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Assessment of Characteristics of State Data Linkage Systems

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16. Abstract

State systems that integrate data by linking police crash reports to medical records provide important information that can be used to better understand motor vehicle crash injuries. The objective of this study was to better understand the facilitators and barriers to successful data linkage systems. Data were collected by questionnaire, focus group, and a literature search. Twenty-five States completed the survey and 19 participated in focus groups. Facilitators of these systems included a community context that supports linkage, one lead agency to oversee the system, coalition of data owners, memorandums of understanding to obtain data, high quality data, staff with the right mix of technical and non-technical skills, technical assistance and training, and stable funding. Barriers included lack of funding, staff turnover, lack of documented procedures, lags in obtaining data, statutory requirements for data use, complex linkage techniques, and failure to adequately market information available from linked databases.

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EXECUTIVE SUMMARY

Motor vehicle crashes are a leading cause of death and injury in the United States, accounting for 33,561 fatalities and 2.4 million injuries in 2012. Although risk factors for fatal crashes are well-documented in transportation safety research, fewer studies exist regarding risk factors for non-fatal injury crashes. Several States have developed systems that link crash reports to medical data to create a source of nonfatal injury data; however, these systems vary from State to State.

One example of a State linkage system is the Crash Outcome Data Evaluation System (CODES), which was originated by the National Highway Traffic Safety Administration in 1992. In CODES, NHTSA provided partial funding and technical assistance to State linkage programs through cooperative agreements in participating States. In 2009, NHTSA advised funded CODES programs to plan for transition to independent State systems—without NHTSA funding or technical assistance. NHTSA finalized that transition in 2013. Outside of CODES, some States have conducted linkage projects, and other motor vehicle safety organizations also have expressed interest in linkage programs.

From 2010 to 2012 the Centers for Disease Control and Prevention and NHTSA formed a partnership to explore the feasibility and benefits of using linked data in CODES to determine risk factors for motor vehicle injury and to design and evaluate interventions to address these risk factors. This report describes a program appraisal of data linkage programs that was conducted during the final year of the partnership. The purpose was to examine State CODES and other State linkage programs to better understand the facilitators and barriers to linking and analyzing data to produce useful products. This information can be used to guide future improvements to a State's data linkage system and to implement a new State data linkage system.

The program appraisal was supported by the University of Maryland National Study Center for Trauma and EMS (NSC) under its CODES cooperative agreement as a resource center. The study team was composed of CDC, NHTSA, and NSC specialists who jointly designed and conducted the study to document information that could improve current and future programs.

The study team conducted a literature review regarding organizational theory to determine what theory would provide a framework for studying State data linkage systems. Because such programs involve a coalition of organizations and an information technology system, the CCAT and the ITIM were selected and used to develop a framework for the study of the following nine theory constructs.

- Community context
- Lead agency/convener group
- Coalition membership
- Leadership and staffing
- Pooled member and external resources
- Member engagement
- Implementation of strategies/information technology infrastructure
- Outcomes
- Community capacity

Data collection consisted of collecting primary data (a survey of States conducting linkage programs, followed by focus groups with the surveyed States to further explore the survey results) and obtaining secondary data on program operations and products (available State Traffic Records Assessments and bibliographies of publications using linked data). CDC obtained approval for primary data collection from the Office of Management and Budget (OMB) under OMB clearance number 0920-0879. The survey was administered to 16 CODES States and 14 States that were known to have State data linkage systems outside of CODES during December 2012. Five focus groups were also conducted with these same States during May 2013 to explore the survey results in more detail. Twenty-five States (response rate 86%) completed the survey, and 19 of the responding States participated in follow-up focus groups (response rate 76%).

Results of the survey indicated that the majority of responding States identified motor vehicle injury as a high priority health problem for their State. States consistently reported having crash, hospital inpatient, and emergency department data available to link, and most States were successful in linking those datasets. Through data results and the construct applications, the team noted key facilitators and barriers to collecting, linking, analyzing, and reporting data .
Key facilitators included:

- Characteristics of the community, such as the importance placed on motor vehicle safety, that either facilitate or inhibit the linkage of data and the use of the resulting database;
- Housing overall responsibility for the data linkage program in one organization;
- Establishing a coalition that includes all data owners;
- Establishing memorandums of understanding and/or undergoing institutional review board review to obtain data;
- Establishing matching variables in the data;
- Interacting with other State and local organizations interested in motor vehicle safety;
- Staffing with personnel that have the appropriate skills, including a high level of expertise with the linkage software packages, epidemiology, statistics, knowledge of traffic safety, data sources being linked, and presentation and marketing skills to ensure data are used;
- Providing technical assistance and training in linking and analyzing linked data;
- Providing stable funding; and
- Participating in a community of practice of data linkage practitioners.

Barriers noted included:

- Insufficient funding,
- Staffing turnover,
- Lack of process documentation,
- Long lag times in obtaining source data for linkage,
- Statutory requirements for obtaining and reporting data,
- Complex linkage techniques such as probabilistic linkage, and
- Marketing linked data so that others understand how they can be used to increase traffic safety.

State data linkage systems that link police crash reports to medical records are important sources of data on non-fatal motor vehicle crashes and injury severity from those crashes. The information obtained in this study on facilitators and barriers to effective State linkage systems can be used by States to modify existing data-linkage systems to improve the efficiency and success rate of data linkage, conduct more analysis of linked data, and increase dissemination of the analysis. This information can also be used by States, when starting a new data linkage program, to design a program based on the experiences of other States.

Table of Contents

INTRODUCTION

Background

Motor vehicle crashes are a leading cause of death in the United States, accounting for 33,561 fatalities and 2.4 million injuries in 2012 (NCSA, 2013). Research exists regarding factors that contribute to motor vehicle crashes (e.g., speeding, use of alcohol) and on protective measures, such as seat belts, that effectively reduce injuries and deaths when a crash occurs (NCSA, 2013). However, the majority of this research on motor vehicle crashes has been based on fatal injuries because less data are available for non-fatal injuries. Because of this lack of data, not as much is known about circumstances leading to nonfatal injury crashes (i.e., contributing factors and other details noted in police reports) and their effects on injury severity.

Large, nationally representative data sources for nonfatal motor vehicle injuries do exist. One such data source is NHTSA's National Automotive Sampling System General Estimates System (NASS GES), a nationally representative probability sample of police-reported crashes that provides information on State-reported traffic crashes, including non-fatal and property-damage–only crashes and allows identification of nationwide trends in occurrences and characteristics of motor vehicle crashes. NASS GES uses the police officer's assessment to define injury severity sustained in a crash on a 5-point scale originally designed by the National Safety Council and known as KABCO: killed (K), incapacitating injury (A), non-incapacitating injury (B), possible injury (C), and no injury (O). Individual State crash databases also use this scale in some form. However, previous research has determined that the KABCO scale does not effectively capture injury severity and/or the actual injury outcome as measured by the Maximum Abbreviated Injury Score (MAIS) (Burch, Cook, & Dischinger, 2013; Compton, 2005; Farmer, 2003; Miller, Viner, Rossman, & Pindus,1991; Popkin, Campbell, Hansen, & Stewart, 1991).

A second source of nationally representative data for nonfatal motor vehicle–related injuries is the National Electronic Injury Surveillance System-All Injury Program (NEISS-AIP), an emergency department surveillance system operated by the United States Consumer Product Safety Commission, which provides ongoing national estimates of nonfatal injuries. The Centers for Disease Control and Prevention's Web-based Injury Statistics Query and Reporting System (WISQARS) online database contains the NEISS-AIP data, which collects detailed data abstracted from medical records of initial emergency department visits for all types and causes of nonfatal injuries (including motor vehicle–related injuries) and poisonings in the United States. These data do not provide information on crash-related factors such as speeding or alcohol use or on protective factors such as seat belt use. Neither of these systems (NASS GES nor NEISS-AIP) can provide data at the State level. Thus, the need exists for a single source of data that provides motor vehicle crash data linked to medical records data to better understand motor vehicle crashes. Certain States have developed systems to link crash reports to medical data to create a single source of State data. One example of a State linkage system is the Crash Outcome Data Evaluation System (CODES)—a sizeable and well-known motor vehicle linkage system originally created by NHTSA, with 15 States participating in 2012.

History of CODES

NHTSA initially created CODES to quantify and report the benefits of safety equipment and legislation relative to mortality, morbidity, injury severity and health-care costs. In 1992, NHTSA sought grant applications from entities with existing statewide crash and injury data systems that were capable of generating crash, medical, and financial-outcome information if linked together. Any State agency, non-profit organization, or educational institution was eligible to develop and coordinate a coalition of data owners and users to perform the desired linkages. Applicants were required to (1) demonstrate the existence and accessibility of appropriate source data systems, (2) work with NHTSA to implement the probabilistic linkage algorithm, and (3) ensure transfer of their linked data to NHTSA for use in preparing a report to Congress. Seven States were awarded grants to establish CODES, effective October 1, 1992. A NHTSA report to Congress on seat belts and motorcycle helmets was created using linked data (NCSA, 1996). CODES became institutionalized in the awarded States based on a series of partnerships among State traffic safety and public health agencies and NHTSA. Since then, States that have successfully linked at least 2 years of crash and injury-outcome data have had the opportunity to apply to join the CODES Data Network. State programs in the CODES Data Network received NHTSA-provided partial funding and technical and program assistance through cooperative agreements. Lead organizations have usually been State agencies, universities or affiliates, or non-profit institutions. In some cases, lead organizations entered into agreements with support entities, such as universities, to conduct the actual data linkage and/or analyses. CODES cooperative agreements were administered through NHTSA's National Center for Statistics and Analysis. Among the grantee requirements were (1) assembling and convening a CODES board of directors composed of State data owners, (2) reporting to NHTSA on the progress of linkage and analysis activities, and (3) participating in NHTSA-initiated data requests and annual training meetings.

As CODES developed, NHTSA encouraged grantees to seek and secure other supplemental funding for their CODES program and to move towards program institutionalization to ensure sustainability. In 2009, NHTSA advised the 16 funded CODES States to prepare for cessation of NHTSA funding and technical assistance and to plan for the transition to independent projects. In 2013, NHTSA finalized the transition and encouraged States to continue to seek other funding sources, including possible NHTSA grants through State Highway Safety Offices, so that data linkage could continue. As of 2013, NHTSA had CODES cooperative agreements with grantees in 15 States: Connecticut, Delaware, Georgia, Illinois, Kentucky, Maine, Maryland, Minnesota, Missouri, Nebraska, New York, Ohio, South Carolina, Utah, and Virginia.

During the course of CODES, some States ended their participation in the CODES Data Network but continued to conduct linkage independently. In other cases, States left the network and retired their program. Other States initiated linkage projects on their own that were not part of the CODES Data Network. Some of these States have projects linking crash and hospital data using matching identifiers and deterministic linkage. Others have initiated projects linking Emergency Medical Services and trauma registry data with the goal of adding crash and other data sets. Still others have used commercial software that replicated the CODES methodology and set up or piloted State projects similar to those seen in CODES.

Interest in Data Linkage in the Transportation Safety Field

In addition to State-based data linkage activities, the topic of crash to medical data linkage has interested other motor vehicle safety focused organizations, including the following:

- CDC: CDC has identified motor vehicle–related injuries as one of six "Winnable Battles," and CDC's National Center for Injury Prevention and Control has a team to address transportation safety (www.cdc.gov/motorvehiclesafety/) (CDC, 2013). In 2010, CDC and NHTSA administrators signed a memorandum of understanding for collaborative strategies. During 2010 to 2012, CDC and NHTSA agreed to explore the feasibility and benefits of an ongoing partnership in the CODES program. CDC determined that linked data, such as that produced by CODES, was valuable to determining risk factors for motor vehicle injury and in designing and evaluating interventions to address these risk factors. CDC's continuing interest in crash-medical data linkage is a primary motivator of this study.

- National Transportation Safety Board (NTSB): In a study of single-unit truck crashes and injuries, the NTSB recommended that data linkage systems such as CODES be continued and issued the following conclusion (NTSB, 2013):

  > "Data from the Crash Outcome Data Evaluation System provide detailed information on injury diagnoses and severities in relation to crash characteristics, cover a large proportion of the population of the participating States, are not available elsewhere, and provide useful insight into traffic safety problems."

- Federal Highway Administration (FHWA): The "Moving Ahead for Progress in the 21st Century" Act (MAP-21), signed into law on July 6, 2012, requires the FHWA to establish measures for State departments of transportation (State DOTs) to assess and report numbers and rates per vehicle mile traveled, including roadway fatalities and serious injuries. (§1203; 23 USC 150(c)). In a Notice of Proposed Rulemaking published on March 11, 2014, FHWA included a proposed recommendation that States prepare themselves so that no later than January 1, 2020, all States use a medical record injury outcome reporting system that links injury outcomes from medical records to crash reports. FHWA issued a Federal Register Notice to elicit comments on this Notice of Proposed Rulemaking and will be issuing a final rule (Fed. Reg. 79).

- Transportation Research Board (TRB): FHWA, NHTSA, and CDC are liaisons to TRB's National Cooperative Highway Research Program (NCHRP) project 17-57, *Development of a Comprehensive Approach for Serious Traffic Crash Injury Measurement and Reporting Systems.* The project's goals are to identify an injury scoring system for further consideration, develop a roadmap to assist States in developing and implementing an interim system, and develop a State-based framework to perform comprehensive linkage of records related to motor vehicle crashes that resulted in serious injuries, and incremental steps and priorities for achieving the linkage (http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3179). A conclusion

of the project, as of January 2013, is that linking police crash reports to medical data is the best way to obtain a serious injury measure (Flannagan, Mann, & Rupp, 2013).

- International Traffic Safety Data and Analysis Group (known as the IRTAD Group): The IRTAD group, an on-going working group of the Joint Transport Research of the Organisation for Economic Co-operation and Development (OECD) and the International Transport Forum, issued recommendations for reporting on serious road traffic casualties including that the assessment of the severity of injuries should preferably be done by medical professionals, that police data should be complemented by hospital data, and that a 'seriously injured road casualty' be defined as a person with injuries assessed at level 3 or more on the Maximum Abbreviated Injury Scale, i.e., "MAIS3+" (International Transport Forum, n.d.)

Purpose

CDC and NHTSA developed this joint project to capture and preserve information on CODES and other State linkage systems to better inform future linkage pursuits. The study was supported by the University of Maryland National Study Center for Trauma and EMS under its CODES cooperative agreement with NHTSA as a CODES resource center. The study team was composed of CDC, NHTSA, and NSC specialists.

The purpose of this report is to study the characteristics of State-level programs that link crash data to medical outcome data to determine the facilitators and barriers of these programs. Information on facilitators and barriers in linkage systems can be used to guide future improvements to a State's data linkage system and to inform implementation of new State data linkage systems. Effective and useful data linkage systems optimize the utility of these systems for addressing public health and traffic safety issues.

