ACUTE CARE RESEARCH UNIT
UNIVERSITY OF MICHIGAN

QUALITY MEASUREMENT OF MEDICAL CONTROL AUTHORITIES

A Mixed-Methods Study to Inform Quality Measures for Medical Control Authority Structure and Performance

Prepared for the State of Michigan Department of Health and Human Services; Bureau of EMS, Trauma, & Preparedness; Division of EMS and Trauma

By the Acute Care Research Unit of the University of Michigan

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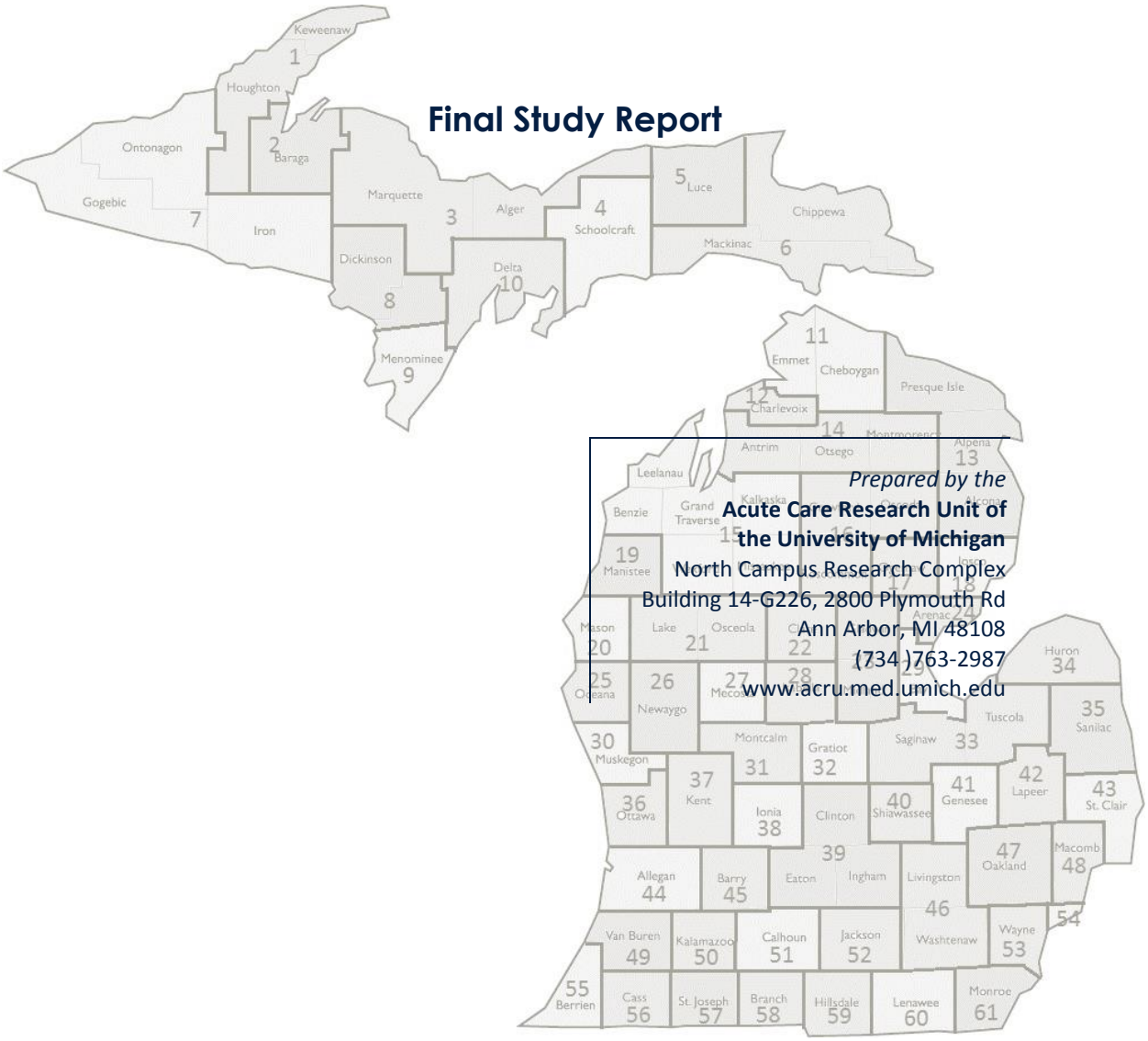

Final Study Report

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MDHHS Michigan Department of Health and Human Services

Preface

The need for emergency medical services (EMS) information systems and databases was recognized as early as the 1970s.[1] But it was not until 2002 that the National Highway Traffic Safety Administration (NHTSA) and the Health Resources and Services Administration (HRSA) sponsored a forum leading to the EMS Performance Measures Project that ultimately identified 35 indicators for EMS systems in 2009.[2] These indicators, or quality measures, served as the basis of the National EMS Information System (NEMSIS)—a national repository with the goal of storing EMS data from every state in the nation.[3] Since then, there have been renewed calls to create a broader set of evidence-based measures as well as a system for maintaining and updating those measures. Such calls led to the NHTSA-funded EMS Compass Initiative led by the National Association of State EMS Officials (NASEMSO).[4] The goal of EMS Compass is to create a process for the continual design, testing, evaluation, and refinement of performance measures relevant to EMS agencies, regulators, and patients. EMS Compass performance measures will be based on the latest National EMS Information System (NEMSIS) compliant data points to allow local and state EMS agencies to meaningfully improve care.

