**Cons**
- FARS analysts in each state and territory review a sample of PAR with a high probability of serious injury	- Existing role - Staff and resources in place - Likely to produce relatively high quality data	- More time intensive FARS analyst role because of the number of serious injury crashes - May overlook some injuries

4.3 EXPAND THE USE OF PROBABILITY-BASED LINKAGES AMONG CRASH AND HEALTH DATA SYSTEMS

Three primary methods exist for linking databases: manual, deterministic, and probabilistic. Manual linkage is only practical for databases that contain few records and little information. A deterministic approach links records with an exact match based on a unique identifier or combination of variables common to both databases; therefore, subject to the accuracy and availability of the identifying variables. Restrictions on the use and portability of data such as social security numbers, driver license numbers, and individual names limit the application of deterministic methods. A probabilistic approach infers linkages based on the highest calculated probability that two or more records do in fact belong to the same individual. The success of record linkage is highly dependent on the quality of the data being linked.

The Crash Outcome Data Evaluation System (CODES) is a component of NHTSA's state data program. This system tracks crash survivors from the scene of an incident through the health care system using a database created by linking different sources of traffic and health records. With privacy concerns related to data collected from both traffic and health record sources, unique identifiers (e.g. an individual's name) are not available. As a result, CODES uses probabilistic linkage methodology which generates an estimate that a matched pair is a valid match.

CODES data are informative; however, several challenges are associated with its practical application in decision making or intervention efforts. The data included within the CODES system are collected by different organizations at different points through a survivor's journey from the incident scene through the medical system. Overall, the data collected by EMS, private hospitals, public hospitals, and public health departments are designed to meet the specific agency's data collection needs. As a result, most data are rarely sufficiently comprehensive to support injury control efforts. For a CODES program to be useful on all levels, data must be accessible, high quality, automated, and linked, as described in the 1996 NHTSA Technical Report on CODES.

Currently, not all states actively support CODES. Survey findings from prior task work indicate approximately half a dozen states have linked health and crash records related to CODES. The survey also revealed probabilistic linkages between crash records and EMS data systems are common, but linkages to hospital discharge, emergency department, trauma registry, and even vital records systems are relatively rare. Should CODES be expanded and the ability to probabilistically link records be instituted more fully, serious injury data from the health system could be linked to crash data and reported consistently among states. This approach addresses the two primary purposes for collecting serious injury data – performance measurement and problem identification.

Several challenges to implementing this approach exist however, including communication among different data owners; conflicting goals and priorities of the data owners; confidentiality and release of CODES data; staffing difficulties; and insufficient dedicated or long-term funding. Challenges with data linkage include difficulties in accessing databases due to privacy restrictions, data quality (completeness, multiple records, person identifiers), and data consistency (formats, definitions) among sources. Currently less than half of all states have CODES or a similar system in place. Implementation of this approach nationally would be costly and would involve substantial lead time. For this approach to succeed, partnerships between NHTSA, FHWA, other federal agencies and the states would have to be expanded or established along with dedicated funding sources and long-term partner commitments.

Option 3 Summary – Expand use of probability-based linkages among crash and health data systems		
Description	**Pros**	**Cons**
- Leverage existing CODES platform to expand linkages and coverage of state crash and health data systems	- Uses existing system - Likely to produce relatively high quality data - Data serves multiple needs and purposes	- Implementation could be lengthy and costly - States would need the resources to support the system - Potential health record confidentiality issues

4.4 DETERMINE SERIOUS INJURIES BASED ON HEALTH OR HOSPITAL DATA

The basic concern about current serious injury measurement is accuracy. Law enforcement officers have limited medical training and PARs only capture injury status identified at the crash scene. Depending upon the type of injury, even a trained officer may not be able to assess an injury, and crash survivors may not be able or willing to report a serious injury. Further, many of the current state injury definitions classify serious injuries as requiring assistance leaving the scene of an incident. This emphasis may result in counting persons transported by emergency personnel as a precaution or in undercounting persons refusing transport who later seek medical attention.