METHODS

Theoretical Framework

Theory provides a framework of constructs and relations that lead to a desired outcome (Glanz, Rimer, & Lewis, 2002). This framework can be used to identify needed data, and to categorize the collected data to obtain a better understanding of the system. The study team conducted a literature review regarding organizational theory to determine what theory would provide a suitable framework for studying State data linkage systems. Because linkage programs involve a coalition of organizations working together to achieve a common goal, and as coalitions are complex organizations, the Community Coalition Action Theory (CCAT) was selected as the best theory to describe and understand State data linkage programs. The product of a State data linkage program is an information technology product, a data base of motor vehicle crash information; therefore, one construct—Information Technology Infrastructure—from the ITIM was selected to supplement the Implementation of Strategies construct from CCAT.

CCAT presents a framework for building and evaluating effective State coalitions (Butterfoss & Kegler, 2002). In this theory, coalition membership is created by a lead agency or convener group. The resulting coalition sets up leadership and staffing, operations, and processes along with structures that lead to pooled resources, member engagement, assessment, and planning. This facilitates coalition's implementation of strategies that address health problems, and lead to improved health outcomes.

A coalition typically defines the strategies that will be implemented. For State linkage programs, the strategy to be implemented is defined ahead of time as a data linkage system. As a data linkage system is an information system, information-system development theories were searched to determine the characteristics that should be studied as part of implementation strategies. The Information Technology Interaction Model (ITIM) has a construct of information technology infrastructure that lists the following components that are relevant to data linkage systems as being critical to developing a computer system (Silver, Markus, & Beath, 1995):

1. Software development tools,
2. Databases (or data sources), and
3. Capabilities of information technology personnel (i.e., people developing the system).

The study team developed a framework for the study, which used eight applicable constructs from CCAT and combined one construct from CCAT with one from ITIM to form a ninth construct. Constructs were selected by considering their applicability to State data linkage systems. Outcomes were an important aspect: attributing improved health outcomes specifically to State linkage systems was not possible, but studying the immediate products was possible— a linked dataset and analyses of the linked dataset that can be used to improve health outcomes. Selected constructs, measures used for each construct, and the data source used to obtain each measure are shown in Table 1.

Table 1: Measurement of Relevant Constructs

Construct	Definition	Measure
Community context	Characteristics of State traffic safety community that affect coalition function and development.	Experience (number years linking data), access to resources (CODES system member), priority of motor vehicle crashes as a problem
Lead agency/ convener group	Agency responsible for primary role of CODES; data linkage, serving as gatekeeper to data.	Lead agency, advantages/disadvantages of type of agency serving as the lead
Coalition membership	Organizations that make up coalition .	Organizations involved
Leadership and staffing	Staff needed to facilitate the coalition team.	Number and type of staffing needed, staffing challenges
Pooled member and external resources	Resources (funding, expertise, equipment, etc.) and collaborations, both internal and external.	Technical assistance, training, funding
Member engagement	Engagement of coalition with the community.	Interaction with community partners
Implementation of strategies/ Information technology infrastructure	Organizational resources that provide capacity to generate the information technology application.	Databases/ data sources, linking techniques, staff capabilities
Outcomes	Community change outcomes that are likely to improve health and to increase capacity.	Linkage success, products from analyses of linked datasets
Community capacity	Increased capacity that can be applied to other health and social issues.	Positive outcomes of being involved in data linkage

All employed constructs are from CCAT (Butterfoss & Kegler, 2002) with the exception of Information Technology Infrastructure, which is from ITIM (Silver et al., 1995).

Data Collection

A study team consisting of traffic safety and public health specialists from NHTSA, CDC, and NSC collaborated on data collection for this project. The team collected both primary data (data collected specifically for the study) and secondary data (data that already exists or can be compiled from existing materials). Data sources and types of data used for this study included:

1) A survey of States conducting linkage programs (primary data collection),
2) Focus groups with the surveyed States (primary data collection),
3) Analysis of traffic records assessment (secondary data collection), and
4) Bibliographies of publications that used linked data (secondary data collection).

Primary Data Collection

States participating in CODES as of 2012 (hereafter CODES States) and also States that had data-linkage systems outside of CODES (hereafter referred to as other State data linkage systems) were included in the sample for the primary data collection. Other State data linkage systems are State data linkage systems that either linked or were actively trying to link police crash data to some form of medical data (e.g., hospital inpatient, emergency department, EMS) and had been active in the past 2 years. A subset of the other State data linkage systems were in former CODES States, and some were still independently conducting data linkages using the CODES methods; however, these systems remained outside of the NHTSA CODES program. The final sample of 29 States included 15 CODES States and 14 other data linkage system States. A list of these States and the parts of the study that they participated in is illustrated in Attachment A. CDC obtained approval to collect primary data for this study under OMB clearance number 0920-0879.

Survey: The study team developed, reviewed, and finalized a questionnaire designed to obtain information regarding each of the constructs identified in Table 1. State-level CODES staff members also reviewed and tested the questionnaire for wording and timing. Testing was conducted via an online survey software SurveyMonkey. CDC submitted the study protocol to the Office of Management and Budget (OMB) for approval under the CDC Office for State, Tribal, Local and Territorial Support (OSTLTS) Survey Center generic clearance package to obtain expedited approval. The Microsoft Word version of the final questionnaire is shown in Attachment B. Upon OMB approval, the survey was administered via SurveyMonkey to 15 CODES States and 14 other data linkage system States (Attachment A) during December 2012. Twenty-five States responded for a response rate of 86 percent.

Focus Groups: Based on initial analysis of the survey data, the team conducted focus groups to further explore the survey results. They developed an interview guide for the focus groups by reviewing survey results and creating open-ended follow-up questions to obtain further understanding of the constructs in Table 1. The team reviewed and revised the focus group questions to ensure that a group of five to seven people could fully discuss the topics within the 2-hour time limit. Upon submission, OMB granted approval to the focus group addendum to the original application. Each of the 25 States that were asked to participate in the survey was invited to identify one person to participate in the focus groups. One trial focus group was conducted

with members of State CODES programs to verify the timing. Results of this focus group were included in this study because minimal changes to the interview guide were necessary as a result of the trial. Four additional focus groups were conducted. The final focus group guide is in Attachment C. In addition to the questions in the guide, follow-up questions were asked to elicit further details. All focus groups were conducted remotely using GoToMeeting software, with 19 of the 25 States participating (Attachment A) for a response rate of 76 percent. Audio recordings were made of all five sessions, including one initial trial GoToMeeting session and four other GoToMeeting sessions.

Secondary Data Collection

Traffic Records Assessments: A State traffic records system usually comprises six core areas: crash, vehicle, driver, roadway, citation and adjudication, and injury surveillance. To qualify for NHTSA traffic records grant funds, States must have a Traffic Records Assessment completed every 5 years. NHTSA's Traffic Records team oversees the assessment process, in which a panel of five independent subject matter experts (SMEs) interview representatives of the six traffic records system components. The SMEs develop a final narrative report that includes information from the interviewees and other research derived from an internet search. States often post their completed assessment on their State Web site.

For this study, traffic records assessments were collected through an internet search or by direct contact to the participating States; assessments for 19 States were obtained (Attachment A). From the assessment, the study team created an abstraction form to gather data regarding the quality and coverage of State motor vehicle and medical data systems. One form was completed for each traffic record assessment.

Bibliographies: State linkage systems produced varied products. However, because a central repository for linkage products (including annual State fact sheets, Web pages, conference presentations) was not available, this study used State Web sites, PUBMED, and compilations from CODES programs reported to NHTSA to identify products produced during the past decade (2004–2013). The Bibliography in Attachment D provides a representation of the various types of products/outcomes identified that can be produced from data linkage; it is not meant to be a reference list or an inclusive list of all products produced by State data linkage systems.

Data Analysis

The study team examined data from four data sources—survey, focus groups, traffic records assessments, and bibliography. Findings were mapped to the appropriate theory construct (Table 1) and are reported by the applicable construct.

Survey

The team created frequencies for each survey question; doing so involved collapsing some categories and, when appropriate, moving write-in answers for "Other" that actually belonged in an existing category. Some questions were cross-tabulated by whether the State was a CODES State. Results were analyzed using Microsoft Excel and SAS 9.3 (SAS Institute, Cary, NC).

Results are descriptive of the responding State programs and do not make extrapolations or tests of significance for inference.

To relate certain conditions to the success of linkage in each State, a linkage outcome indicator was developed by dividing the number of years that the State successfully linked police crash records to medical records (hospital inpatient, emergency department, or emergency medical service) by the number of years that the State had these sources of data available. Analysis was limited to the 10 years before the survey. If a State had been performing linkage for only a subset of those 10 years, only that subset of years is in the analysis. For the purposes of analysis, the linkage outcome indicator is dichotomized with values ≥0.75 defined as high linkage success and values below 0.75 defined as low linkage success. The value of 0.75 was obtained by graphing the resulting linkage outcomes and examining them for a natural breakpoint, which was based on the way the data were clustered.

The number of full time equivalents (FTEs) for each program was estimated by multiplying the number of hours a person worked per week (e.g., 20, 40) by the percentage of time that person was assigned to work on the data linkage program. The resulting numbers were first summed and then divided by 40 hours to obtain the total FTEs required to operate the State data linkage program. Microsoft Excel® was used to explore the associations between the linkage outcome indicator and the number of FTEs.

Focus Groups

A single member of the study team analyzed the five focus group sessions to identify general themes. The team then compiled notes from three different transcribers and compared them to create one set of response outputs by question. Notes from the different scribes were consistent, finding the exact or similar wording themes between scribes for individual respondent statements. Word processing software was used to find common words, and text was reviewed for key points and common themes. Words and themes repeated by more than one respondent were given higher priority. Team members also reviewed notes for key points that might have only been stated once. These tools were used to prepare a final set of prioritized outputs by question. In addition, the three most data-rich focus group sessions were independently analyzed by a second member of the study team. During this second review, the study team member listened to the audio recordings and created an abridged transcript (Kruger & Casey, 2009). The abridged transcript transcribed the participants' responses, but not directions and/or questions from the moderator. The transcripts were then analyzed in an iterative manner using word processing software. In the first round, the data were organized using broad codes based on the focus group questions and topics that spontaneously emerged, such as the best type of organization to lead linkage programs. In the second round, team members analyzed data within each code and further refined common themes, giving consideration to extensiveness (how many different people stated the same theme while keeping in mind that key insights might only be made once) and specificity (comments that were detailed rather than general or vague) (Krueger & Casey, 2009). After the team had fully developed themes, exemplar quotes were selected to help illustrate key points made by participants.

Traffic Records Assessments

Members of the research team developed a template abstraction form to gather data from the participating State's traffic records assessments on the quality and coverage of State motor vehicle and medical data systems. The template included:

- A review of the core data sets often used in relevant linkage (i.e., crash, citation, EMS, hospital, trauma registry, mortality);
- The data files a State had available;
- Whether data followed a uniform State template;
- How data were transmitted;
- Whether others in the State participated in the use of the collection; and
- Whether the data had been linked, and if so, for how many years.

To create a standard review, one member of the research team conducted information extraction from the traffic records assessment by reading the assessments and documenting standardized information on the research template.

Bibliography

The team reviewed the bibliography (Attachment D) to determine the general topic areas covered by the products and to determine how and where linked data were disseminated.

Synthesis of Data Sources

Information from each of the data sources was grouped by applicable construct. Each of the five team members independently reviewed the results and drafted a list of key points. The five lists were consolidated and factors mentioned by more than one team member retained to produce the final facilitators and barriers. Information from the Traffic Records Assessment data were used to check results from the survey and focus group for consistency.

RESULTS

Community Context

The CCAT construct of "Community Context" refers to the characteristics of the community that impact the coalition function and development (Table 1).

In data results mapped to this construct, the majority of States (72%) identified motor vehicle injury as either the highest or a high priority compared with other health problems.

Fifteen of the 25 States responding to the survey were part of the CODES linkage program. States who identified themselves as CODES States indicated that they had been linking data longer than other State data linkage systems with 67 percent of CODES States having started before 2000, as opposed to 20 percent of other linkage States (Table 2).

Table 2: Time period when State started linking data (n=25)

Year data linkage began	CODES States (n=15) % (n)	Other State data linkage systems (n=10) % (n)	Total (n=25) % (n)
Before 2000	67% (10)	20% (2)	48% (12)
2000–2005	13% (2)	10% (1)	12% (3)
After 2005	20% (3)	70% (7)	40% (10)
TOTAL	100% (15)	100% (10)	100% (25)

Lead Agency/Convener Group

The Lead Agency/Convener Group construct refers to the agency responsible for the data linkage and serves as the gatekeeper to the data (Table 1).

In data results mapped to this construct, the State department of public health was most likely to be the department responsible for coordination of the overall State linkage program, data linkage, and data analysis with at least half of the States reporting public health as the lead agency (Table 3). The next agency most likely to be responsible was an academic institution followed by a State DOT. Only one State had a linkage program that was not run by one of these three types of agencies. Furthermore, this information was validated through Traffic Records Assessments. These 19 assessments (data not shown) revealed that multiple agencies perform the data linkage, including departments of health, highway safety, and academic institutions; however, more States used State agencies rather than academic institutions as the lead agency/convener group.

Table 3: Agency type by responsibility for function in linkage program (n=25)

Agency	State Dept. of Public Health	Academic Institutions	State Dept. of Transportation/ Highways	Other State Department
Function	**% (n)**	**% (n)**	**% (n)**	**% (n)**
The coordination of your overall linkage/CODES project?	52% (13)	24% (6)	20% (5)	4% (1)
Your primary linkage/CODES project linkage?	60% (15)	20% (5)	16% (4)	4% (1)
Your primary linkage/CODES project data analysis?	56% (14)	24% (6)	16% (4)	4% (1)

In the focus groups, several participants commented on the best organizational home for linkage programs. Academic settings have the advantage of being a neutral third party and enjoy more freedom when selecting methodology and topics of study. The major disadvantage is that it can take longer to obtain data because they do not own any of the source data sets and are dependent upon other organizations to provide it. Of possible homes among State agencies, consensus was that the best home varies from State to State, depending on data ownership and rules/regulations concerning data sharing. As one person put it,

> "…we could have made it work, I think, were it housed in any of the other participating agencies as well…there's not necessarily a right home or a best home. It kind of depends on the State's situation."

Several participants agreed that placing linkage programs in an agency that already owned one or more data sets was advantageous. Having a single agency serve as the data hub also was reported as beneficial. In such a plan, data collection activities are streamlined with one entity collecting the majority of the data and serving as a data warehouse for the State. Another benefit is minimizing service duplication with one single entity collecting, cleaning, linking, and analyzing data.