In Michigan, an assessment of EMS was conducted by NHTSA in 2007. NHTSA recommendations based on this assessment included continued implementation of NEMSIS-Gold compliant, statewide EMS Information System (MI-EMSIS), and a requirement from the state for hospitals participating in MCAs to provide outcomes data to the MCA and the state.[5] In 2012, the MCA evaluation tool was administered by the Michigan Department of Health and Human Services (MDHHS) in order to assess the strengths and challenges of Michigan MCAs.[6] This tool evaluated MCA designation and organization, medical directorship, granting of medical control (due process), protocol development, quality improvement, pharmacy, communications systems, and participation in related community activities. Even so, at both the national and state levels, there are persisting knowledge gaps regarding evidence-based quality measures for MCA structure and performance, and the identification of community/region-specific EMS quality measures that are informed by local needs and challenges.

The goal of this project is to fill these gaps and help inform policy related to MCA structure and performance measures that most closely correlate with successful MCAs.

Acknowledgments

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Foremost, we thank Ms. Kathy Wahl, Dr. Jacqueline Scott, and colleagues at the Michigan Department of Health and Human Services Bureau of EMS, Trauma, & Preparedness, for enthusiastically promoting the value of stakeholder input and the importance of local and regional context in the delivery of pre-hospital care.

We also want to thank our colleagues, Jane Forman from the VA Center for Clinical Management Research for mixed-methodology expertise; Margaret Chamberlin and Rosalie Malsberger from the RAND Corporation, Jason Goldstick and Anthony Provenzano from the University of Michigan for data analysis and research support; Ruth Gretzinger from the University of Michigan for proofreading and copyediting; and the librarians of the University of Michigan and the RAND Corporation for environmental scan support.

Finally, we must acknowledge the very significant contributions provided by all the dedicated EMS and MCA stakeholders across the state, without whose practical experience providing essential care to Michiganders this project would not have been possible.

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Abbreviations

ACLS – Advanced Cardiac Life Support
ALS – Advanced Life Support
AMI – Acute Myocardial Infarction
ATLS – Advanced Trauma Life Support
BLS – Basic Life Support
CMS – Centers for Medicare and Medicaid Services
CQI – Continuous Quality Improvement
DBP – Diastolic Blood Pressure
EMS – Emergency Medical Services
EMSCC – EMS Coordination Committee
EMT – Emergency Medical Technician
MCA – Medical Control Authority
MFR – Medical First Responder
MDHHS – Michigan Department of Health and Human Services
MFR – Medical First Responder
MI – Michigan
MI-EMSIS – Michigan EMS Information System
NAM – National Academy of Medicine
NAESEMO – National Association of State EMS Officials
NEMSIS – National EMS Information System
NHTSA – National Highway Traffic Safety Administration
PSRO – Professional Standards Review Organization
SBP – Systolic Blood Pressure
SVMCA – Saginaw Valley MCA
STEMI – ST-Elevation Myocardial Infarction
IOM – Institutes of Medicine
QI – Quality Improvement
QA – Quality Assurance

Executive Summary

In 2015, the Institute of Medicine (IOM) cited persistent knowledge gaps regarding best practices in quality measurement and data reporting for Emergency Medical Services (EMS) oversight, which includes Medical Control Authorities (MCAs).[1] The IOM recommended understanding what roles the federal government, states, and local communities play in the oversight and evaluation of EMS system quality and how they may better work together to improve care. This project helps fill this knowledge gap and informs structure and performance quality measures for MCAs and related state policy through triangulating data from the following three study phases:

Phase 1: Environmental Scan

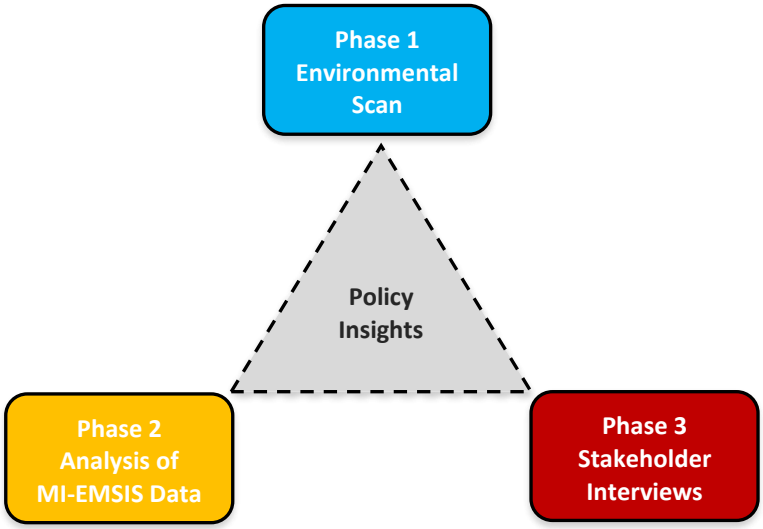
A systematic review of peer-reviewed and grey literature to evaluate existing quality measures of EMS oversight.

Phase 2: Analysis of MI-EMSIS Data

Quantitative descriptive analysis of the level of missingness of reported variables in the Michigan EMS Information System (MI-EMSIS).

Phase 3: Stakeholder Interviews

Qualitative analysis of focus groups and key informant interviews with EMS stakeholders representing diversity in performance, community setting, geographic region, and professional roles.