One method for addressing these concerns is to rely on a different data source to count serious injuries. Emergency health or hospital data include assessments of injury severity, which are often based on the internationally recognized indices such as the Abbreviated Injury Scale (AIS) or the Maximum Abbreviated Injury Scale (MAIS). These assessments are standardized, based on quantitative measurements, and evaluated by trained medical professionals. However, health system injury data classifications may be unique to a hospital or vary among state public health agencies.

Identifying the most appropriate health or hospital data source is complicated. Health data are collected by different parties at different points throughout a patient's journey through the health system. Data collected en route to the hospital may involve multiple units, which may result in records duplication. Upon arrival at a hospital, patient admission data are collected and entered into a separate database, which may also be duplicated, should the patient require transfer to a different specialty care center. Patient data are collected and compiled by hospitals from admission through departure, or in the event of death through state mortality records. Throughout this process, the data collected by each agency are intended for different purposes and may ultimately reside in different databases. Those databases may not include a unique identifier that can be linked to PAR, use consistent injury classification, or more importantly, include a higher-level, aggregate code for serious injuries.

The challenges associated with utilizing health system data to collect serious injury data are threefold. First, while medical assessments produce higher quality serious injury diagnosis, the lack of consistency across states and data sources continues to present problems. Second, identifying which health data system contains the most complete patient data is a challenge. Third, the lack of a common and unique identifier across all databases prevents ready linkage back to PAR and traffic records. However, this option may provide a short-term solution to report on serious injury performance at the national level. In the long-term, expanding linkages between health data and crash records would enable more exact tracking of serious injuries at the state level.

Option 4 Summary – Determine serious injuries based on health or hospital data		
Description	**Pros**	**Cons**
- Use health records to classify and count serious injuries and link back to traffic records	- Injury severity determined by medical professionals - Improved serious injury reporting accuracy	- Lack of consistent data source(s) - No comprehensive system, or identifiers, to link health and traffic records

4.5 IMPLEMENT AN APPROACH TO DIRECTLY LINK DATA SOURCES

Given multiple data systems, one method for relating an injury diagnosis back to the crash record is to assign a single, unique patient or crash identifier that follows injured individuals through all data reports. Many states are focusing on achieving such system integration.

The focus of these efforts is on linking key data fields so information can be shared across crash records and health information systems. It may be possible to link high quality serious injury data directly to crash report data by assigning a consistent record number (i.e., identifier) to the crash and carrying the identifier through crash, EMS, hospital, health, trauma, and mortality databases. However, instituting a system of common identifiers among crash and health information systems may violate the privacy and security rules within the Health Insurance Portability and Accountability Act of 1996, also known as HIPAA.

Several possible pathways could be taken to achieve a closer linkage of traffic and trauma data sources.

- Better link EMS and hospital data. Both of these records have a medical focus; therefore, it may be easier to first link these records and then retain a probabilistic linkage to crash records, which serves a different function.
- Provide a means for law enforcement records to travel with EMS personnel. A key step in creating a linkage between different data systems is to increase the capture of records electronically in real time. Already, many agencies electronically record information about crashes, EMS, and hospital information. Electronically completed crash records could be provided to EMS personnel on the scene of a crash, and become part of the EMS and hospital records. This would allow for a single data source to capture serious injury data. It would, however, increase the burden for data storage and retrieval.
- Provide a crash record identifier to EMS personnel and hospitals. Another version of the above may be to institute a unique identifier assigned at the scene and travels with EMS personnel. This would facilitate a direct linkage of data sources or enable for example a FARS analyst to locate the relevant information. This may reduce potential privacy concerns in addition to limiting the burden on EMS and hospital databases.

Ultimately, an exchange of information among various systems that leverages a technological solution may be more ideal for capturing a serious injury performance measure. The major challenges with this approach are potential privacy concerns, implementation costs, and data maintenance in the appropriate source. A well designed solution that allows direct access to ‘public’ data fields, while restricting access to sensitive private data could enable data sharing that limits privacy issues.