Coalition Membership

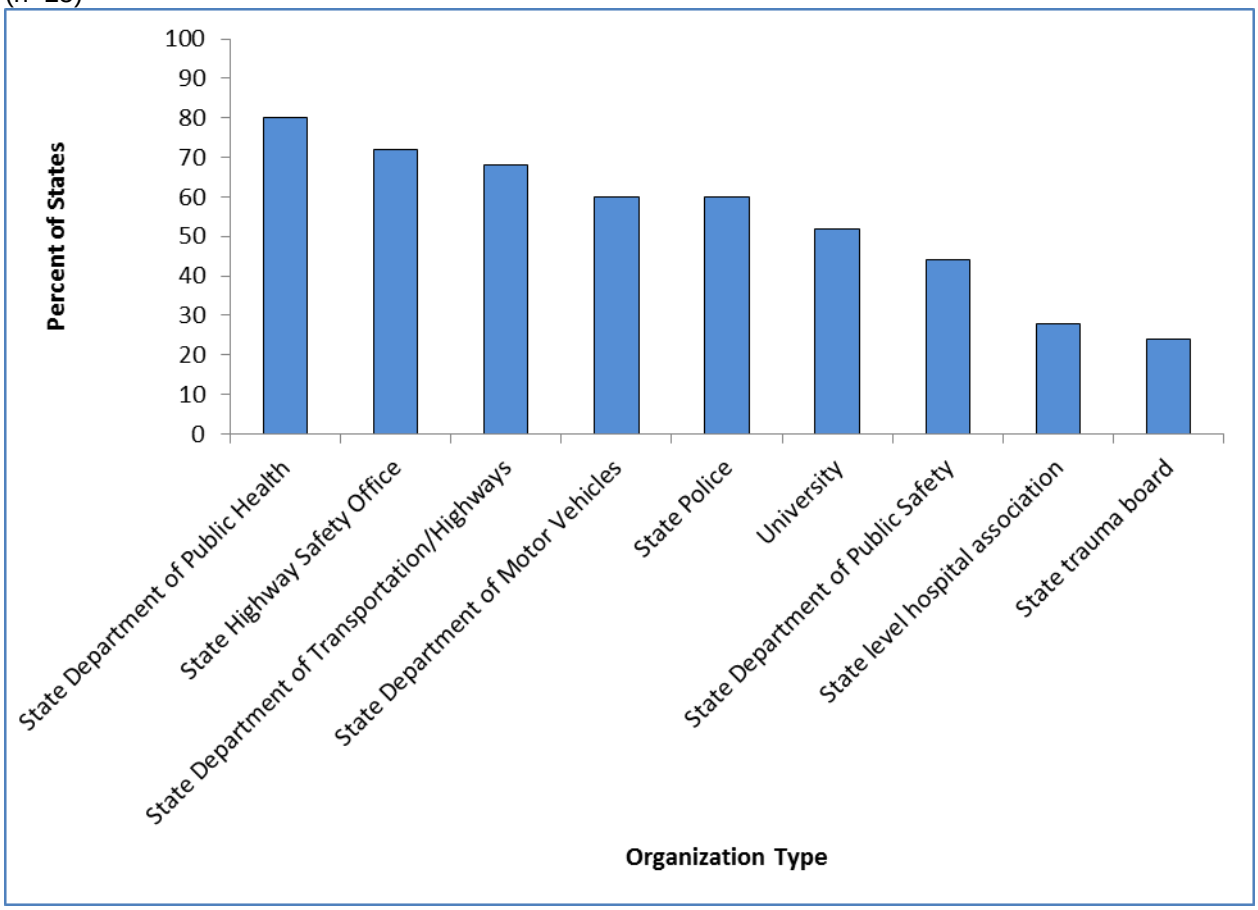
The CCAT construct of "Coalition Membership" refers to organizations that make up the membership of the coalition (Table 1).

In data results mapped to this construct, 80 percent of those surveyed had a board of advisors or directors for their State linkage program. However, fewer than half (44%) had a small group or subcommittee that served as an advisory board for identifying linkage or research priorities. The majority (96%) of States indicated that formal and informal partnerships with agencies were essential to linking and analyzing data.

In focus groups, the board of advisors or directors was described as the key mechanism through which data are shared among multiple data owners. Coalitions and boards of directors also were described as essential facilitators of interagency partnerships. Although most spoke positively of this type of group and its role in linkage programs, one person did note that agencies still have different needs and interests. In addition to a board of advisors or directors, focus group participants also spoke about the value of a subcommittee that had a shared vision in obtaining a linked data set. Participants explained that if all data owners participate, the subcommittee can be a useful vehicle for making decisions about research topics. The arrangement also can promote increased accountability because the subcommittee must report to the larger board. Finally, one participant mentioned using her subcommittee's relationship with the board to address policy roadblocks because the board is composed of higher-level agency management.

Of programs with a board of directors or advisors, a majority (64%) reported quarterly board meetings. State Departments of Public Health were the organizations most likely to be on the board of advisors, followed by State motor vehicle agencies (Figure 1). The number of organizations represented on the board ranged from 1 to 12 with a median of 6 for States that had boards of directors.

Figure 1: Percentage of States listing organization as a member of board of advisors or directors (n=25)



Other identified members (not shown) listed by at least one State included EMS regulatory boards, AAA, Vital Records, other data users, Safe Kids, Council of Governments, public safety, other State agencies that have legislative needs/inquiries, and highway patrol/law enforcement members.

Leadership and Staffing

The CCAT construct of "Leadership and Staffing" refers to the staffing needed to facilitate the coalition (Table 1).

In data results mapped to this construct, the majority of States (75%) had at least one position for which the job description included planning, implementing, and/or evaluating data linkage and analysis activities. Focus group participants most frequently identified epidemiologist, SAS programmer, statistician, and administrator as key positions for a State linkage program. Other positions mentioned include health educator, GIS analyst, and marketer. Further probing identified the following as important attributes for proficiency in linking and analyzing data: analytical/statistical training; experience in programming; some understanding of traffic safety; familiarity with data variables and data sets; some understanding of linking and analysis software; comfort with SAS, MS Excel, or MS Access; and working with large data sets. Other attributes mentioned less frequently included understanding hospital coding (AIS, ICD-9 and ICD-10), knowledge of the Health Insurance Portability and Accountability Act (HIPAA) and other confidentiality considerations, and experience doing theory-guided analysis. Personality attributes identified for linkage staff included being focused, curious, analytical, and detail-oriented.

The number of FTEs per State that were devoted to linkage ranged from .13 to 2.75 employees. Participants in the focus groups emphasized the need for full-time staff. As one person explained,

> "Yeah, I would advocate for a full-time – go ahead and say it takes a full-time employee to make a successful linkage system... You can't have them come in and out, like a student come in over the summer and do it, just because they're a Ph.D. statistical candidate."

Staffing was identified as a key challenge to linkage and analysis. Turnover, both among core project staff and partner agencies, also was identified as a barrier. A single person working in isolation was mentioned as another barrier. As a focus group participant put it,

> "I just have to say, to have another scientist working on it who is of equivalent background that you can bounce things off back and forth, I think it goes a long way to just being able to move it ahead in a high-quality data way that, you know, you're going to be proud of that data and the output from it."

Pooled Member and External Resources

The CCAT construct of "Pooled Member and External Resources" refers to resources and collaborations, both internal and external, needed for linkage programs to function (Table 1). Resources can include funding, expertise, equipment, and more.

Data results mapped to this construct covered technical assistance and funding.

Technical Assistance and Training

For all topic areas, CODES States had either equal or higher proportions of training compared with other State data linkage systems (Table 4).

Table 4: Percentage of States by CODES status and training areas received (n=24)

Training area		CODES State % (n=15)	Other State % (n=10)	Total % (n=24)
Data preparation	Understanding the structure and content of crash data	53% (8)	50% (5)	52% (13)
	Creating clean useable datasets for analysis: using linkage results	67% (10)	20% (2)	48% (12)
Linkage	Linkage using CODES2000	93% (14)	30% (3)	68% (17)
	Linkage using Linksolv	40% (6)	40% (4)	40% (10)
	Linkage using other linkage software	13% (2)	10% (1)	12% (3)
Analysis	Missing data imputation	93% (14)	30% (3)	68% (17)
	Analyzing linked, imputed data	80% (12)	30% (3)	60% (15)
	Understanding the structure and content of crash data	53% (8)	50% (5)	52% (13)

Discussion in the focus groups confirmed that other State data linkage systems had less access to training and technical assistance on linkage than CODES States. These programs relied on the expertise possessed by available staff and resource learning materials/books.

If additional training could be provided for data linkage and analysis, States would be interested in the following topics:

- Missing data imputation;
- Analyzing linked and imputed data;
- Creating public use data sets;
- Creating an online query system, including mapping;
- Probabilistic matching;
- Evaluating the validity of using deterministic linkage methods; and
- Increased understanding about the role and limitations of imputed data.

Training that is hands-on, meaning either interactive in-person sessions or webinars with homework afterward, was seen as more helpful than lecture-style training. Focus group participants indicated that practice and repetition were necessary for attaining proficiency in linkage and analysis.

Most programs surveyed agreed or strongly agreed they had adequate access to technical assistance on linking (75%) and analyzing (74%) data. Further exploration in the focus groups found that one-on-one technical assistance was viewed as helpful, but linkage projects were often stalled while States waited their turn for one-on-one assistance. This occurred among both CODES and other State data linkage systems. As one participant explained,

> "…when we needed the technical assistance…we had to wait for the next time technical assistance was available. So on our end, we had, I had a data person sitting there, waiting, not able to move the project forward."

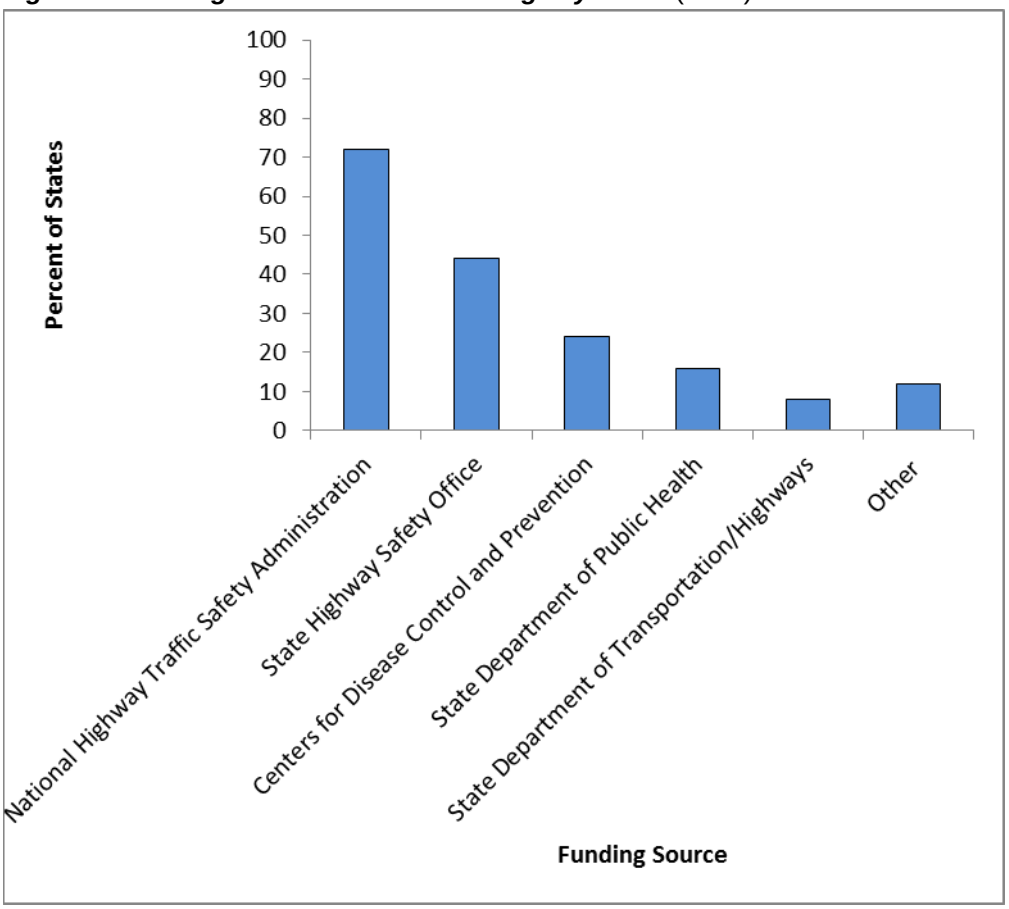
The focus groups also found that States desired a best practice, self-help manual or some other nationally outlined plan of what is considered acceptable standards for probabilistic linkage. Having access to such a tool would reduce some of the roadblocks to training, especially for new employees; such a plan also would serve as a roadmap for current projects. States discussed the need for training on techniques for those collecting the inputdata sources on techniques for improving data quality, since

> "…outputs are only as good as the data collected."

Funding

NHTSA was the major source of funding reported (Figure 2). Further probing through the focus group discussions revealed that States received NHTSA funding directly from NHTSA and from other State organizations (i.e., highway safety offices or DOTs) via pass-through funding. In addition to NHTSA-specific CODES funding, respondents discussed that State data linkage system funding was originally derived through section 408: Traffic Safety Information System funds. However, that funding had been replaced in 2013 with MAP-21 NHTSA section 405 and 402 funds and could alter their funding application with the State.

Figure 2: Funding sources for State linkage systems (n=25)



More than half (54%) of States indicated they had inadequate financial resources to sustain data linkage and analysis programs.

Several States had not considered where they might seek new funding as NHTSA CODES-specific funding was ending. Others indicated that they were planning to connect with their State Traffic Records Coordinating Committee to pursue NHTSA Section 405 funding, and others indicated that they were beginning to make connections with other public health or injury prevention interest groups/agencies or with the CDC. Respondents indicated that they thought their data would have some utility outside of the traffic safety realm; therefore, other non-traffic sources of funding might be possible. The majority of States indicated that future funding was uncertain. Although several anticipated receiving funds through the State Highway Safety Office, the future of MAP-21 introduced an additional element of uncertainty. One State that is funded on a year-to-year basis addressed the time that is diverted from linkage and analysis towards grant writing.

> "And so when you're funded year to year, that's one of our biggest challenges is we spend a lot of administrative time just trying to write the next year's grant, and you know, doing all of the things that we need to do administratively that takes away from the science of it."

Two States indicated that they had decided to discontinue their linkage programs, but that they would make every effort to obtain the data so it would be available when funding might be secured.

A majority of States (96%) did not charge other agencies for data requests. In fact, some participants actively avoided charging fees, because they believed that as public dollars funded the linkage program, the data and analysis should be available to others free of charge.

> "To the degree, when there were prodigious requests involving a lot of hours or potentially, we tried make it something the health department or CODES board was interested in anyway, so we could dedicate the time necessary to do it … even though we have permission to [charge for data requests] we try not to get in the position where we're charging. I think we pretty much tried to avoid that."

States that do charge for data and data requests took different approaches to pricing. Two States, both of which are housed in universities, charge for the time required to fulfill a large data request, but not the data itself. They determine the cost based on the salaries of staff involved and the number of hours estimated to complete the request. If it is a simple request like a fact sheet, they do not charge. One State charges a flat rate per 1,000 records for the data itself, and if additional programming were needed, charges are based on an hourly rate. Their customers are typically researchers, other State agencies, and hospitals.

Member Engagement

The CCAT construct of "Member Engagement" refers to engagement of the coalition with the community (Table 1).

In data results mapped to this construct, data-linkage programs reported the highest engagement with their State Traffic Records Coordinating Committees (TRCC), entities set up as a pre-condition for NHTSA grants under Section 411, CFR 23 - State Highway Safety Data Improvements (Table 5). They showed a lesser amount of engagement with other agencies and the lowest with NHTSA's Regional Offices. (The survey did not ask about NHTSA's National Center for Statistics and Analysis because that interaction was required for all CODES cooperative agreements.) In the focus groups, several participants noted that a history of collaboration with other agencies is a valuable facilitator of linkage projects.