Summary of Findings

Preexisting literature and our own investigations with MCA stakeholders suggest that most quality measurement occurs at the EMS personnel level, so the quality of MCA oversight has been much less of a focus. The quality of data-reporting in MI-EMSIS is also an area of concern raised not just by MCA leadership but also by EMS agency staff and the reviewed literature regarding EMS quality measurement. In our analysis of missingness of reported variables in MI-EMSIS, we found it to vary significantly by software platform, agency, and MCA. These trends do not appear to be improving at the aggregated level. Stakeholders often reported that this missingness may be partly attributed to data-mapping issues, uncertainty regarding variable definitions, and unfamiliarity with reporting procedures. Data from the

three phases of the study were triangulated suggesting that high-quality EMS oversight occurs through the following seven areas: organizational structure, leadership, relationships & communication, resources, competition & collaboration, community specific factors, and quality improvement culture & practice. Nested within these areas are practices and characteristics that should be developed into validated best practices for effective operation, quality measurement, and improvement of MCAs.

Summary of Recommendations

MCAs must be deliberate in their structures and processes in the context of the seven identified areas. Doing so can support the standardization and coordination of care, develop positive quality improvement cultures, and promote higher-quality EMS delivery. We offer the following recommendations to MDHHS:

Recommendation 1: Promote an MCA organizational structure that includes both an administrative director and medical director.

Recommendation 2: Encourage MCA boards to include representation from all key stakeholders.

Recommendation 3: Identify and promote strategies to help MCAs retain staff and promote the development of training materials for replacement staff to mitigate the effects of turnover.

Recommendation 4: Advocate for MCA leadership to have demonstrated ability and/or actively develop key leadership traits: Informed and engaged leadership that is collaborative, open to different perspectives, and able to balance multiple priorities effectively.

Recommendation 5: Promote cross-MCA medical directorship in regions with limited number of expert individuals.

Recommendation 6: Promote regional MCA conferences for MCA leaders to coordinate and collaborate, especially in regions where such conferences are currently not held.

Recommendation 7: Promote MCA protocols that are agency type neutral and that can be applied in a fair and even manner across agencies.

Recommendation 8: Advocate for MCAs to further develop their relationships with EMS training programs across the state and promote partnerships between these educational institutions and the state's EMS agencies and professional organizations.

Recommendation 9:	Develop an MCA Self-Assessment Toolkit with specific structure and performance measures and suggested best practices.
Recommendation 10:	Reformat and build upon 2011 MDHHS Evaluation of Michigan MCAs as an electronic survey of core statutorily required elements of MCAs and additional best practices related to the facilitators and barriers found in this report.
Recommendation 11:	Develop regional EMS quality improvement programs that assess and evaluate EMS care, including a review of system component processes and outcomes.
Recommendation 12:	Develop and disseminate an MCA Guidebook with actionable insights for successful MCA strategies and operations.
Recommendation 13:	Develop MI-EMSIS data entry and reporting protocol, including uniform pre-hospital data element definitions, to increase reporting and reduce variation in completeness.
Recommendation 14:	Incorporate MCA ID and Trauma Region ID for all incidents in MI-EMSIS so that MCA level analyses can be run and used by MCA as a quality improvement tool.
Recommendation 15:	Promote and lower barriers to pre-hospital care quality improvement and innovation by making MI-EMSIS data available for public use.
Recommendation 16:	Consider promoting the use of data reporting software known to data-map properly with MI-EMSIS.
Recommendation 17:	MDHHS should collaborate with MCA and EMS agency stakeholders to investigate and resolve sources of data-incompleteness and data-mapping.
Recommendation 18:	Explore methods of providing adequate and consistent MCA funding through agencies, hospitals, foundations, and private industry.
Recommendation 19:	Promote consistency of protocols across regions while allowing for differences in protocols based on local needs and challenges.
Recommendation 20:	Institute a statewide drug box with regional differences based on need.

These recommendations are based on the triangulation of a systematic environmental scan, MCA stakeholder input, and an analysis of reported variables in MI-EMSIS. They reflect demonstrated needs in EMS oversight and lay the groundwork for the quality measurement and improvement of MCA structure and performance. Ultimately, MCA leadership are there to ensure EMS agencies provide quality care, provide them motivation to excel, and remain dedicated to improving pre-hospital care. Through collaboration from key stakeholders in pre-hospital care, MCAs can serve as the nexus for engaging local, state, and federal stakeholders, EMS agencies, hospitals, and fire and police departments to improve the treatment of commonly encountered conditions in the pre-hospital setting. This vision requires enhanced transparency, accountability, and collaboration between these organizations. Through the stakeholder input received, we recognize that the state of Michigan, its EMS agencies, and its MCAs already recognize and strive to practice in this spirit. We hope that our recommendations bolster where this already occurs and sets in place deliberate plans where it is needed.

Introduction to Emergency Medical Services

Emergency Medical Services (EMS) is often described as the intersection between public health, public safety, and healthcare.[7] According to the 2011 National EMS Assessment, there were more than 31 million EMS responses and close to 23 million EMS transports in the United States (U.S.) (excluding LA, IL, MI, OH, OR, and RI).[8]

Despite the importance and ubiquity of pre-hospital EMS care, EMS providers and the systems they operate in differ greatly depending on their geographic location, financial resources, and municipal and healthcare infrastructure; as such, the types of EMS systems are often suggested to be as numerous as the systems themselves.[9] Even so, these systems are ultimately a combination of various providers and facilities that come together to provide three basic medical functions: stabilization, evacuation, and distribution of patients. [10]

TYPES OF EMS PROVIDERS

Although the organizational structures and resources of EMS providers and systems vary, the fundamental components and purposes of any EMS system are essentially the same, allowing for the application of general quality measures. The different types of systems in the U.S. are listed in Table 1. The more common types of systems are described in the following sections.