Option 5 Summary – Implement an approach to directly link data sources		
Description	**Pros**	**Cons**
- Utilize technological applications to directly link health and traffic records	- Injury severity determined by medical professionals - Highly accurate serious injury reporting - Enables more exact tracking of serious injury crashes	- Costly to design and implement - Burdensome data requirements for public and private agencies - Potential health record confidentiality issues

5.0 State Best Practices and Input on Implementation Options

To further develop the conceptual approaches to tracking serious injuries presented in Chapter 4, the research team sought feedback directly from state safety and health agency representatives. Phone interviews with experts from several states were completed. The purpose of these interviews was to solicit input on the feasibility and viability of the approaches identified in this report, as well as to identify other hybrid or alternative implementation approaches. Findings from these discussions are synthesized and reported below.

5.1 Identifying State Practice Area Leaders

Survey data reported in Chapter 3 was reviewed to identify states leading the way on linking crash and health datasets, advancing probabilistic linkage systems, conducting injury surveillance, and actively engaged in efforts to better understand serious injury crash data. After reviewing those states with comprehensive efforts in place to more readily integrate health and crash data systems, the project team also looked at states considered by their peers to be innovative. Barbara Harsha, former Executive Director of GHSA, provided additional recommendations of states with leading edge practices. Based on survey responses and peer recommendations, six states were selected for interviews. Each of these states is pursuing innovative efforts and has experiences directly applicable to each of the strategic options identified in Chapter 4.

Interviews were conducted with representatives from Indiana, Massachusetts, Maryland, Minnesota, Utah, and Washington. Positions of individuals interviewed included: Traffic Records Coordinating Committee (TRCC) coordinators, SHSO directors, traffic records managers, university researchers, epidemiologists, and program directors from both transportation and public health agencies. The NCHRP 17-57 Principal Investigator also was interviewed to continue ongoing efforts to coordinate research efforts.

Discussions were structured and intended to solicit feedback on the feasibility, tradeoffs, challenges, and opportunities of the initial implementation options. In addition, possible hybrid or alternative interim approaches were also discussed along with current efforts among the states. The following section presents a synthesis of key comments and feedback received on each implementation concept. This work is intended to test assumptions, further refine potential implementation pathways, and identify implementation barriers.

5.2 FEEDBACK ON STRATEGIC IMPLEMENTATION OPTIONS

Perceptions and insights from interviews with state transportation safety and health representatives are reported for each option. State respondents were asked to consider the advantages and disadvantages of each option.

1. Improving the source of current serious injury crash report data.

An interim step toward better measuring serious injuries involves standardizing the classification of injury severity data among state crash records. State representatives generally perceive this option as unrealistic and unlikely to help move the nation toward a comprehensive and accurate serious injury reporting system. Implementing this option would require states to adopt new crash forms, revise databases, change software programs, and undertake significant law enforcement training. The majority of states indicate comprehensive implementation of this option would likely offer marginal improvements to the accuracy of serious injury reporting nationally.

While most state respondents did not support pursuing this option, they do believe this will happen over time as more states update their PARs and switch to MMUCC definitions. Additionally they expressed that the resources this option would require could be better directed toward improving data linkage efforts or improving the quality of existing health and safety databases. Finally, respondents strongly indicated the responsibilities of first responders should always be first and foremost concern for public safety, rather than data accuracy.

2. Expanding the responsibilities of Fatal Analysis Reporting System to include serious injuries.

A potential pathway to improve the nation's capabilities for tracking and reporting serious injury data is to expand the roles and responsibilities of FARS analysts to include verifying serious injury records. FARS analysts are currently responsible for utilizing health system information and other data sources to confirm known fatalities. An expansion of the FARS mandate to include confirmation of serious injuries using health and hospital records would result in higher quality data that are more consistently and commonly reported nationally. This approach leverages existing cooperative agreements and processes and could be efficiently instituted along with a system that flags for follow-up cases where serious injuries are likely to have occurred. FARS analysts cannot be expected to track every motor vehicle incident, so initial crash reports with suspected serious injuries would have to be sampled statistically. Expansion of the FARS system would potentially involve significant additional workload and implementation costs and may still encounter privacy and security barriers related to individual health records.