Table 5: Agency or other coalition member by frequency of interaction (n=25)

Agency or other Coalition interaction (N=25)	**We interact frequently**	**We interact occasionally**	**We rarely interact**	**We never interact**
	% (n)	**% (n)**	**% (n)**	**% (n)**
State Traffic Records Coordinating Committee	84% (21)	16% (4)	0	0
Department of Public Health	60% (15)	32% (8)	4% (1)	4% (1)
Strategic Highway Safety Plan Coalition*	48% (12)	28% (7)	12% (3)	8% (2)
Core Violence and Injury Prevention Program	48% (12)	16% (4)	16% (4)	16% (4)
NHTSA Regional Office*	16% (4)	38% (9)	38% (9)	8% (2)
*Some respondents did not answer – missing not shown				

One measure of engagement was the frequency with which data requests are received from various entities (Table 6).

Table 6: Frequency of data requests from outside organizations (n=25)*

Indicate how often you get data requests from each of the following:	**Frequently**	**Occasionally**	**Rarely**	**Never**
	% (n)	**% (n)**	**% (n)**	**% (n)**
Traffic Records Coordinating Committee	16% (4)	28% (7)	20% (5)	28% (7)
Department of Public Health – Injury Surveillance	16% (4)	40% (10)	20% (5)	12% (3)
Strategic Highway Safety Plan	16% (4)	24% (6)	20% (5)	32% (8)
NHTSA Regional Office	0% (0)	12% (3)	36% (9)	44% (11)
State Core Violence and Injury Prevention Program	20% (5)	12% (3)	20% (5)	28% (7)
**Other	16% (4)	4% (1)	0% (0)	12% (3)
* Some respondents did not answer – missing not shown ** Other requests include Highway Safety Offices and research entities such as universities.				

Linkage projects that had been in place longer (i.e., began linkage before 2000) received more data requests per year than linkage projects that began after 2005 (Table 7).

Table 7: Data request frequency by length of time linkage project has been in place (n=22)*

Frequency data requested for the following reasons:	Ongoing/Several per year		Rarely/never	
	Prior 2000 (n=12)	After 2005 (n=10)	Prior 2000 (n=12)	After 2005 (n=10)
	% (n)	% (n)	% (n)	% (n)
Identifying traffic safety problems	67% (8)	40%(4)	0% (0)	20% (2)
Supporting traffic safety decision makers	50% (6)	20% (2)	8% (1)	30% (3)
Educating the public	58% (7)	20% (2)	16% (2)	20% (2)
Legislative decision making	58% (7)	10% (1)	8% (1)	30% (3)
* Some respondents did not answer – missing not shown Years 2000 to 2005 were excluded because of small numbers				

Linked data were shared most frequently with TRCC groups and Department of Public Health Injury surveillance divisions (Table 8).

Table 8: Frequency of sharing data with other organizations (n=25)*

Indicate how often you share or provide linked/CODES data to each of the following:	Frequently	Occasionally	Rarely	Never
	% (n)	% (n)	% (n)	% (n)
Traffic Records Coordinating Committee	20% (5)	40% (10)	20% (5)	12% (3)
Department of Public Health – Injury Surveillance	16% (4)	44% (11)	16% (4)	12% (3)
Strategic Highway Safety Plan	16% (4)	20% (5)	24% (6)	32% (8)
NHTSA Regional Office	8% (2)	12% (3)	32% (8)	40% (10)
State Core Violence and Injury Prevention Program	16% (4)	16% (4)	12% (3)	36% (9)
Other **	16% (4)	16% (4)	12% (3)	36% (9)
*Some respondents did not answer – missing not shown				

State linkage programs received data requests from a list of partners; however, they did not believe that their data were being used to the fullest capacity. The focus groups confirmed this finding.

Focus group discussion revealed that States don't know how to market their data to other potential users. Also, as linkage programs become more established, marketing might become a lower priority. As one focus group participant explained,

> "I think I kind of fall into the trap that we've been around for 20 years and people should know us."

Misperceptions among potential users regarding linked data and its capabilities also were noted as a challenge. As one person explained,

> "It's still not well known what's available, and more importantly, what you can do with the data that is available."

When data were released to potential users, the recipients used it in several ways, such as to support or oppose legislation on seat belts and motorcycle helmets. Participants indicated those who did use their products were pleased and regularly requested additional analysis. The most frequently reported requesters were traffic safety decision makers/State executives, legislative lobbyists, health professionals, and the media. Several States also discussed the option of making certain data accessible through their Web sites. States who believed they were successful in marketing their data indicated that they promoted the use of their data by attending traffic safety coalition meetings, joining the TRCC, presenting at other task forces committed to injury prevention, presenting at conferences, issuing press releases, and collaborating with law enforcement.

Implementation of Strategies/Information Technology Infrastructure

The ITIM construct of "Implementation of Strategies/IT Infrastructure" refers to organizational resources that give the organization the capacity to generate the information technology application (Table 1).

Data results that apply to this construct covered databases, linking data, and staff capabilities.

Databases/Data Sources

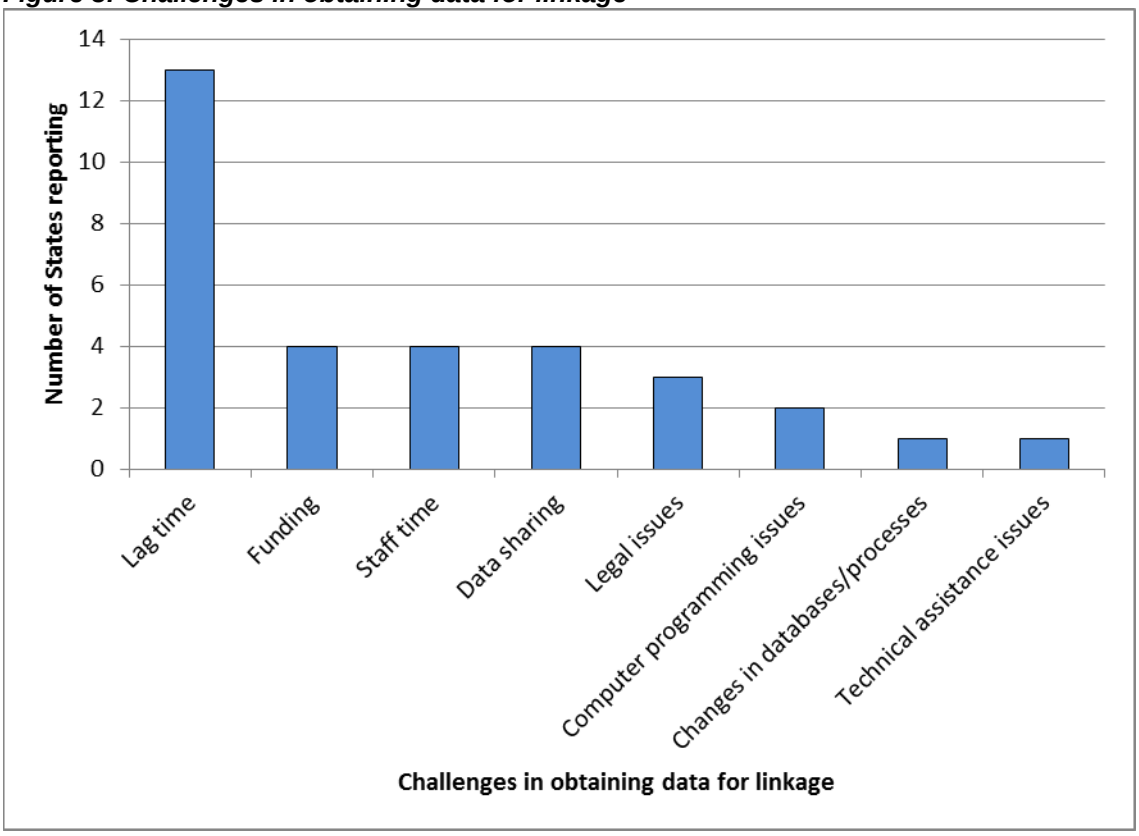
Traffic-record assessment analysis documented that a majority of the States had access to variables needed for linkage in the three datasets that are most commonly linked (Table 9). All of the States had a uniform crash report, but several had no reports submitted to the statewide file electronically. Similarly, the majority of States (15 of 19) had a uniform traffic citation but not all had electronic transfer of those citations, and fewer than one-third had the ability to receive electronic transmissions at the court level. Medical records are almost exclusively submitted electronically to their respective reporting agencies (i.e., hospital association or State health department). The records might be sent on a monthly, quarterly, or annual basis.

Information regarding variables typically used for linkage in each dataset was available. In the crash database, all States had access to driver date of birth, license number, date, and location (jurisdiction) of crash. In the citation database, nearly all States had access to driver date of birth, license number, and vehicle tag number. In the EMS database, all States had access to the patient's date of birth, date of incident, and mechanism of injury whereas most had access to the location (jurisdiction) of the receiving hospital. In the hospital databases (emergency department and hospital inpatient), all States had access to the patient's date of birth, date of admission, and

e-code, which identifies cases by the mechanism of injury. Of the States with a statewide trauma registry file, all had access to the patient's date of birth, date of admission, e-code, and Abbreviated Injury Scale (AIS) scores. Finally, in the mortality database, all States had access to the victim's date of birth, date of death, location (jurisdiction) of death, and International Classification of Disease (ICD)-10 cause of death code. Little information was contained in the assessments regarding the specific variables used for linkage. However, the information above indicates that date of birth, date of incident, and locations of incident are available and most likely are used for probabilistic linkage.

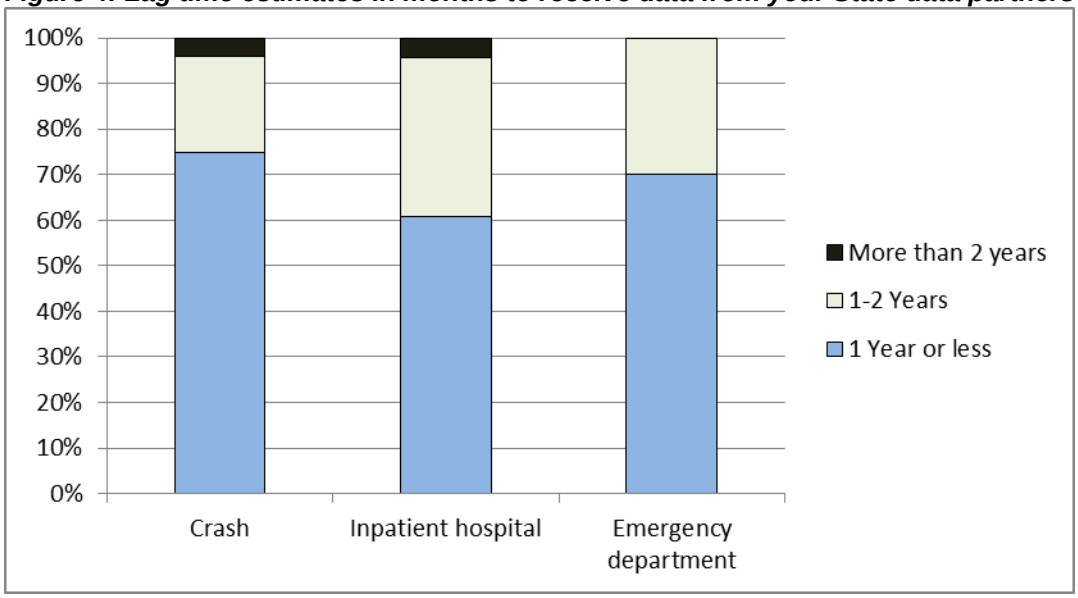
Data lag time was identified as a main barrier to obtaining data for linkage (Figure 3).

Figure 3: Challenges in obtaining data for linkage



Data lag times varied from less than 1 year to more than 2 years, depending on the State and the data source, with the majority of States reporting lag times of 1 year or less (Figure 4).

Figure 4: Lag time estimates in months to receive data from your State data partners



Focus group sessions also found that lag time was a primary barrier to receiving data.

> "…by the time we get them linked and analyzed they're 2-3 years old"

No single type of data was found to be the reason for the lag; several States reported the crash data set took longer to obtain, whereas others reported the hospital, mortality, or emergency department data as having the longest lag time. When States were asked why lag times occurred, they indicated that lengthy lag times are sometimes unavoidable because of statutory requirements or legal concerns. A participant explained,

> "The inpatient data by law has to be embargoed for a year after the end of the year, so we usually get, we'd get the 2012 data set in December [2013] or January [2014]. And that's just, you know, the statutes that govern the use of that data set."

However, other States reported that statutes helped facilitate speedy linkage, such as including vehicle-crash injuries as a reportable condition or requiring that hospital and emergency department data be submitted within 30 days of the end of a month.

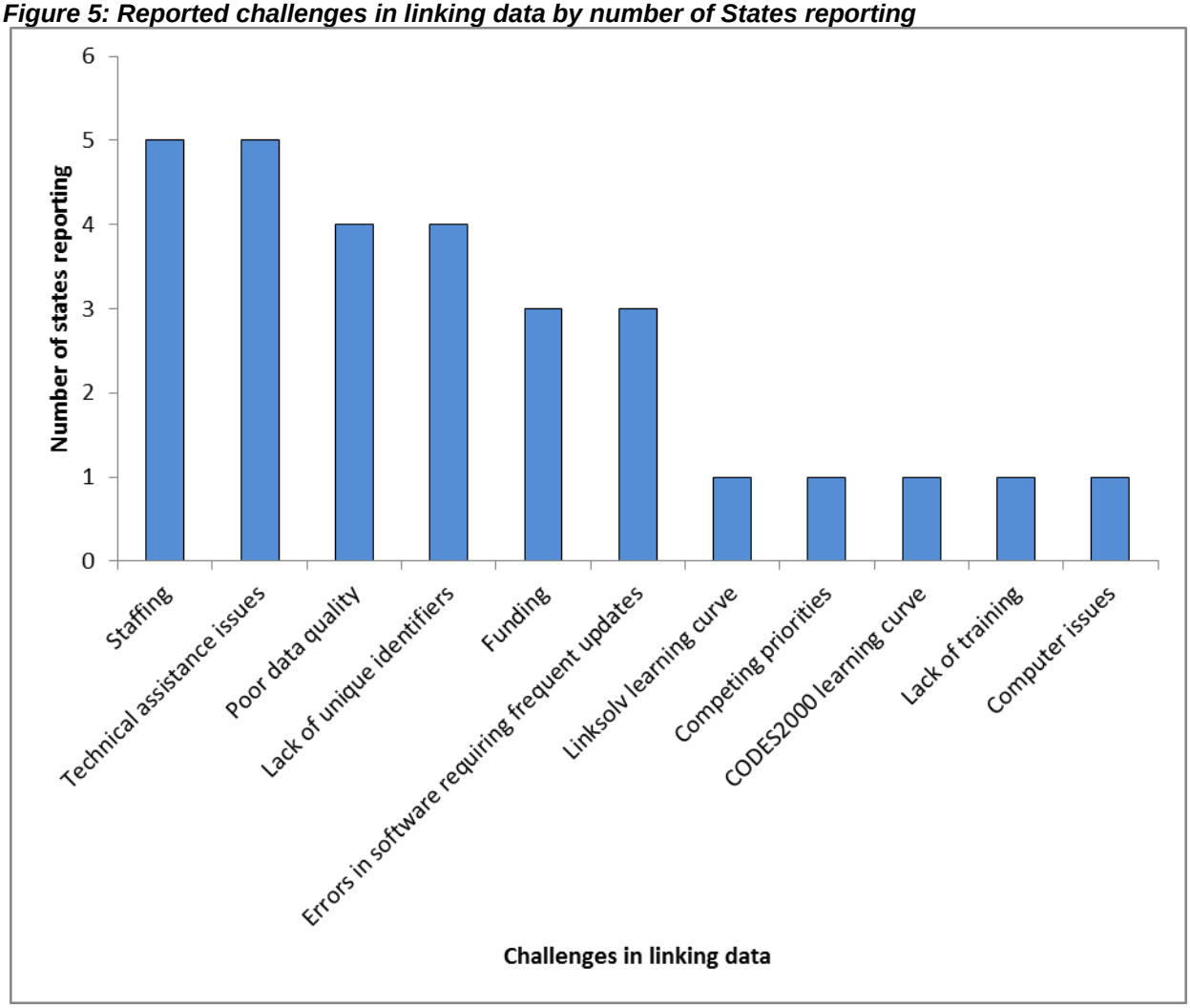
The focus group sessions reported Institutional Review Board (IRB) requirements were a barrier or an addition to lag time. A majority believed that the requirements to protect confidentiality in their State were reasonable, but a few perceived their State's requirements as overly strict and a barrier to data use. Other reasons for lag times included major changes to computer systems or transferring from paper data collection to electronic data collection.