Table 1. Types of Systems in the U.S.[11]

Fire Department with Cross-Trained EMS Personnel	40%
Private Company	18%
Government or Third Service	14.5%
Fire Department with Separate EMS Personnel	9%
Other	8%
Public Utility Model	2%
Police Department with Separate EMS Personnel	2%
Police Department with Cross-trained EMS Personnel	0.5%

VOLUNTEER

Volunteerism provides a significant source of EMS personnel in primarily suburban and rural communities. Challenges include recruitment and retention, limited funding streams, and assembling highly qualified staff able to meet the demand for services during peak times. Most agencies provide only 9-1-1 services and can rarely offer interfacility or scheduled service. Many volunteer agencies have moved to supplemental paid staffing to meet call demand.

FIRE-BASED

The number of fire-based EMS systems continues to increase and there may be some benefits seen in optimizing the first response and transport roles when organized in such a structure. Funded primarily by local government, many fire departments are also able to bill for services (depending on state or local law). Similar to volunteer systems, fire-based EMS often provides only 9-1-1 service and rarely provides interfacility or scheduled service.

HOSPITAL-BASED

Despite being early providers of EMS in the U.S., hospital-based emergency services are not nearly as common as they were in the past. Some of these systems provide only interfacility transports; others also provide 9-1-1 service. Similar to fire-based EMS, legislative and/or regulatory restrictions in some states either foster or discourage hospital-based EMS systems.

PRIVATE

Private EMS companies, whether for-profit or not-for-profit, often operate under contract with municipalities to provide 9-1-1 services. These often provide interfacility and non-emergency transport services, while first response is typically delegated to the fire department. Private companies fund their services by billing the patient or third party. In some cases, agencies may receive subsidies or pay franchise fees to the municipality for service rights.

THIRD SERVICE

When EMS is provided by a governmental department or authority, as are law-enforcement and fire services, it is referred to as a *third service model*. There are multiple variations based on the deployment model. Funding includes tax subsidies, billing for service, and combinations of the two. These are able to provide first-response capabilities, and generally provide interfacility transports.

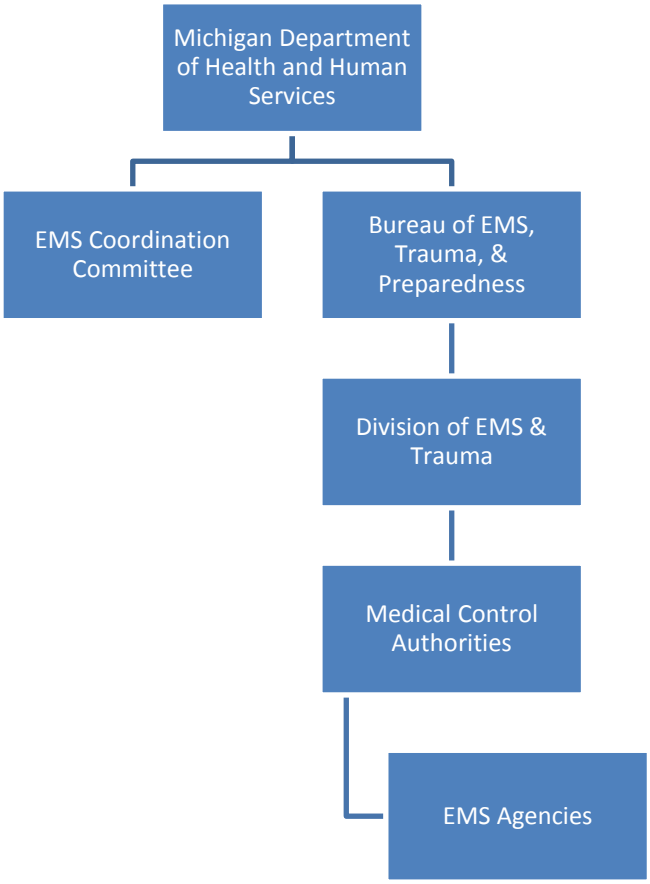
PUBLIC UTILITY AND FRANCHISE

In this model, an EMS agency or authority is overseen by a board of directors and, usually, independent medical oversight. This group establishes the expectations of service delivery, from response time to clinical performance, and then contracts with a private company. In the *public utility model*, the agency or authority owns all assets, determines billing rates and collects revenue, and pays the contractor a set fee. The contractor is then responsible for managing the system to meet the performance standards for the lowest cost in order to realize a profit. The *franchise model* allows the contractor to collect revenue, but the agency or authority has specific controls over the contractor's assets.

Overview of Michigan EMS Oversight

Michigan EMS providers operate under policies set forth by MCAs that are designated by the Michigan Department of Health and Human Services (MDHHS). [12]

Figure 1. Michigan EMS Organizational Structure



EMS COORDINATION COMMITTEE

The Emergency Medical Services Coordination Committee (EMSCC) was originally created by statute under the Michigan Department of Consumer and Industry Services. It has since been transferred over to MDHHS. [12]

The director of MDHHS appoints the voting members of this committee, who in turn advise the department and the Michigan legislature on EMS matters. [12]

The committee comprises the following voting members:

- Four representatives from the Michigan Health and Hospital Association.
- Four representatives from the Michigan chapter of the American College of Emergency Physicians.
- Three representatives from the Michigan Association of Ambulances Services.
- Three representatives from the Michigan Fire Chiefs Association.
- Two representatives from the society of Michigan Emergency Medical Services Technician Instructor-Coordinators.
- Two representatives from the Michigan Association of Emergency Medical Technicians.
- One representative from the Michigan Association of Air Medical Services.
- One representative from the Michigan Association of Emergency Medical Services Systems.
- Three representatives from a statewide organization representing labor involving EMS.
- One consumer.
- One individual who is an elected official of a city, village, or township located within a county that has a population of no more than 100,000.