State representatives were intrigued and encouraging about exploring this option further. Leveraging the existing framework and relationships of FARS analysts to verify a sampling of serious injury crashes based on health data would serve multiple purposes. First, consistent injury counts for each state helps move toward a national solution for performance reporting. Second, state safety and health officials would have access to a data sample of serious injuries linked to crash records for prevention efforts.

While this option was judged feasible, interviewees identified significant issues that would have to be addressed for this option to be viable. How would FARS analysts be notified of serious injury crashes? Would hospitals readily cooperate to verify or release patient information given HIPAA concerns and other state restrictions? How would sampling and statistical analysis of serious injuries be conducted? How would funding be provided to support these efforts?

One respondent said for every fatality in his state there may be ten hospitalizations and more than 100 emergency room visits. The FARS system could not be utilized to track every injury case. However statistical sampling methods could yield instructive information. Even with relatively small sample sizes, correlations between serious injuries and crash types could be completed and states could better understand how first responders in certain areas interpret and apply existing injury classifications scales, such as KABCO. Individual cases would have to be tracked through hospital discharge data rather than EMS agencies which could prove time consuming and encounter privacy concerns. Not all states track which hospital a patient is transported to on the PARs, and when recorded the information is often not accurate. FARS analysts may have to contact half a dozen area hospitals to verify individual cases. FARS analysts work directly with medical examiners and coroners, but those networks do not necessarily extend to hospitals. FARS programs in some states report challenges following up with individual hospitals to confirm toxicology reports. For this option to be feasible new data sharing agreements and networks would have to be established. Finally, state respondents said without additional funding, the expansion of current FARS programs would overload analysts.

Still this option has merit and its feasibility is worth further consideration. Some states are already engaged and experimenting with this approach. For example, the State of Washington currently has a project to automate FARS coding and apply the same process to serious injuries. The FARS analyst pulls a subset of data from enforcement databases which includes raw data from crash reports, and applies standards to assess serious injury data for a one year sample. This project is expected to be completed in 2014, however budget reductions have impacted the FARS program overall and this effort may not be continued.

The FARS program has the infrastructure in place and established relationships with coroners, vital records registrars, and hospital data administrators. With increasing automation and efficiencies in the FARS process, the expansion of the system to include serious injury data sampling could be feasible for some states. However, additional funding, improved training for analysts, and perhaps Federal or state legislation would have to be in place for this option to succeed.

3. Expanding use of probability-based linkages among crash and health data systems.

Probabilistic linkages between crash records and EMS data systems are common among states, but linkages between hospital discharge, emergency department, trauma registry, and even vital records systems are in relatively few states. Probability-based records linking software is becoming increasingly available to states and exponentially sophisticated. Programs such as CODES could be expanded in all states so that serious injury data from the health system could be linked to crash data and reported consistently across states.

Respondents indicated significant barriers do exist to expanding the use and application of probabilistic records linkages including difficulties accessing databases due to privacy restrictions, data quality, timeliness, and consistency, and the financial resources and skilled expertise needed. Yet, expanding probabilistic linkages systems across the states would help establish relatively uniform reporting of injury data across all states for performance measurement purposes and would enable greater injury tracking and analysis by states for prevention purposes.

Data privacy concerns were cited as the greatest barrier to more sophisticated and widespread linkage efforts among states. Those states currently implementing advanced linking programs are doing so because someone on the health side is pursuing the linkage. It is much easier for health agencies to accomplish because they have a better understanding of the data, better contacts across the system, and the ability to manage HIPAA privacy requirements. Without addressing data security and privacy issues, even states advancing the state of the practice in linkages may not benefit from this research. Universities, who are often the ones with the technical capabilities to conduct linkage efforts, often cannot share the results with state DOTs or health and safety agencies due to privacy issues. For example one state, after experimenting with various projects and negotiating bureaucratic hurdles, realized legislative action will be required to establish an ongoing linked collision-health data system. Differences in the treatment of health system data among states are also problematic to advancing nationally consistent and comparable performance measures.