Linking Techniques

Fewer than half (n=10) of the States answered the question regarding the type of linkage they used. Of the States who answered, two-thirds of these States reported using probabilistic methods with the remaining one-third reporting using deterministic methods. Focus group

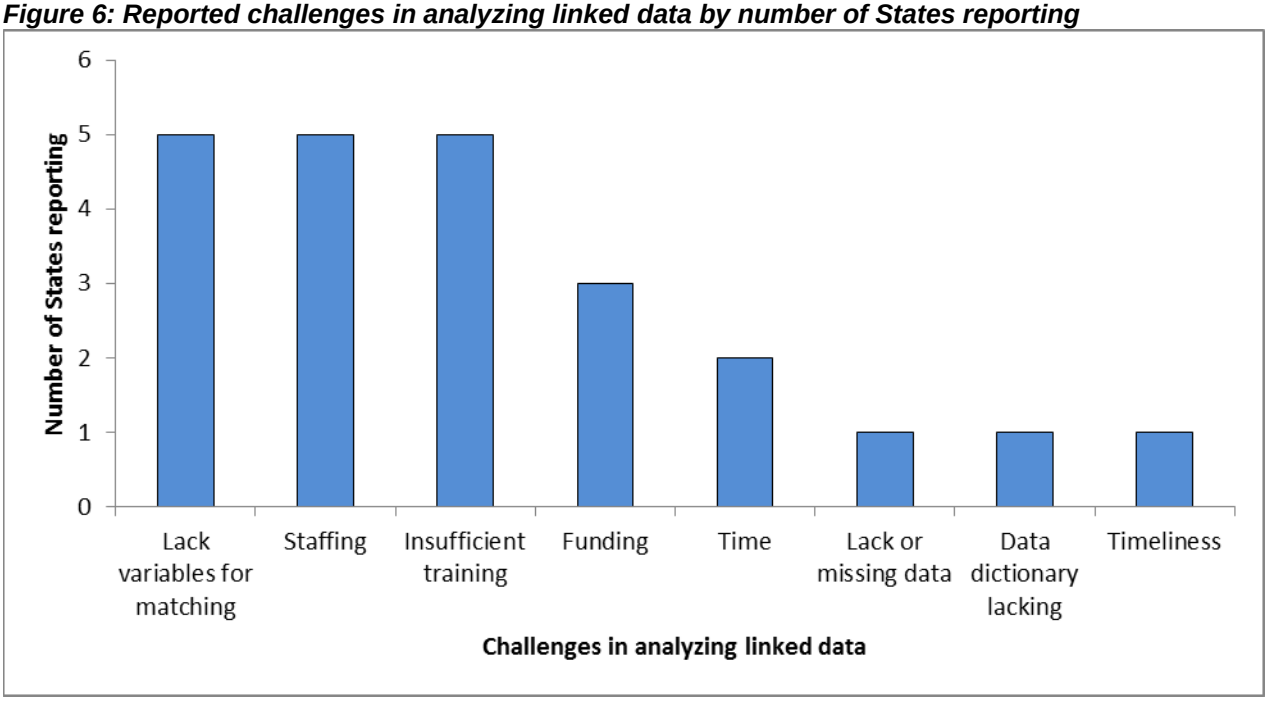
participants indicated that the linkage technique can be complicated and the linking difficult. For this reason, staff involved with data linkage need a high level of understanding and technical expertise. The primary challenge to linking data was found to be staffing and technical assistance problems followed by poor data quality and/or lack of unique identifiers (Figure 5).

Figure 5: Reported challenges in linking data by number of States reporting



The primary challenges to analyzing data were lack of variables for matching, staffing, and insufficient training (Figure 6).

Figure 6: Reported challenges in analyzing linked data by number of States reporting



Staff Capabilities

Approximately half of the States had either expert or intermediate proficiency in using two common linkage software packages: Linksolv and CODES2000 (Table 9).

Table 9: Proficiency in linking by software type

Software	Proficiency in Linking			
	Expert[1] % (n)	Intermediate[2] % (n)	Beginner[3] % (n)	Not proficient[4] % (n)
Linksolv (n=13)	38% (5)	31% (4)	23% (3)	8% (1)
CODES2000 (n=18)	39% (7)	44% (8)	6% (1)	11% (2)
SAS (n=19)	74% (14)	26% (5)	0% (0)	0% (0)
ACCESS (n=19)	67% (10)	33% (5)	0% (0)	0% (0)
EXCEL (n=15)	42% (8)	58% (11)	0% (0)	0% (0)

[1]Expert: Assists or able to teach others in using software
[2]Intermediate: Can generally develop linkage specifications/program or run software without assistance
[3]Beginner: Needs assistance in developing linkage specifications/programs or running software
[4]Not proficient at all

Expertise in using the software packages typically used to analyze linked data was higher. States had high expertise in SAS, a software used for analyzing linked data (Table 10).

Table 10: Proficiency in analysis by relevant software type

Software	Proficiency in analysis			
	Expert % (n)	Intermediate % (n)	Beginner % (n)	Not proficient % (n)
SAS (n=19)	74% (14)	26% (5)	0% (0)	0% (0)
EXCEL (n=13)	69% (9)	31% (4)	0% (0)	0% (0)
ACCESS (n=12)	42% (5)	58% (7)	0% (0)	0% (0)
IVEWARE (n=9)	22% (2)	44% (4)	22% (2)	11% (1)

Outcomes

The theory construct of "outcomes" refers to community change outcomes that are likely to improve health and increase capacity (Table 1).

Linkage Success

When considering linking police crash reports to hospital, emergency department, or EMS, the majority of States (80%) were able to link 75 percent to 100 percent of the years of available data. For those States with lower linkage success (linking <75% of available years of data), two of the five had just started their linkage effort. The Traffic Records Assessments validated these findings. Certain States reported successful linkages with and without a CODES program. Twenty-three States linked hospital records (emergency department and hospital inpatient) with crash data for at least 1 year. Only 1 State integrated citation data with other traffic records systems. All but 2 States linked hospital records (emergency department and hospital inpatient) with crash data. Fewer than half of States reported linking trauma registry or mortality data to crash reports, perhaps because of accessibility or completeness.

States that had high linkage success (linking ≥ 75% of available years of data) had higher median FTEs (median: .94 FTE, range: .13–2.75 FTE) than States with lower success (median: .75 FTE, range: .63–1 FTE). However, some States achieved high linkage success with fewer than one FTE. Forty percent of the States with high linkage success had more than one FTE and none of the States with lower linkage success had more than one FTE.

Products from Analyses of Linked Datasets

Products included presentations, reports, peer-reviewed publications, and fact sheets. Linked data were also used to support legislative activities and to provide information on specific motor vehicle concerns. One other linkage State provided access to their linked data via an online database. The topic areas of these products included but were not limited to motor vehicles overall, analyses by age of driver/passenger, restraint use, motorcycles and traumatic brain injury (See Attachment D for a sample bibliography). Linked data also were used for several methods studies that resulted in suggestions for improving data quality. Areas that were unique to linked data included exploring motor vehicle crash data for morbidity, and by injury severity, nature of injury, and body region. Because of the linkage of crash reports with medical records, analyses

were able to explore relationships such as seat belt use and injury outcome and helmet use and cost of injury.

Linked data were presented at various conferences and in numerous publications (Table 11). The conferences where linked data were presented ranged from regional to State, national, and even one international conference. Publications appeared in several specialized journals, including those that focused on medical, injury prevention, and motor vehicle injury topics.

Table 11: Places where linked data have been presented or published

Conferences
Annual Meeting of National Association of Emergency Medical Services Physicians
Annual Michigan Traffic Safety Summit
California Child Passenger Safety Community Teleconference
CODES Network Technical Assistance Meeting
Council State and Territorial Epidemiologists
Delaware Trauma System Committee
Emergency Medical Services for Children Annual Program Meeting
Illinois Traffic Engineering and Safety Conference
International Forum on Traffic Records & Highway Safety Information System
International Traffic Forum
Joint Annual Meeting of the Safe States Alliance, SAVIR and CDC Core I & II State Injury Grantees
Midwest Region/Iowa Safety Summit
Motorcycle Winter Conference
New York Highway Safety Symposium
New York State Association of Traffic Safety Boards
New York State Partnership for Teen Driving Safety
NHTSA Region 7 Safety Data Conference
Safe Communities Best Practices Conference
Safe Communities Workshop
State CODES Advisory Groups
State Lifesavers Conference
State Traffic Records Coordinating Committee Meeting
Traffic Records Forum
Western Trauma Association Annual Meeting
Journals
Accident Analysis and Prevention
The American Surgeon
Annals of Advances in Automotive Medicine
Annals of Emergency Medicine
Injury Prevention
Journal of Neurosurgery of the Spine
Journal of Nursing Scholarship
Journal of Public Health Management Practice
Journal of Safety Research
Journal of Safety Research-Traffic Records Forum Proceedings

The Journal of Trauma
Kentucky Epidemiologic Notes & Reports
Missouri Medicine
Missouri Monthly Vital Statistics
MMWR
Pediatrics
Prehospital Emergency Care
Topics in Health Records management
Traffic Injury Prevention
Wisconsin Medical Journal
Other Publications
NHTSA Reports
State Reports

Examples of the types of requests linked data were used for include the following:

- The effects of child safety seats on motor vehicle crash injury that were shared relative to a bill requiring safety seats for children 4 to 8 years old.
- Data on injuries to children in bus crashes given to State governor's school bus safety task force.
- Safety belt use and degree of injury data given to State Department of Transportation to present to district engineers.
- Crash types and costs given to Transportation Safety Board to develop costs of different types of crashes.

Community Capacity

The CCAT construct of Community Capacity refers to increased capacity that can be applied to other health and social problems (Table 1).

Results mapped to this construct covered unexpected benefits of State data linkage systems that increased the Community Context. These following benefits were not covered in our survey but were discussed during the focus groups:

Linking data improved data quality. Because a single agency collects and monitors all the data sets, a certain level of quality control and monitoring is possible. Because of familiarity with the data systems, linkage staff have helped State agencies rewrite data collection forms such as EMS and police/citation. Linking data had a legislative impact as findings related to booster seats, seat belts, graduated driver's licenses, motorcycle helmets, and cell phone laws were used to help explain the traffic safety concerns more clearly. In a focus group, a participant spoke about their legislative impact, saying,

> "But it's always really exciting to me whenever we can put together a fact sheet and provide it to people who, you know, are at the legislature that are actually interested in seeing our results and interested in it. We've had the opportunity to, you know, testify

> during various committees about our data and to educate people that would help support or not support laws. So we've been able to be involved in, you know, motorcycle helmets or safety belts. We helped with the GDL that's currently in [State], booster seats. We've helped with cell phone laws. Different things like that, so it's been a really fun thing to see, and a really good benefit of linkage."

Interagency collaboration improved. Because agencies were naturally collaborating when they shared data, they also had begun to collaborate in initiating and developing agency ideas. States have also connected with new partners. One participant put it,

> "I think an unexpected benefit is we thought prior to this that we were pretty well connected to the injury community in the State. Through TRCC and our CODES project we found a number of additional partners that we had not engaged before that have really informed our work in a number of areas."

DISCUSSION

General Findings

State data linkage programs were successful in linking crash data to medical data with the majority linking three quarters or more of the years of available data. The resulting databases provided diverse data findings that enabled States to create numerous products (e.g., fact sheets, presentations and peer reviewed publications on various motor-vehicle– related topics). These products were disseminated through the internet, journals, and scientific meetings. Linkage also led to positive outcomes beyond data and data products, most notably increased community capacity through greater collaboration with partner agencies, improved data quality, and more efficient data collection and processing. Finally, States were able to apply their linkage skills to other data sets outside of the typical crash, roadway, vehicle, driver, enforcement, and injury surveillance data systems used in traffic safety analysis.

NHTSA CODES provided essential resources to the States that participated. It enhanced sustainability of linkage programs by providing States with a funding source for several years, which allowed States to focus on program implementation rather than on obtaining funding. One possible result of this is that CODES programs, overall, had been in place longer than other State data linkage programs. Another crucial resource provided by CODES was training and technical assistance that were important to successful data linkage. As a result, CODES programs received more technical assistance and training compared with other State data linkage programs. In the absence of the overarching NHTSA CODES infrastructure, States might consider implementing a community of practice to exchange information and ideas as found beneficial through other research efforts (Snyder, 2003).

Common Themes

In synthesizing the results of the study, the team noted common themes and findings from the four data collection modes. In particular, the survey and focus groups provided insight into key themes and points for developing or sustaining a linkage program. Facilitators and barriers were identified as follows:

Facilitators

Facilitators are positive factors that influence a program (Robinson, 2006). Certain facilitators stood out as contributing to success in linkage and in analysis of linked data. Those the study team identified include the following:

- Community Context
  A community context that facilitates linkage includes establishing traffic safety as a high priority and having access to data that are suitable for linkage.

- Housing the overall responsibility for the data linkage program in one organization
  When establishing a linkage program, strategically selecting the right organization to run the linkage program facilitates success. One factor to consider is which organizations own the

source datasets to be linked; choosing one of these as the lead can facilitate obtaining the data. In contrast, if a State linkage project wants greater neutrality and freedom to select topics of study, a non-State organization such as an academic institution might be a better choice.