In addition to the voting members described above, the committee also includes the following non-voting members:

- One representative of the Office of Health and Medical Affairs of the Department of Management and Budget, appointed by the director.
- One representative of the Department of Health and Human Services, appointed by the director.
- One member of the House of Representatives, appointed by the Speaker of the House of Representatives.
- One member of the Senate, appointed by the Senate majority leader.

The committee is responsible for:

- Providing coordination and exchange of information on EMS programs and services.
- Acting as liaison between organizations and individuals involved in EMS.
- Making recommendations in the development of EMS in Michigan.
- Advising the state legislature and the department on matters concerning EMS.
- Providing the department with advisory recommendations regarding local MCA appeals.
- Participating in educational activities, studies, and evaluations of EMS as requested.
- Advising the department concerning vehicle standards for ambulances.
- Advising the department concerning minimum patient care equipment lists.

MEDICAL CONTROL AUTHORITIES

A Medical Control Authority (MCA) is an organization designated by MDHHS for the purpose of supervising and coordinating an EMS system, as prescribed, adopted, and enforced through department-approved protocols for a particular geographic region. [12] MCAs are responsible for:

- The supervision and coordination of their local EMS system.
- Adopting an organizational structure of their choice that includes an advisory body.
- Appointing a medical director who is board-certified in emergency medicine or who practices emergency medicine and is current in Advanced Cardiac Life Support (ACLS) and Advanced Trauma Life Support (ATLS).
- Establishing written protocols for the practice of life support agencies and EMS personnel.
- Circulating draft protocols to all significantly affected persons for review and submitting to the department for approval.
- Ensuring physicians, hospital staff, and providers are educated on protocols.
- Establishing a quality improvement program.
- Adhering to protocol.

Michigan's 61 MCAs are mapped **(Figure 2)** and listed **(Table 2)** on the following page.