Funding for CODES and individual state efforts presents another challenge. Support for CODES has decreased substantially in recent years, and for many states exploratory research on this topic may not be a priority funding concern. Federal resources would have to be made available and sustained for this option to be fully scaled up and operational across all states. One respondent noted NEMSIS has had success because it has strong champions, captive stakeholders, and a nationally applicable platform. CODES and similar home-grown programs, or programs provided by external vendors, do not enjoy the same level of support.

Expanding probabilistic data linking systems offers great promise and technological advances and increasingly sophisticated analytical techniques may enable states to learn much more about the extent and causes of serious injury crashes. This option remains feasible and, with further research to address data privacy and dedicated funding, it could represent a viable path forward.

4. Determining serious injuries based on health or hospital data

The basic concern about current serious injury measurement is accuracy. Law enforcement officers have limited medical training and PARs only capture injury status as identified at the crash scene. One approach that could address these concerns is to rely on a different data source to count serious injuries.

Health department or hospital discharge data include assessments of injury severity, which are often based on the internationally recognized indices such as AIS or MAIS. These assessments are standardized, based on quantitative measurements, and assigned by trained medical professionals. Aggregate counts of serious injuries resulting from motor vehicle crashes could be obtained from these records for each state. This option faces considerable barriers concerning data privacy and health data may not be readily linked back to crash records, but it may also provide a short-term solution to report serious injury data for performance measurement purposes.

State representatives generally agreed this option is viable and would enable states to report serious injury data consistently. For the purposes of national performance measurement, defining serious injuries based on hospital data would produce relatively accurate counts for each state. However, from the injury prevention perspective, information contained within the hospital record are limited. Without further linkages to crash records, states will not have access to risk and crash characteristics associated with injuries.

Using state trauma registries or compiled health department databases based on hospital discharge data, analysts could extract the total number of serious injuries resulting from motor vehicle crashes. Hospital discharge data often include External Causes of Injury codes (e codes) or International Conference for the Ninth Revision of the International Classification of Diseases (ICD-9) codes. These codes include identifiers for mechanism of injury (i.e. vehicle and type) and patient characteristics (i.e. driver or passenger). In some states, toxicology reports and blood alcohol levels would also be available. Additionally, occupant protection characteristics are sometimes included, however the source of this information is self-reporting by the patient at the hospital, rather than police or EMT records.

Relying on hospital data for serious injury data overcomes some of the failings of current approaches. The severity of serious injuries would be classified by medical practitioners using internationally recognized scales. The total number of serious injuries would be counted more accurately, by eliminating false positives from police crash reports and by capturing injuries not reported to police or not occurring on public roadways. States could also use the total number of serious injury crashes to refine or correct estimates derived from the initial PAR and based on the KABCO scale.

States respondents suggest significant challenges may be associated with this option. Not all states have comprehensive trauma datasets or fully integrated health records databases and the owners of the data differ from state to state. For some states, new legislation or agreements may be required to access hospital discharge data for these purposes. Relying on trauma registry data instead, will undercount serious injuries because these registries only include a smaller sample of trauma center data. Some states also suggested concerns may arise when state totals include injuries from crashes that occurred in another state; when a major trauma center serves a multistate area; or the nearest hospital for transport is located in an adjacent state. Other state representatives suggested data may not be a pressing concern as states both import and export injury data, and it may not result in significant fluctuations. Hospital data may also include reports of motor vehicle crashes occurring off-highway or in motorized, but not street-legal, off-road vehicles. Finally, without linking health records back to initial crash reports, serious injury totals based on health records provide only a picture of total state injuries. The data would not be immediately useful for examining the characteristics or locations of serious injury crashes.

This option garnered the most support from state representatives interviewed – particularly from state health agencies. Considerable barriers exist, but implementing this option would offer significant benefits. It is also consistent with recommendations made by national and international organizations to better assess and report serious injury crashes.