- Establishing a coalition that includes all data owners
  In addition to choosing an organizational home, setting up a coalition that includes all data owners and any other relevant parties that meets regularly is a key facilitator. This provides a forum for agencies to meet on a regular basis and provides leadership and direction.

- Establishing memorandums of understanding and/or undergoing institutional review board review to obtain data
  Formal memorandums of understanding and institutional board review set parameters for obtaining data and releasing results.

- Good identifiers/matching variables in the data
  The majority of the States had at least a minimal set of variables in the police and medical datasets that could be used to link.

- Interactions with other organizations
  Interacting with other organizations such as Traffic Record Coordinating Committees and the Core Violence and Injury Prevention Programs gives linkage programs a way to understand data needs and to market linked data and products.

- Having the right staff with the right skills
  The right skills include not only a high level of expertise with software packages and epidemiology/statistics but also knowledge of traffic safety, the data sources being linked, and presentation and marketing skills to ensure data are used. Permanent staff who are able to carry over past years linkage knowledge are preferable to temporary staff brought in to perform linkage. Multiple persons (either staff or members of the coalition) working on linkage facilitates progress as they can provide the skills and knowledge needed for success.

- Technical assistance and training
  Successful linkage is facilitated by staff that has access to training and technical assistance on the software and methods used in preparing data for linkage, linking data, and analyzing the linked data. Repetitive training and technical assistance that allow the recipient to learn something, work on it, then return for the next step is preferable to one-time offerings.

- Stable funding
  Stable funding (for a period of more than a year) for the data linkage program relieves the program of constantly writing grants and applications for funding.

- Organized data-linkage system beyond the State level.
  Being part of an organized data linkage system such as CODES can facilitate data linkage and analysis as members have more access to technical assistance and training and also had funding guaranteed for more than 1 year.

Barriers

Barriers are negative factors that can impede or reduce the success of a State linkage program. As with facilitators, the study team looked through common responses in the survey and focus groups to identify common themes of barriers. Noted barriers included the following:

- Lack of funding and other resources
  Most States already felt they did not have adequate financial resources for linkage and analysis. These barriers will likely increase as States transition from CODES-specific NHTSA funding. In many cases, States currently lack a concrete plan for seeking other sources of funding. Additionally, when sufficient resources are not available for training/technical assistance, that can present a barrier.

- Staffing turnover
  Finding and retaining staff with appropriate skills can be difficult. Turnover can slow a project substantially because departing staff take with them key institutional knowledge such as data quality and State data characteristics Considerable time and resource investment are required to bring a new employee up to speed on intricacies and nuances of data sets and linkage methodology.

- Documentation of processes
  A lack of documented procedures related to cleaning and linking data delayed linkage in States that either did not have or had to wait for technical assistance or training.

- Data lags
  Data were sometimes not available for as long as 2 years after the end of the data year and often one data set had a substantially longer lag time than the others, limiting linkage. A long data lag can diminish stakeholder enthusiasm for linkage, because it is considered "old data" and presumed to be no longer relevant.

- Statutory requirements for data use
  Statutory requirements, legal concerns, and institutional review board requirements could be overly burdensome. They contributed to data lag times and posed substantial roadblocks to obtaining data in some States.

- Linkage techniques
  Probabilistic linkage and imputation are advanced statistical techniques that require training or assistance to learn. In combination with the barrier of staffing turnover, linkage techniques can be a barrier to successfully completing linkages. Furthermore, results can be difficult to explain to those using the data.

- Marketing linked data
  Failure to market linked data, network to expand the audience that linkage projects reach, or to cultivate new partnerships were barriers for continued demand of the linked data.

The facilitators and barriers to successful data linkage that this study identified were supported by other studies. A case study of five Canadian provinces involved in the dissemination of a Heart Health Initiative found that the major facilitators were appropriately skilled and/or committed persons, funds/resources, and strong partnerships (Robinson, 2006). Major barriers were competing priorities, lack of funds/resources, and lack of skilled/committed persons. Leadership competence, effective collaboration, demonstrating program results, and strategic funding are components of community-based program sustainability (National Opinion Research Center, 2010). This study confirmed that resources, including funding and skilled staff, leadership, and collaboration and partnerships, were facilitators of linkage programs. A concern for existing State data-linkage programs is that two keys for sustainability are demonstrating program needs and strategic funding. The current study found that data-linkage results were not used or recognized as much as they could be and that most States did not have a plan for future funding.

Use of Theory

Using theory to design the research instruments in this study was essential to suggesting vital characteristics of systems that should be studied. Theory is useful not only in studying data linkage systems but could also be used to design and improve such systems by specifying essential characteristics and the relationships between characteristics that lead to a desired outcome (Glanz, 2002). Data linkage systems are public health programs, often overseen by a coalition, and involve an information system. As a result, theories from these three areas can be used to inform how to design and implement better data linkage systems. Finally, given the lack of a system such as CODES to coordinate and fund linkage programs, theories of program sustainability can help States who are considering maintaining their data linkage system or starting a new one to determine factors needed to sustain these programs (Schell, 2013; Benz, Infante, Oppenheimer, Scheer, & Tilson, , 2010).

Limitations

This study had several limitations. It was initially planned as a more quantitative analysis of the factors related to successful linkage, but the number of States who were considered not successful was so low that quantitative analysis was not appropriate. A second limitation is that the majority of the States in this study made traffic safety a priority and two-thirds of the States were in the CODES program. Participation in this program required States to demonstrate that they had access to data sets and the ability to successfully link them. As a result, these findings might not be applicable to all States. Another limitation is that the information taken from traffic records assessments is accurate only to the State's last assessment (within 5 years). Finally, not all constructs of the theories used to structure this study were included. Because of a desire to limit the time required of subjects to respond to the questionnaire and to participate in the focus groups, constructs selected were the ones most relevant to data linkage systems. Additionally, the measures for the constructs selected were the ones considered to be most relevant and serve as proxies for the constructs.

Conclusions

Given the interest in and need for linked police crash with medical record data and the success of many states States in linking data and producing products, this assessment can be useful in identifying the facilitators of and barriers to an effective data linkage program. In addition to considering these facilitators and barriers in implementing and maintaining data linkage programs the following are guidelines that States should consider for current and future linkage programs:

- Set up a coalition or create a subcommittee of an existing motor vehicle safety coalition.
- Select an organizational home.
- Hire full time, permanent staff, rather than part-time or temporary staff. Select staff with appropriate skills and abilities.
- Provide, on an annual basis, funds for training and technical assistance. Data linkage is a complex process that requires highly skilled staff. Choose hands-on training and technical assistance that can be available on an as-needed, ongoing basis to maximize value.
- Create/join a community of practice of linkage practitioners to avoid working in isolation.
- Use Memorandums of Understanding and Institutional Review Boards to establish parameters around data use and data sharing, but work to overcome rules that create substantial data lag.
- Prioritize training and marketing to others on the use of linked data outputs and data products.
- Plan for longevity and sustainability rather than relying on year-to-year grant writing.

State data linkage systems that link police crash reports to medical records are a valuable source of data on non-fatal motor vehicle crashes and on the severity of injuries from these crashes. These data might be used to identify risk factors, design strategies to address these risk factors, and evaluate these strategies once implemented. In addition to directly producing important public health data, linkage systems increase the State's capacity to understand and analyze both motor vehicle crash and other data. Understanding the facilitators and barriers to an effective and useful linkage system can optimize the system's utility for public health and transportation safety.

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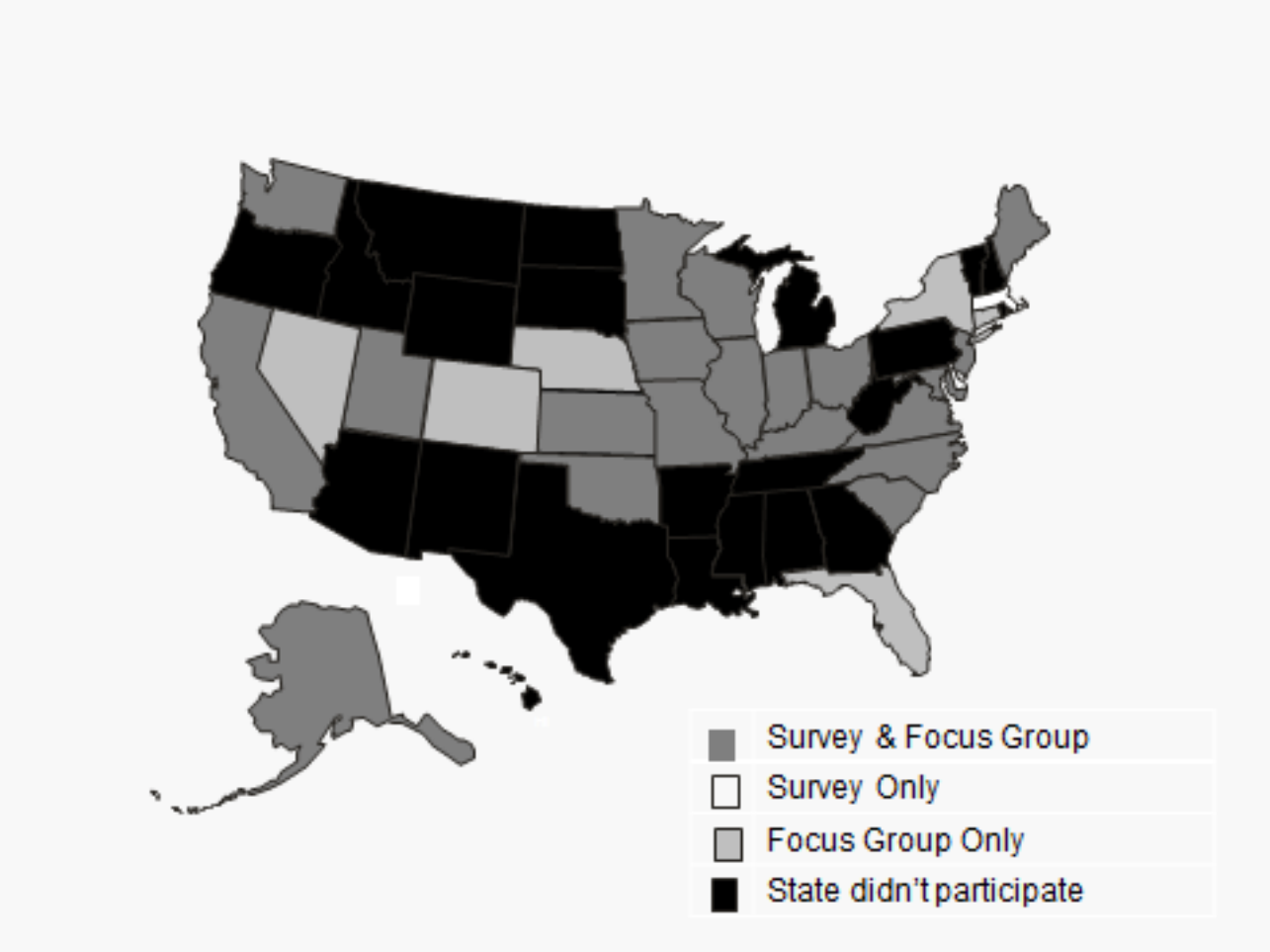
ATTACHMENTS

Attachment A. State participation in study



Attachment B. Questionnaire for Study

Characteristics of a State Linkage System

Form approved
OMB No. 0920-0879
Expiration Date: 03/31/2014

1. What is today's date?

Please enter today's date using the following format. MM / DD / YYYY

2. Which state are you representing in completing this survey?

3. What is your email address, in case we have any questions or need clarification of any responses. Email addresses will not be connected to final data outputs.

4. How much of a priority would you say motor vehicle injury is in your state compared with other health problems?

- ◯ Highest priority
- ◯ Priority
- ◯ Somewhat of a priority
- ◯ Not a priority at all

5. What year did your state start its linkage project?

6. Is the linkage and analysis project in the state for which you are responding part of the National Highway Traffic Safety Administration (NHTSA) Crash Outcome Data Evaluation System (CODES)?

- ◯ Yes
- ◯ No

Public reporting burden of this collection of information is estimated to average 40 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to CDC/ATSDR Reports Clearance Officer; 1600 Clifton Road NE, MS D-74, Atlanta, Georgia 30333; ATTN: PRA (0920-0879)

Page 1

Characteristics of a State Linkage System

7. Which agency is responsible for....

	State Department of Public Health	State Department of Transportation/Highways	Other:
The coordination of your overall linkage/CODES project?	◯	◯	◯
Your primary linkage/CODES project linkage?	◯	◯	◯
Your primary linkage/CODES project data analysis?	◯	◯	◯

If you indicated "Other", please specify the agency name(s):

8. If your state participates in the NHTSA CODES effort, in what year was the program begun?

9. Indicate the years of source data that are suitable for linking that you have available

	Crash	Inpatient	ED	Emergency Medical Services (EMS)	Drivers License	Traffic Violation/Citation	Vehicle Registration
2002	☐	☐	☐	☐	☐	☐	☐
2003	☐	☐	☐	☐	☐	☐	☐
2004	☐	☐	☐	☐	☐	☐	☐
2005	☐	☐	☐	☐	☐	☐	☐
2006	☐	☐	☐	☐	☐	☐	☐
2007	☐	☐	☐	☐	☐	☐	☐
2008	☐	☐	☐	☐	☐	☐	☐
2009	☐	☐	☐	☐	☐	☐	☐
2010	☐	☐	☐	☐	☐	☐	☐
2011	☐	☐	☐	☐	☐	☐	☐

If you have "Other" data sources available, indicate the name and year(s) of data available:

Characteristics of a State Linkage System

10. For which of the following years and databases have you linked your CRASH data:

	Inpatient	ED	Emergency Medical Services(EMS)	Drivers License	Traffic Violation/Citation	Vehicle Registration	Other
2002	☐	☐	☐	☐	☐	☐	☐
2003	☐	☐	☐	☐	☐	☐	☐
2004	☐	☐	☐	☐	☐	☐	☐
2005	☐	☐	☐	☐	☐	☐	☐
2006	☐	☐	☐	☐	☐	☐	☐
2007	☐	☐	☐	☐	☐	☐	☐
2008	☐	☐	☐	☐	☐	☐	☐
2009	☐	☐	☐	☐	☐	☐	☐
2010	☐	☐	☐	☐	☐	☐	☐
2011	☐	☐	☐	☐	☐	☐	☐

If your state has "Other" data sets linked (i.e.E.M.S. data linked to trauma data), indicate the name and years of data sets that are linked:

11. Consider the following:

	Yes	No
Do you have a Board of Advisors or Directors for your linkage/CODES project?	○	○
Do you have a small group or subcommittee that assists as a steering committee, work group, task force, or other advisory board that assists you with identifying your linkage/research priorities?	○	○

Other comments:

Characteristics of a State Linkage System

12. Consider the following in relation to your linkage/CODES project:

	Annually	Bi-annually	Quarterly	Monthly	Other time period, please specify below	N/A
If your state has a Board of Advisors or Directors, how often does that group meet?	○	○	○	○	○	○
If your state has a small group or subcommittee that assists as a steering committee, work group, task force, or advisory board that identifies linkage/research priorities, how often does that group meet?	○	○	○	○	○	○