Figure 2 Map of Michigan EMS Medical Control Authorities

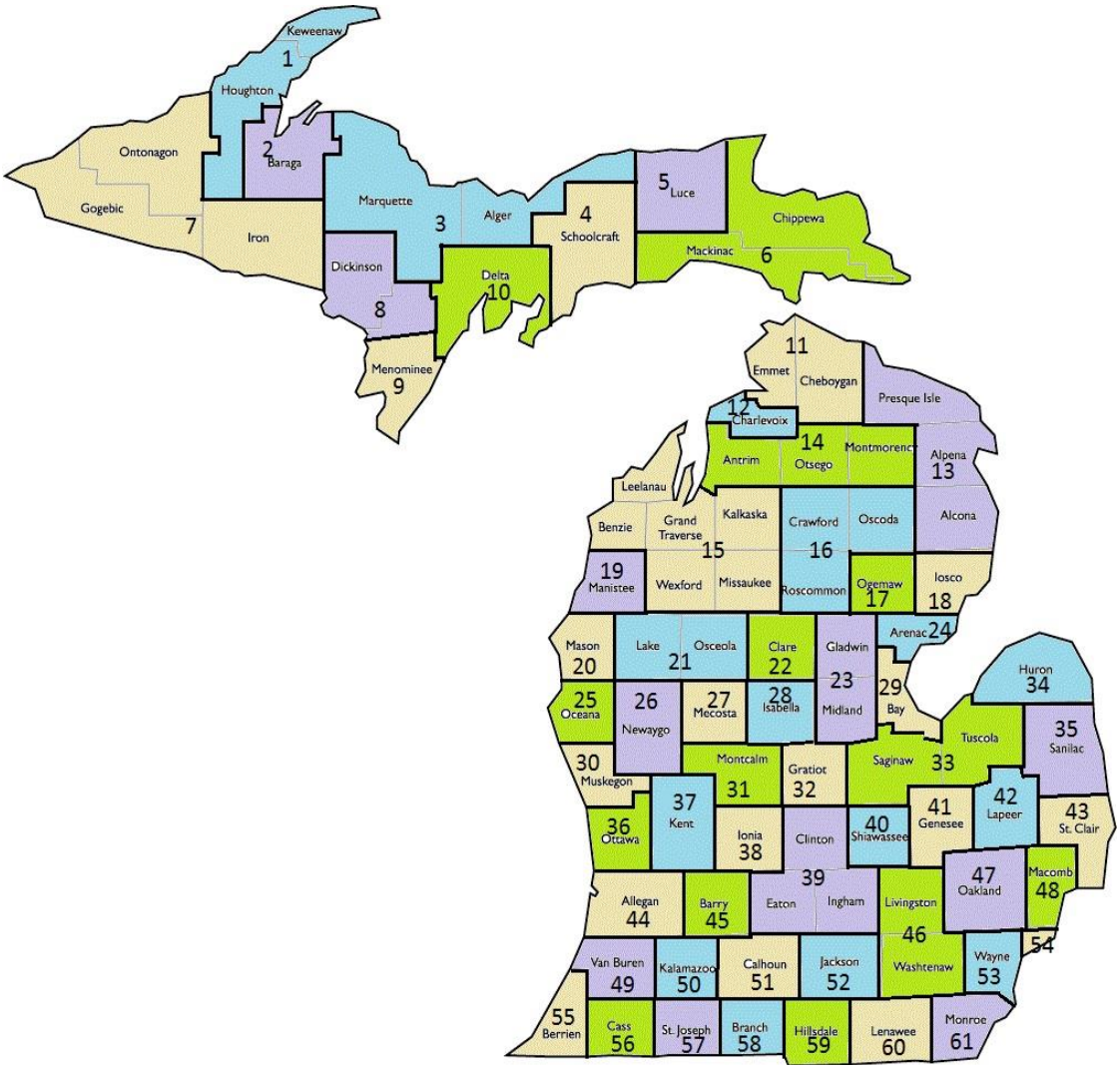


Table 2. Michigan EMS Medical Control Authorities

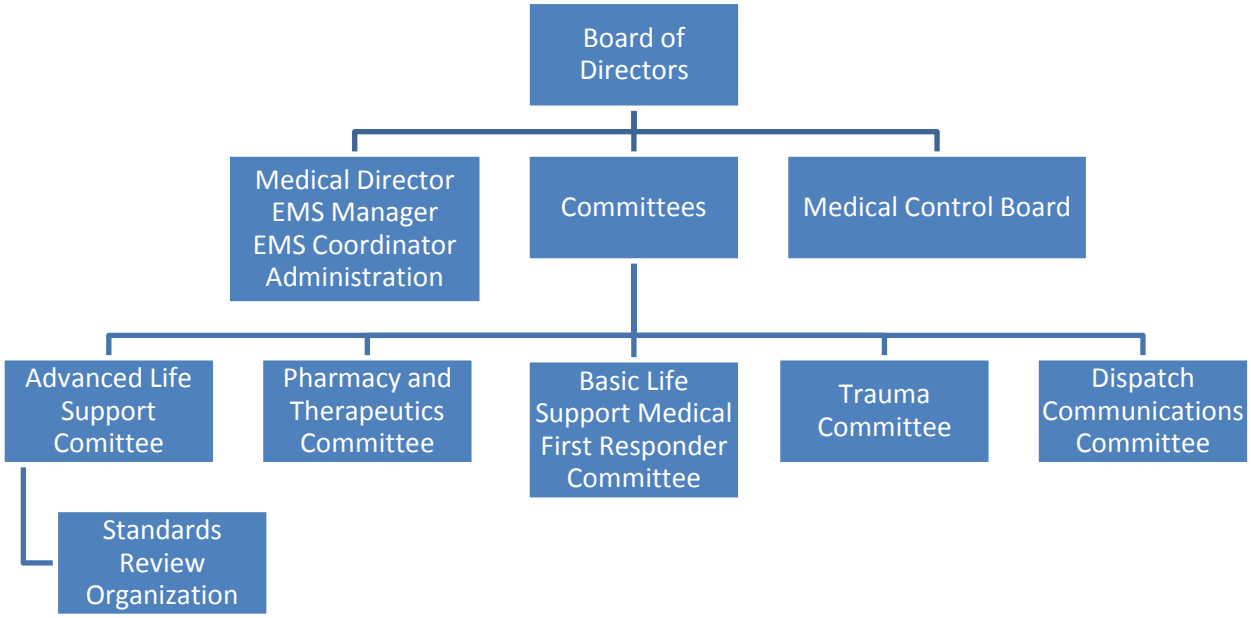
1. Keweenaw, Houghton	11. Northern Michigan	21. Lakola	31. Montcalm	41. Genesee	51. Calhoun
2. Baraga	12. Charlevoix	22. Clare	32. Gratiot	42. Lapeer	52. Jackson
3. Marquette, Alger	13. North East Michigan	23. Midland, Gladwin	33. Saginaw Valley	43. St. Clair	53. Wayne
4. Schoolcraft	14. Otsego	24. Arenac	34. Huron	44. Allegan	54. Detroit East
5. Luce	15. North West Regional	25. Oceana	35. Sanilac	45. Barry	55. Berrien
6. Eastern UP	16 North Central	26. Newaygo	36. Ottawa	46. Washtenaw, Livingston	56. Cass
7. Ontonagon, Gogebic, Iron	17. Ogemaw	27. Mecosta	37. Kent	47. Oakland	57. St. Joseph
8. Dickinson	18. Iosco	28. Isabella	38. Ionia	48. Macomb	58. Branch
9. Bay Area	19. Manistee	29. Bay County	39. Tri-County	49. Van Buren	59. Hillsdale
10. Delta	20. Mason	30. Muskegon	40. Shiawassee	50. Kalamazoo	60. Lenawee 61. Monroe

EXAMPLE MCA STRUCTURE – SAGINAW VALLEY MEDICAL CONTROL AUTHORITY

The Saginaw Valley MCA (SVMCA) is composed of close to 800 staff across 27 separate agencies and serves nearly 100,000 residents of Saginaw and Tuscola counties. The MCA is made up of the following member-hospitals: Covenant Healthcare, St. Mary's of Michigan, Caro Community Hospital, and Hills & Dale General Hospital. Each member hospital provides funding for the MCA and appoints one member to the board of directors.[13]

The SVMCA has the following **(Figure 3)** organizational structure and components:

Figure 3. Saginaw Valley MCA Organizational Structure [13]



MCA BOARD OF DIRECTORS

Each MCA member hospital that provides funding for the SVMCA appoints one member to the Board of Directors of the Authority. There are always as many directors as there are members of the MCA. Hence, with four area hospitals contributing to SVMCA funding, there are currently four members on the Board of Directors. This group meets at least annually to discuss and approve the overall direction of the SVMCA. They act on the recommendations of the Medical Director and the Medical Control Board.[13]

MEDICAL CONTROL BOARD

The Board of Directors of the MCA appoints a Medical Control Board. The Medical Control Board acts as an advisory body in order to assure medical accountability within the EMS system. All minimum standards of medical care, protocols, and operating procedures established within the EMS system must be approved by the Medical Control Board prior to going into effect.[13] The board is composed of:

- Two designated representatives of each hospital member of SVMCA.
- A representative from each type of Life Support Agency in the EMS system.
- The chairman of each standing committee of the Medical Control Board.
- The director of Saginaw and Tuscola Central Dispatch or his/her designee.
- A designated representative from each type or category of emergency medical services personnel functioning within the EMS system.