5. Implementing an approach to directly link data sources

One approach for relating injury diagnosis to the crash record is to assign a single, unique patient identifier that follows injured individuals through all data reports. Direct linkage systems rely on methods of assigning a consistent record identifier to the crash or patient and carrying the identifier through crash, EMS, hospital, health, trauma, and mortality databases. With a direct linkage it would be possible to produce high quality serious injury data for use in both injury surveillance and prevention efforts. This option is ideal because the source for injury severity data is medical datasets and the source of crash characteristics is highway safety data.

Implementing direct linkages is simple in theory, but complex in practice. Kansas, Oregon, Arkansas, Idaho, Florida, and other states have at various times implemented programs to assign patients unique identifiers consistent across health and hospital records. These programs use technologies such as radio-frequency identification, pre-printed trauma registry bands, or even Bluetooth data transfers to track patients from first EMS care through hospital discharge. These efforts are often short-lived pilot programs, only implemented at county or regional levels, expensive to maintain, and require education and training efforts for first responders and hospital staff. The most successful of these approaches center on the use of trauma bands to assign a unique number to a patient at the scene of the crash. States that have tried or are currently using this approach found without significant training and marketing efforts even trauma band identifiers fail to make it through the system. First responders are not focused on tagging patients or transferring the information to crash reports or EMS records, many hospital staff are not familiar with the system, or their own internal databases do not track additional needed information. Additionally, states found this approach costly to implement.

The major challenge associated with this approach is potential privacy concerns. In general, methods that allow for the identification of individuals is either prohibited by state or Federal law or viewed unfavorably by the public. Even with unique identifiers, the data permissions necessary for accessing many unique and privacy protected datasets make analysis or linkages impractical. State representatives suggest that while it is relatively easy for states to create uniformity among data included in crash reports, enforcement citations, EMS transporters, hospitals, and even trauma databases; it is very difficult to implement a common platform or integrate a common linked identifier into these systems.

A well designed solution that allows direct access to ‘public’ data fields, while restricting access to sensitive private data, could enable data sharing and limit privacy issues. One state suggested GPS data collected at the crash scene may provide a direct identifier because location data aren’t related directly to an individual patient. Using location data may address privacy issues. Some police departments collect latitude/longitude (lat/long) coordinates at crash scenes, but not all. NEMSIS has a field code for geographic coordinates and though it is required, it is not often completed. However, should technology enable first responders to automatically record detailed geographic data which is consistently carried through into NEMSIS, it could provide a linkage source for crash records and EMS data. EMS data in turn is more readily linked to health databases.

An additional pathway to more directly linking data may come from leveraging connections in states which use the same commercial vendor for their EMS and Trauma Registry systems. The compatibility of software systems enables analysts to more readily match data and for pre-populated fields. Although links must be made manually, similar systems allow for nearly direct linkages. Within a state, software systems could be mandated to 'speak to each other' to enable data transfers and linkages. This would produce efficiencies in data processing and could yield better quality data for immediate analysis, or for further probabilistic matching efforts. However, trauma registry data does not include all serious injuries resulting from motor vehicle crashes. Additionally, software and software vendors do not commonly support systems used in both crash databases and health records. The two markets are distinct and served by different firms. This limits the application of a technologically driven solution, at least in the short term, to directly linking crash records and health data. Despite these challenges, this approach if implemented consistently and institutionalized over time offers benefits not only for transportation safety officials but for many others interested in the surveillance and prevention of injuries of all types.

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6.0 Conclusion

NCHRP 20-24 (37)K describes potential methods for developing a basis for comparative analysis of DOT safety performance;; describes feasible options for addressing the issues; and assesses the relative merits. This research effort surveyed current state practices, reviewed existing approaches and pilot programs, described possible implementation options, and sought feedback from safety and health practitioners to assess the options' feasibility. Findings provide input into ongoing efforts and support continued national dialogue to address the challenges associated with serious injury data.

From the national performance measurement perspective, the option to determine serious injury crash statistics based on hospital discharge data is most viable and productive. Solutions are needed to address data privacy concerns and resources must be devoted to establishing programs in each state. However, the insights and information gathered could yield consistent injury data and provide state practitioners with valuable information. Implementing this option would require significant lead time – two to five years – following enabling state legislation or a Federal mandate. Full implementation at the state level would progress faster in those states with active and engaged partners and current efforts to compile and analyze health datasets. Implementation could be led by state health departments with joint support from Federal agencies.