Please specify other time periods for each if option not provided:

13. Indicate the organizations that are represented on your linkage/CODES Board of Advisors or Directors.

	Members
State Highway Safety Office	○
State Department of Motor Vehicles	○
State Department of Public Safety	○
State Department of Public Health	○
State Department of Transportation/Highways	○
State Police	○
State Trauma Board	○
State level hospital association	○
University/College: Specify name(s) below	○
Other state department, non-governmental organization, or other: specify name(s) below	○

If you listed University/College or other state department, non-governmental organization, or some other potential agency, please specify those agency name(s):

Characteristics of a State Linkage System

14. If your state has a small group or subcommittee that assists as a steering committee, work group, task force, or advisory board that identifies linkage/research priorities, list those agencies that participate in this with you. If this doesn't apply please indicate with N/A:

15. Indicate the funding streams that your state utilizes to support your linkage/CODES project.

	Funding available to our state
Centers for Disease Control and Prevention (CDC)	◯
NHTSA	◯
National Institutes of Health (NIH)	◯
State Highway Safety Office	◯
State Department of Public Health	◯
State Department of Transportation/Highways	◯
State Department of Motor Vehicles	◯
Substance Abuse and Mental Health Services Administration (SAMHSA)	◯
The Robert Wood Johnson Foundation (RWJF)	◯
Other	◯

If you selected "other" indicate who those partners include:

16. Do you charge other agencies for data outputs from your linkage/CODES project?

◯ Yes

◯ No

If you indicated "yes", please share how you might charge other agencies (i.e. hourly, price by size of project or output, etc...):

Characteristics of a State Linkage System

17. Indicate your agency's level of involvement with each of the following in your state: (i.e. involvement might mean that you attend meetings that they hold or they attend meetings that you hold - you mutually support those program efforts or they support yours)

	We interact frequently	We interact occasionally	We rarely interact	We never interact
Traffic Records Coordinating Committee (TRCC)	◯	◯	◯	◯
Department of Public Health - Injury Surveillance	◯	◯	◯	◯
Strategic Highway Safety Plan (SHSP)	◯	◯	◯	◯
NHTSA Regional Office	◯	◯	◯	◯
State Core Violence and Injury Prevention Program (Core VIPP)	◯	◯	◯	◯
Other	◯	◯	◯	◯

If you selected "other" indicate who the other partners are that you interact with and your level of involvement with them.

18. Indicate how often you share or provide linked/CODES data to each of the following: (meaning that you have an ongoing relationship and commitment to provide them with data outputs or analyses)

	Frequently	Occasionally	Rarely	Never
Traffic Records Coordinating Committee (TRCC)	◯	◯	◯	◯
Department of Public Health - Injury Surveillance	◯	◯	◯	◯
Strategic Highway Safety Plan (SHSP)	◯	◯	◯	◯
NHTSA Regional Office	◯	◯	◯	◯
State Core Violence and Injury Prevention Program (Core VIPP)	◯	◯	◯	◯
Other	◯	◯	◯	◯

If you indicated "Other", please specify the agency name(s) and the frequency with which you interact:

19. Indicate how often you get data requests from the following:

	Frequently	Occasionally	Rarely	Never
Traffic Records Coordinating Committee (TRCC)	◯	◯	◯	◯
Department of Public Health - Injury Surveillance	◯	◯	◯	◯
Strategic Highway Safety Plan (SHSP)	◯	◯	◯	◯
NHTSA Regional Office	◯	◯	◯	◯
State Core Violence and Injury Prevention Program (Core VIPP)	◯	◯	◯	◯
Other	◯	◯	◯	◯

If you indicated "Other", please specify the agency name(s) that submit data requests and the frequency with which they request data from you:

Characteristics of a State Linkage System

20. How would you rate the demand for linkage/CODES data in your state....

	Many people use our data on an on-going basis	We receive data requests several times per year	We receive data requests occasionally	We rarely receive data requests	We never receive data requests
for use in identifying traffic safety problems.	◯	◯	◯	◯	◯
for use in supporting traffic safety decision makers.	◯	◯	◯	◯	◯
for use in educating the public.	◯	◯	◯	◯	◯
for use in legislative decision making.	◯	◯	◯	◯	◯

21. For each person working on your linkage/CODES project, indicate the percent FTE, percent effort, and familiarity with statistics/epidemiology. (working on the project meaning: preparing a data feed for linkage, participating in meetings regarding linkage/analysis, preparing data regarding linkage/analysis, writing papers or preparing presentation materials on the results of analyses, etc..).

	Percent FTE	Percent Effort	Familiarity with Statistics/Epidemiology
Person #1			
Person #2			
Person #3			
Person #4			
Person #5			
Person #6			

If more than 6 people work on your linkage/CODES project, continue your list here:

22. If your state is NOT part of the CODES effort what linkage method do you use?

☐ Probabilistic

☐ Deterministic

Please describe linkage method or any software used:

Characteristics of a State Linkage System

23. How would you describe your project staff's proficiency in the following....(proficiency meaning: statistical background, knowledge of appropriate software, understanding of outputs, and ability to draw conclusions)

	to link data	to analyze linked data
LinkSolv		
CODES2000		
IVEWare		
SAS		
Microsoft Access		
Microsoft Excel		
Other software in general		

If you selected "Other software in general", please specify what your linkage/CODES project uses and their proficiency in using: Expert, Intermediate, Beginner, Not proficient

24. For each of the following, indicate the areas in which linkage/CODES project has received technical assistance or training:

	Yes	No
Understanding the structure and content of crash data	◯	◯
Linkage: using Linksolv	◯	◯
Linkage: using CODES2000	◯	◯
Linkage: using other linkage software (specify the software package name below)	◯	◯
Creating clean usable data sets for analysis: using linkage results	◯	◯
Missing data imputation	◯	◯
Analyzing linked, imputed data	◯	◯

If you indicated that your linkage/CODES project uses some "Other" linkage software, specify the name of that software package:

25. If you had the opportunity for additional technical assistance/training, what topics would your linkage/CODES project find important or relevant?

Characteristics of a State Linkage System

26. Estimate the lag time in months that it takes to receive data from your state data partners:

	Our state doesn't use this data source	3 months or less	4-6 months	7-9 months	10-12 months	13-18 months	19-24 months	more than 24 months
Crash	◯	◯	◯	◯	◯	◯	◯	◯
Inpatient Hospital	◯	◯	◯	◯	◯	◯	◯	◯
ED	◯	◯	◯	◯	◯	◯	◯	◯
EMS	◯	◯	◯	◯	◯	◯	◯	◯
Drivers License	◯	◯	◯	◯	◯	◯	◯	◯
Traffic Violation/Citation	◯	◯	◯	◯	◯	◯	◯	◯
Vehicle Registration	◯	◯	◯	◯	◯	◯	◯	◯

If your state links data sets other than those listed, specify what data sets that includes and the lag time in months it takes to receive that data:

27. The next several questions refer to aspects of your linkage/CODES project that may serve as resources or barriers. Please indicate the extent to which you agree or disagree with the following statements. Our linkage/CODES project has...

	Strongly agree	Agree	Disagree	Strongly disagree	Neither agree nor disagree
adequate financial resources to participate in data linkage and analysis efforts.	◯	◯	◯	◯	◯
had at least 1 position in which the job description included work related to planning, implementing, and/or evaluating data linkage and analysis efforts.	◯	◯	◯	◯	◯
provided access to data linkage and analysis results through publications, factsheets, etc...	◯	◯	◯	◯	◯
formal or informal partnerships with agencies with which we can collaborate on data linkage and analysis efforts.	◯	◯	◯	◯	◯
adequate access to technical assistance when we run into problems linking data.	◯	◯	◯	◯	◯
adequate access to technical assistance when we run into problems analyzing data.	◯	◯	◯	◯	◯

28. List the top three obstacles that might keep you from OBTAINING data or data sets timely:

Obstacle 1:

Obstacle 2:

Obstacle 3:

Characteristics of a State Linkage System

29. List the top three challenges that you have in LINKING data for your linkage/CODES project:

Challenge 1:

Challenge 2:

Challenge 3:

30. List the top three challenges that you have in ANALYZING data from your linkage/CODES project.

Challenge 1:

Challenge 2:

Challenge 3:

Attachment C. Focus Group Script

<Display slide 1 – Attachment F>

Welcome, thank you for joining us today for our focus group. As described in our email invitation, we are here to discuss the characteristics of the Crash Outcomes Data Evaluation System (CODES) and similar State Linkage Systems that are related to successful data linkage and analysis. We conducted an assessment of States who had CODES/linkage programs during December and January. During this session, we will present initial results from that assessment, ask for feedback on some of them, and ask new questions based on the results. Today's session will be recorded so that members of the research team can listen to the recordings to identify general themes and conduct analysis. The data will be kept anonymous and no individual results will be released with either your name or State attached to them.

We'd first like to introduce the members of the team that are joining for today's call. I am Jackie Milani and I will be serving as the facilitator. I am a research project coordinator with the University of Maryland Baltimore, National Study Center for Trauma and EMS. Also joining are (CDC Representatives, NHTSA Representatives, and NSC Representatives).

<Display slide 2-Attachment F >

I'd like to ask everyone joining us today to introduce his- or herself by giving his/her name, job title, organization, and verbally let us know that you agree to be recorded. Once we finish with our introductions we will formally begin our session.

<Display slide 3-Attachment F>

Thank you for those great introductions. We are going to now move on to talk with you about the flow of our session today. We will begin by sharing the objectives, move on to establish working ground rules and then start the actual question and answer session.

<Display slide 4-Attachment F>

So our Objectives for today are:

To gain a better understanding of the characteristics of successful linkage and analysis programs in your State

To identify barriers and facilitators of current linkage and analysis programs in your State and

To learn more about the sustainability of linkage and analysis programs for the future.

Does anyone have any questions or feedback for us to this point?

<Display slide 5-Attachment F >

OK great then we will move on as a group to establish our ground rules.
We're going to share some of the rules that we have established and then ask you to contribute some additional ideas. Here are some base ground rules:

- The focus group session will run for 2 hours and no longer.
- There are six areas that will need to be covered in that 2 hour time period. We will have a separate person serve as time keeper for the session to help us stay on task.
- No answer is a bad answer.
- All participants will be asked to give some information. We will try to go around the room encouraging everyone to respond to each question in some manner.
- And as a reminder again, all information and ideas will be recorded.

  Does anyone have any additional ideas to contribute to our ground rules?

  At this point discuss ideas for ground rules and add new ones.

Now we will start with the question and answer session. For some of the questions we will be showing you relevant results from the assessment that was recently conducted on CODES/linkage programs. These will be displayed on your computer screen.

<Display slide 6-Attachment F>
We'll start the first section with questions about the agencies involved in your linkage project.

- For our first question, please look at this slide that shows the assessment responses to the question of which agency is responsible for coordinating the linkage project.
  - In thinking about these results, can you share some of the advantages of each of these types of agencies being involved with the coordination of a linkage project?
  - Can you share some of the disadvantages of each of these types of agencies being involved with the coordination of a linkage project?

- If while working on your linkage project you have worked on small-groups or sub-committees outside of your board of directors or advisors
  - Share with us the reasons why these small-groups or sub-committees may have been formed.
  - Share with us some of the successes that your group encountered while working in this type of setting?
  - Share with us some of the barriers that your group encountered while working in this type of setting?

- If while working on your linkage project you have never worked on small-groups or sub-committees outside of your board of directors or advisors, can you share with us the reasons why small-groups or sub-committees may have never been formed?

(Display slide 7-Attachment F)

- Shown on the screen is a list of agencies that we found from our assessment that were most frequently mentioned as being represented on your linkage/CODES Board of Directors or Advisors.
  - Which agencies do you believe are needed to perform
    - the linkage
    - to analyze the results

- How do these agencies uniquely contribute to your efforts in linking the three data sets?

Discussion of question along with probes from the facilitator.

Next we'll talk about funding linkage programs.

<*Display slide 8-Attachment F* >

This slideshows the various sources of funding identified from the assessment.

- Which of these is the primary funding source for your linkage program?

Discussion of question along with probes from the facilitator.

- For each of these agencies, which funding streams, grant titles, or program areas are used to provide funding to your linkage program?

Discussion of question along with probes from the facilitator.

- Where do you plan to obtain funding for your linkage program in the future? (*brainstorm ideas*)

Discussion of question along with probes from the facilitator.

- If you perform analysis of linked data do you establish a means to charge for those products or deliverables?
  - If so, please describe and explain how charges are calculated.
  - Are there different charges based on the nature and type of the requesting agency?

Discussion of question along with probes from the facilitator.

Now we'd like to move on and discuss the organizations who have used your linked data along with the way in which these data were used.

(*Show slide 9-Attachment F*)

This slide shows the percentage of States that interact with various State and regional organizations along with the frequency of data interactions.

- Please describe the types of interactions you have with these organizations .
- The next question is going to be displayed to you on the screen. We would like to ask you to give us some immediate feedback about the types of products that you have created for each of these organizations using your linked data:

(*Show slide 10-Attachment F*)

This slide shows the ways in which States have reported using their linked data.

- Were these linked data used as much as you would have liked for them to have been used? If not, why not?

- How have you promoted the use of your linked data with other potential partners?

Discussion of question along with probes from the facilitator.

(Show slide 11-Attachment F)

This slide shows the proficiency in linking and analyzing data using various software packages that the States reported.

- How were these software packages used in linkage and analysis?

Discussion of question along with probes from the facilitator.

- We'd like to know what is needed to make staff proficient at linkage and analysis.
- What types of experience do you think are needed for an individual to be proficient in linking the data (for example work or training experiences that might contribute)

Discussion of question along with probes from the facilitator.

- What types of experience do you think are needed for an individual to be proficient using the linked data for data analysis (again reflecting on work or training experiences)

Discussion of question along with probes from the facilitator.

(*show slide 12-Attachment F*)

Slide 12 shows the areas of training and technical assistance that States reported receiving.

- If you had training or technical assistance support what aspects did you find were of particular benefit in supporting your linkage or analysis efforts?

Discussion of question along with probes from the facilitator.

- Thinking back over the training and technical assistance support you have received what do you think could have been improved?

Discussion of question along with probes from the facilitator.

Another aspect of linkage systems is obtaining the source data to be used in linkages. We'd like to discuss how that process worked in your State.

(*show slide 13-Attachment F*)

This slide graphically shows the lag times for receiving the top three sources of data – crash, inpatient hospital, emergency department.

- Did you have barriers obtaining source data in your State? If so describe some of the barriers in obtaining

  Discussion of question along with probes from the facilitator.

  *Probe more if this is not shared to examine potential responses:

  What barriers did you encounter due to data confidentiality or data release policies?

  Discussion of question along with probes from the facilitator.

Finally we'd like to finish with a discussion of overall challenges and successes in conducting linkage.

(show slide 14-Attachment F)

This slide shows some of the challenges with linkage identified in the assessment,

- Please share more about these challenges and
- Are there any other challenges that we may not have discussed that you think we should know about?