ADVANCED LIFE SUPPORT COMMITTEE & PROFESSIONAL STANDARDS REVIEW

This committee deals with consumer and provider complaints, incident reports, review of actions initiated by the medical director, and dispensation of discipline on Advanced Life Support (ALS) agencies and ALS personnel. The ALS Committee is composed of the Medical Director and representatives from the ALS agencies along with other representatives from the pre-hospital community. [13]

BASIC LIFE SUPPORT / MEDICAL FIRST RESPONDER COMMITTEE

This committee is similar to the ALS Committee. Every BLS/Medical First Responder (MFR) agency within the SVMCA has representation on this committee, which often acts a liaison between the MCA and its agencies. This group also provides input on new protocols and policies along with a field perspective of how the system is working. [13]

PROFESSIONAL STANDARDS REVIEW ORGANIZATION SUBCOMMITTEE (PSRO)

This subcommittee provides the routine audit of patient treatment compliance and other activities prescribed by the Medical Control Board. The PSRO is charged with ensuring that all treatment is in accordance with current protocols and guidelines. [13]

PHARMACY AND THERAPEUTICS COMMITTEE

This committee is made up of a pharmacist from each participating hospital in the EMS system and deals with matters pertaining to the development and use of standardized pharmaceutical protocols and the content and exchange of drug boxes between participating hospitals and pre-hospital provider agencies.

TRAUMA COMMITTEE

This committee, which comprises local surgeons and hospital officials, is charged with development and implementation of trauma guidelines for the SVMCA and its providers.

DISPATCH COMMUNICATIONS COMMITTEE

This committee is composed of stakeholders who ensure that the pre-arrival phase of EMS care is consistent and timely. Dispatch protocols, communications, and interoperability between multiple agencies are just some of the topics this committee handles.

Project Overview

To develop evidence based policy insights and recommendations this study used a mixed methods approach **(Figure 4)** that triangulated evidence from the following three phases:

Phase 1: Environmental Scan

The environmental scan included a review of the grey and peer-reviewed literature regarding existing quality measures related to MCA/EMS structure and performance in the U.S. Other reviewed documents included the 2007 NHTSA reassessment of Michigan EMS; the MDHHS MCA Evaluation Tool; the 2015 Institute of Medicine Report, *Strategies to Improve Cardiac Arrest: A Time to Act;* and variables in NEMSIS and EMS Compass. These documents were included based on content-expert recommendation. The environmental scan was conducted with a particular eye for identifying quality measures that correlate with successful EMS oversight and achieving improved patient outcomes in the pre-hospital setting.