Measuring serious injuries using health data would address national performance measurement needs, but would not provide full information to states for surveillance and prevention efforts. This option must be pursued in concert with sustained commitment to directly link state health and traffic crash data or dedicated funding for further advancing probabilistic linkage programs. Aggregate counts of serious injuries not linked to traffic records do not equip safety professionals with the information needed to address problems and implement interventions. Quality data are needed from both the traffic safety and health communities to reduce the severity and frequency of serious injury crashes.

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A. Appendix

NCHRP Project 20-24(37)K – Serious Injury Online Survey

State Information

Name and Title of Person Completing Survey:
Contact Information:

1. Does your state measure and report on serious injuries as part of your transportation safety improvement efforts?

   __Yes
   __No

2. What is the definition of a serious injury, as reported on your state's police accident report (PAR)?

   Open Comment

3. In what ways is injury severity utilized for transportation safety efforts in your state? (check all that apply)

   __ Research
   __Safety/program planning and management
   __Generating reports
   __Evaluating and refining existing policy and regulation
   __Unknown
   __Other (explain)
   __Is not used

4. For each of the data systems in your state that are listed in the following table, please provide responses to the following questions.

   - Which are currently, or planned to be, linked to the motor vehicle crash data system? (Yes, No, N/A)
   - What type of linkage is used? (Deterministic, Probabilistic);
   - Is the linkage (Direct) to the crash data or (Indirect) through another data system; and
   - Is the linkage part of a Crash Outcome Data Evaluation System (CODES) project? (Yes, No, N/A)

	Crash Data Link			Type of Linkage		Direct or Indirect		CODES Related		
	Yes	No	N/A	Deter-ministic	Probab-ilistic	Direct	Indirect	Yes	No	Na
EMS Patient Care Data										
Emergency Dept. Data										
Hospital Discharge Data										
Trauma Registry Data										
Vital Records										
Roadway Inventory										

5. Following are the direct linkages identified in question 4. Please indicate the identifiers used to link to crash data:

   5a. EMS Patient Care Data
   5b. Emergency Department Data
   5c. Hospital Discharge Data:
   5d. Trauma Registry Data
   5e. Vital Records
   5f. Roadway Inventory

6. What is the definition of a serious injury, as reported in your state's EMS Patient Care data system?

   Open Comment

7. What is the definition of a serious injury, as reported in your state's Emergency Department data system?

   Open Comment

8. What is the definition of a serious injury, as reported in your state's Hospital Discharge data system?

   Open Comment

9. What is the definition of a serious injury, as reported in your state's Trauma Registry data system?

   Open Comment

10. For each of the datasets listed, generally how complete is coverage in your state?

    X Complete   X Partial %   X None   X Unknown

    10a. Crash Data
    10b. EMS Patient Care Data
    10c. Emergency Department Data
    10d. Hospital Discharge Data
    10e. Trauma Registry Data
    10f. Roadway Inventory
    10g. Vital Records

11. Does your state statute(s) specifically (Check all that apply):

    X Yes   X No   X Pending   X Unknown

    __Set conditions for records linkage
    __Require records linkage
    __Establish access to linked data sets for research purposes

12. Which (if any) of the following characterize problems or challenges your state faces in linking discrete datasets? (Check all that apply)

    __ Funding
    __ Confidentiality issues
    __ Data usage restrictions
    __ Inadequate access to technical expertise
    __ Interest/Willingness of partners to collaborate
    __ Software/Hardware infrastructure
    __ Jurisdictional issues
    __ State law prohibits data linkage
    __ Other (explain)

13. Which (if any) of the following would help facilitate the linkage of serious injury data in your state? (Check all that apply)

    __ Increased funding
    __ Enabling legislation
    __ Regulatory changes
    __Greater access to technical expertise
    __ Interest/Willingness of partners to collaborate
    __ Updated equipment/software
    __ Other (explain)