Discussion of question along with probes from the facilitator.

(show slide 15-Attachment F)

This slide shows some of the challenges with analysis identified in the assessment.

- Please share more about these challenges and
- Are there any other challenges that we may not have discussed that you think we should know about?

Discussion of question along with probes from the facilitator.

- For this next question we would like learn how you have managed questions about the linkage process and data outputs that come from customers who have requested the data. Could you share specific experiences and how you responded?

Discussion of question along with probes from the facilitator.

- Have you found any unexpected benefits from working with the linkage project in your State?

Probe further to explore: data quality, additional variables that could be added, feedback to law enforcement for additional training, enhancing other reporting forms to connect the data more easily

Discussion of question along with probes from the facilitator.

- Does anyone have anything else that they would like to say on any areas that we've covered or any new areas?

Thank you for participating in this focus group.

Attachment D. Bibliography

This bibliography provides a representation of the various types of identified products/outcomes that can be produced from data linkage; it is not meant to be a reference list or an inclusive list of all products produced by State data linkage systems.

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- Shepherd, D. A Comparison of Iowas Crashes Involving Older Drivers Using Linked Data. (Iowa)

2011

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- Singleton, M. CODES nonfatal injury indicator reports for 2009. (Kentucky)
- Nebraska CODES Management report 2005-2011. (Nebraska)
- Center for Injury Research and Policy, the Research Institute at Nationwide Children's Hospital, Motorcycle Injuries in Ohio. (Ohio)

2012

- Center for Injury Research and Policy, the Research Institute at Nationwide Children's Hospital, Injuries Among Older Adults in Ohio. (Ohio)
- The Community Crash Reports have been produced since 1995 using the CODES linked data. The Reports have been used in a variety of Community Education Programs throughout the State, including communities involved in Wisconsin's 'Safe Communities Program'. The reports are produced using the zip code of residence of the occupants of vehicles involved in crashes in as requested by the Wisconsin Department of Transportation. (Wisconsin)

2013

- National Transportation Safety Board. (2013). Crashes involving single-unit trucks that resulted in injuries and deaths. (Publication number NTSH/SS-13/01, PB2013-13-106637). Washington, DC:NTSB. (Multiple States)

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- Motorcycle Helmets and Traffic Safety- Nebraska 1974-2004, 2005. (Nebraska)
- Seatbelts and Teens- Nebraska. (Nebraska)
- Death and Injury Rates and Posted Speed Limit- 1999-2000, 2005. (Nebraska)
- Alcohol Related Crash Costs and Morbidity, Wisconsin. (Wisconsin)
- Seatbelt Use Outcomes, Wisconsin. (Wisconsin)
- Motorcycle Helmet Use and Crash Outcomes, 2003-2005. (Wisconsin)

2006

- Non-Nebraska Drivers Involved in Motor Vehicle Crashes Occurring in Nebraska. 1999-2003, 2006. (Nebraska)
- Motor Vehicle Crashes (MVC): The Leading Cause of Injury Death in Nebraska. 1999-2003, 2006. (Nebraska)
- Alcohol Related Crash Costs and Morbidity. Wisconsin. (Wisconsin)
- Seatbelt Use Outcomes. Wisconsin. (Wisconsin)
- Motorcycle Helmet Use and Crash Outcomes. Wisconsin. (Wisconsin)
- Utah Teenage Distracted Driving Crashes, 2006. (Utah)

2007

- Restraint Use of Pickup Truck Occupants in Nebraska. 2002-2005, 2007. (Nebraska)
- Alcohol Related Crash Costs and Morbidity , Wisconsin, 2007. (Wisconsin)
- Seatbelt Use Outcomes, Wisconsin, 2007. (Wisconsin)
- Motorcycle Helmet Use and Crash Outcomes, Wisconsin, 2007. (Wisconsin)
- Children Involved in Crashes. 2006-2007. (Utah)

2008

- Motor Vehicle Crashes: The Leading Cause of Injury Death in Nebraska. 2002-2006, 2008. (Nebraska)
- Alcohol Impaired Driving in Nebraska. 2005-2007, 2008. (Nebraska)
- Restraint Use in Nebraska. 2007, 2008. (Nebraska)
- Increased risk of injuries for riding in the back seat unrestrained. (New York)
- Alcohol Related Crash Costs and Morbidity , Wisconsin, 2008. (Wisconsin)
- Seatbelt Use Outcomes, Wisconsin, 2008. (Wisconsin)
- Motorcycle Helmet Use and Crash Outcomes, Wisconsin, 2008. (Wisconsin)

2009

- Underage Drinking and Driving Fact Sheet- Nebraska. 2004-2008, 2009. (Nebraska)
- Motorcycle Helmets and Head Injury- Nebraska. 2004-2008, 2009. (Nebraska)
- Illinois Department of Transportation. Car Crash Factsheet. (Illinois)
- Illinois Department of Transportation Teenage Driver Factsheet. (Illinois)
- Illinois Department of Transportation Factsheet –Impaired. (Illinois)
- Illinois Department of Transportation Motorcycle Crash Victims and their Health Care Charges in Illinois, Fact Sheet. (Illinois)
- Injuries and costs of unbuckled occupants during a crash, with a comparison to those buckled up, New York. Targeted toward police and not available for the general public. (New York)
- Increased risk of injuries for riding in the back seat unrestrained, New York. (New York)
- Alcohol Related Crash Costs and Morbidity, Wisconsin, 2009. (Wisconsin)
- Motorcycle Helmet Use and Crash Outcomes, Wisconsin, 2009. (Wisconsin)
- Medical Outcomes of Safety Restraint Compliance on High-Speed Roadways, 2009. (Utah)
- Hospital Characteristics by Safety Restraint Compliance on High-Speed Roadways. 2000-2009. (Utah)

2010

- Motor Vehicle Crash Deaths in Nebraska, 2010. (Nebraska)
- Restraint Use and Crash Outcomes in Nebraska, 2010. (Nebraska),
- Alcohol and Crash Outcomes in Nebraska, 2010. (Nebraska)
- Injury burden for unrestrained passengers for each county in New York and for the whole State. Targeted toward police and not available for the general public. (New York)
- Injury burden for unrestrained children (15 and younger) in the back seat, New York. Targeted toward police and not available for the general public. (New York)

- South Carolina Motorcycle Fact Sheet, 2010. (South Carolina)
- Alcohol Related Crash Costs and Morbidity , Wisconsin, 2010. (Wisconsin)
- Motorcycle Helmet Use and Crash Outcomes, Wisconsin, 2010. (Wisconsin)

2011

- Glare-related Crashes in Nebraska, 2011. (Nebraska)
- Adverse Weather Related Crashes in Nebraska, 2011. (Nebraska)
- Do Not Let Distraction Take Your Life Away, 2011. (Nebraska)

2013

- South Carolina Teen Driving Fact Sheet, 2013. (South Carolina)

Journal Publications (Author Title, Journal, Volume/Issue, Pages, (State that data came from))

2003

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- Hyde, L. K,, Cook, L.J., Olson, L. M., Weiss, H. B., & Dean, J. M. (2003). Effect of motor vehicle crashes on adverse fetal outcomes. *Obstet* and *Gynecol*, 102(2):279–286. (Utah)
- Hutchings, C.B., Knight, S., & Reading, J. C. (2003). The use of generalized estimating equations in the analysis of motor vehicle crash data. *Accident Anal Prev*, 35(1):3−8. (Utah)

2004

- Singleton, M., Qin, H., & Luan, J. (2003). Factors associated with higher levels of injury severity in occupants of motor vehicles that were severely damaged in traffic crashes in Kentucky, 2000-2001. *Traffic InjPrev* (June 2004) (Kentucky)
- Smith, R., Cook, L. J., Olson, L. M., Reading, J. C., & Dean, J. M. (2004). Trends of behavioral risk factors in motor vehicle crashes in Utah, 1992-1997. *Accident Anal Prev*, 36(2):249–255. (Utah)
- Vernon, D. D., Cook, L. J., Peterson, K. J., & Dean, J. M. (2004) Effect of repeal of the national maximum speed limit law on occurrence of crashes, injury crashes, and fatal crashes on Utah highways. *Accident Anal Prev*, 36(2):223–229. (Utah)
- Knight, S., Cook, L. J., & Olson, L. M. (2004) The fast and the fatal: street racing fatal crashes in the United States. *Inj Prev*, 10(1):53–55. (Utah)

2005

- Dhungana, P., & Qu, M. (2005). The risks of driving on roadways with 50 miles per hour posted speed limit. *J Safety Res*-Traffic Records Forum proceedings. 36 501–504. (Nebraska)
- Zhu, M., Hardman, S., & Cook, L. (2005). Backseat safety belt use and crash otcome." J Safety Res – Traffic Records Forum Proceedings. (New York)
- Durkin, M., McElroy, J., Guan, H., Bigelow, W., & Brazelton, T. (2005). Geographic analysis of traffic injury in Wisconsin: Impact on case fatality of distance to level I/II trauma care. *Wisc Med* J, 104:(2). (Wisconsin)
- Sauter, C., Zhu, S., Allen, S., Hargarten, S., & Layde, P. M. (2005) Increased risk of death or disability in unhelmeted Wisconsin motorcyclists. *Wisc Med J*, 104(2):39–44., 2005. (Wisconsin) Hyde, L. K., Cook, L. J., Knight, S., & Olson, L. M. (2005). Graduated driver licensing in Utah: is it effective? *Ann Emerg Med*, 45(2):147–154. (Utah)
- Mann, N. C., Knight, S., Olson, L. M., & Cook, L. J. (2005). Underestimating injury mortality using statewide databases. *J Trauma*, 58(1):162–167. (Utah)
- Zhu, M., Hardman, S. B., & Cook, .L. J. (2005). Backseat safety belt use and crash outcome. *J Safety Res*, 36(5):505–507. (Utah)
- Cook, L. J., Knight, S., & Olson, L. M. (2005). A comparison of aggressive and DUI crashes J Safety Res, 36(5):491–493. (Utah)

- Soderstrom, C.A., Dischinger, P. C., Kufera, J. A., Ho, S. M., Shepard, A. (2005). Crash culpability relative to age and sex for injured drivers using alcohol, marijuana or cocaine. Annual Proceedings/Association for the Advancement of Automotive Medicine. pp. 327–341, 2005. (Maryland)

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- Allen, S., Zhu, S., Sauter, C., Layde, P., Hargarten, S. A comprehensive statewide analysis of seatbelt non-use with injury and hospital admissions: new data, old problem. *Acad Emerg Med*. 2006 Apr;13(4):427–34. Epub 2006 Mar 10. (Wisconsin)
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2009

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- Wang, M. C., Pintar, F., Yoganandan, N., & Maiman, D. J. (2009). The continued burden of spine fractures after motor vehicle crashes. *J Neuro*. 10(2):86–92. (Wisconsin)
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- Conner, K. A., Xiang, H., & Smith, G. A. (2010). The impact of a standard enforcement safety belt law on fatalities and hospital charges in Ohio. *J Safety Res*, 41(1):17–23. (Ohio)
- Olsen, C. S., Cook, L. J., Keenan, H. T., & Olson, L. M. (2010). Driver seat belt use indicates decreased risk for child passengers in a motor vehicle crash. *Accident Anal Prev*, 42(2):771–777. (Utah)

2011

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- Thomas, A. M., Cook, L. J., & Olson, L. M. (2011). Evaluation of the Click It or Ticket intervention in Utah. Accident AnalPrev, 43(1):272–275. (Utah)
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- Nordstrom, D. L., Yokoi-Shelton, M. .L, & Zosel, A. (2012) . Using Multiple Cause-of-Death Data to Improve Surveillance of Drug-Related Mortality. *J Public Health Management and Practice*. 19(5):402-11. (Wisconsin)
- Thomas, A. M., Thygerson, S. M., Merrill, R. M., & Cook, L. J. (2012). Identifying work-related motor vehicle crashes in multiple databases. *Traffic InjPrev*, 13(4):348–354. (Utah)
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- Burch, C., Cook, L., & Dischinger, P. (2014). A comparison of KABCO and AIS Injury severity metrics using CODES linked data. *Traffic Inj Prev* 15(6):627-30. (Maryland and Utah)
- Zhang, Y., & Lin, G. (2013). Disparity surveillance of nonfatal motor vehicle crash injuries. *Traffic Inj Prev*14(7):697–702. (Nebraska)

Data supplied to answer requests

2008

- Booster seat required for children aged 5-7 years. Provided statistics to traffic safety groups and legislators. Spoke to legislators about statistics. Bill passed. (2002-2007 activity) (Utah)
- Graduated Driver Licensing law repeal. Provided statistics to traffic safety groups and legislators. Presented to legislators. Bill defeated. (Utah)

2009

- Texting while driving. Provided statistics to traffic safety groups and legislators. Spoke to legislators about statistics. Bill passed. (Utah)
- Safety belt enforcement of commercial vehicle occupants. Provided statistics to traffic safety groups and legislators. Bill amended to include all work-related occupants. Bill defeated. (Utah)

2010

- Cell phone ban for teen drivers. Provided factsheets to traffic safety groups, legislators, and American Academy of Pediatrics. Spoke to legislators about factsheets at educational session. Bill passed. (Utah)
- Booster seat law repeal. Provided factsheets showing protective impact of booster seats to traffic safety groups and legislators. Bill defeated. (Utah)

2011

- Booster seat law repeal (second attempt) Provided factsheets showing protective impact of booster seats to traffic safety groups and legislators. Bill defeated. (Utah)

2012

- Safety belt enforcement on high-speed roadways. Provided factsheets to Utah Highway Patrol and Utah legislators. Spoke at legislative interim session. Bill brought to 2013 legislative session. (Utah)

2013

- Safety belt enforcement on high-speed roadways. Provided factsheets to Utah Highway Patrol and (Utah) legislators. Invited to speak at legislative committee session. Bill defeated. (Utah)

No Year Available

- Data on the effects of child safety seats were provided to a hospital administrator for sharing with a State legislator pursuant to a bill requiring safety seats for children 4-8. (Missouri)
- An overview of CODES data was given to MODOT analysts. As a result, they requested a crosstab table comparing the KABCO scale to CODES injury data. A similar table was sent to Robert Pollack at DOT for a presentation on the value of CODES data. (Missouri)
- Data on injuries to children involved in bus crashes was summarized to the Missouri Governors School Bus Safety Task Force. (Missouri)
- An overview of CODES data was presented at a planning meeting of the Missouri Trauma System Evaluation and Planning Committee. (Missouri)
- Data on safety belt use and degree of injury were provided to MODOT for presentation to district engineers. (Missouri)
- Data was supplied for: “The New York City (NYC) Pedestrian Safety and Action Plan: Technical Supplement”, published on the NYC Department of Transportation Website, August 2010. (New York)
- Motorcycle injury cost data and injury prevention program information were provided to the GTSC in response to a request from the US Government Accountability Office (GAO) (New York)
- 2012 Charleston county charges and cost data request. (South Carolina)
- Request on Children in South Carolina in motor vehicle injuries using 2006-2008 CODES data. (South Carolina)

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