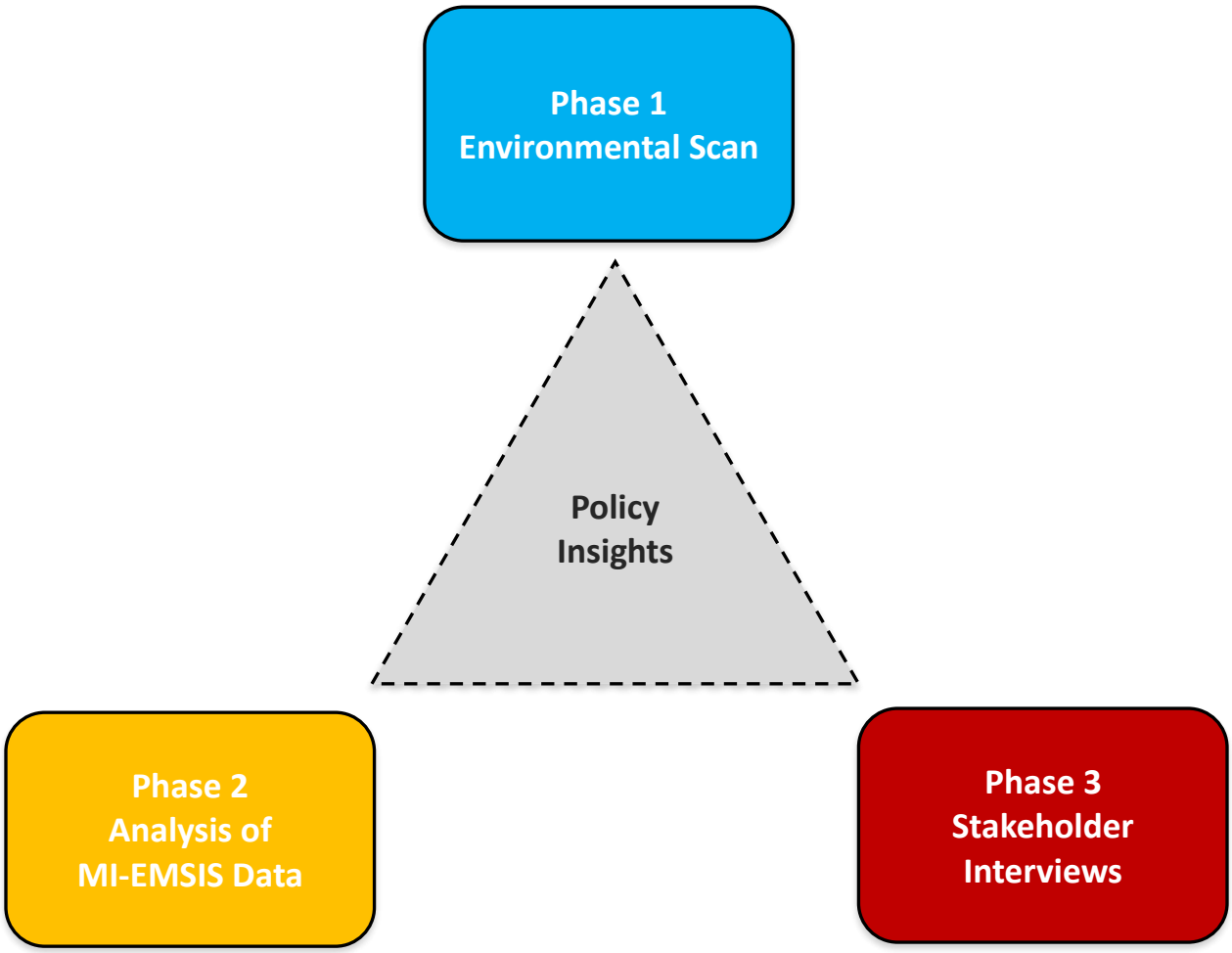
Phase 2: Analysis of MI-EMSIS Data

MI-EMSIS data for the years 2010–2015 were analyzed with the goal of: 1) determining trends of missingness for key reported variables over the years (2010–2015) of the dataset at the incident level; 2) Identifying variation in missingness of key reported variables at the MCA level for the most recent year of data (2015); 3) identifying variation in missingness of key reported variables by data reporting software for the most recent year of data (2015); 4) determining variation in missingness at the agency level for the most recent year of data (2015); and 5) identifying variables that may be more consistently missing across the data years for all localities.

Phase 3: Stakeholder Interviews

Through information gleaned from the environmental scan (Phase 1) and analysis of MI-EMSIS (Phase 2) we developed guides for focus groups and key informant interviews to be conducted with key stakeholders in Michigan, including emergency medical technicians (EMTs), MCA leadership, hospital administrators and leadership, emergency room directors, EMS agency leadership staff, and others. We conducted four focus groups of 5 to 13 participants each, and 10 key informant interviews. The recruitment strategy for focus group and one-on-one interview participants and the composition of focus groups was decided on with input from MDHHS partners and in a manner that had representation from an array of MCAs across the state. The goal of these focus groups and one-on-one interviews were to: 1) Determine the facilitators and barriers of successful EMS oversight to inform MCA structure and performance quality; 2) identify quality measures that may be important to MCAs in specific localities (e.g. Upper Peninsula vs. metropolitan areas); and 3) identify challenges to more reliable and valid data collection and reporting through MI-EMSIS.

Figure 4. Study Approach: to develop evidence based policy insights and recommendations this study used a mixed methods approach that triangulated evidence from an environmental scan (Phase 1), an analysis of MI-EMSIS data (Phase 2), and Stakeholder interviews (Phase 3).



Environmental Scan

The environmental scan included a review of the grey and peer-reviewed literature regarding existing quality measures related to MCA/EMS structure and performance in the U.S. Other reviewed documents included the 2007 NHTSA reassessment of Michigan EMS; the MDHHS MCA Evaluation Tool; the 2015 Institute of Medicine Report, Strategies to Improve Cardiac Arrest: A Time to Act; and variables in NEMSIS and EMS Compass. These documents were included based on content-expert recommendation. The environmental scan was conducted with a particular eye for identifying quality measures that correlate with successful EMS oversight and achieving improved patient outcomes in the pre-hospital setting

BACKGROUND

The Centers for Medicare and Medicaid (CMS) define quality measures as *"tools that help us measure or quantify healthcare processes, outcomes, patient perceptions, and organizational structure and/or systems that are associated with the ability to provide high-quality health care and/or that relate to one or more quality goals for health care.*[14] The review and compiling of existing EMS quality measures is an essential step in identifying and filling gaps in our understanding of what constitutes high quality EMS and EMS oversight. In a 2009 report, NHTSA recommended indicators of system performance through the following service functions and community attributes: system design and structure, human resources, clinical care and outcome, response, finance/funding, quality management, and community demographics. [15] While considering EMS in terms of service functions is essential, we contend that understanding the concepts of EMS oversight and care provision is also critical to identifying gaps in quality measurement.

For pre-hospital care, quality measures are applied to multiple overlapping components of the EMS system **(Table 3)**. The fundamental goal of quality improvement is to improve patient care and outcomes. Oversight includes those entities that hold EMS providers accountable to providing appropriate care.[16-23] The agency medical director is the first layer of oversight. Other entities include local-, regional-, or state-level government agencies and institutions. The *agency-level* may be a private or public, non-profit or for-profit organization that provides EMS services in a defined area.[24,25] The next level of EMS care is the *personnel* level, which for our purposes is one or more EMS providers (e.g., an individual EMT or an EMS team). [26-31] *Systems of care* refers to a single disease or injury entity that uses predefined quality measures focusing on that particular patient diagnosis.[32-33] Quality measures are often organized according to the Donabedian Model, which distinguishes measure types into three categories (1) structure, (2) process, and (3) outcome. In the most basic sense *structure* refers to the institutions and providers in which care takes place, while *process* refers to what is done to the patient, and *outcomes* are the results of this care.[34] Quality measures of all three types can be applied to pre-hospital care.

The goal of this environmental scan is to is to assess the current state of EMS quality measurement from a systems perspective and to evaluate characteristics and practices associated with high-quality EMS oversight. This work complements the EMS Compass Initiative, a national effort funded by the National Traffic Safety Administration (NHTSA) Office of EMS and led by the National Association of State EMS Officials. EMS Compass engages stakeholders to develop quality measures in the following six domains: clinical process/effectiveness, patient and family engagement, patient safety, care coordination, population/public health, and efficient use of healthcare resources.[35] EMS Compass is aimed at reaching consensus indicators but is not yet at the stage of recommending best practices in EMS oversight.

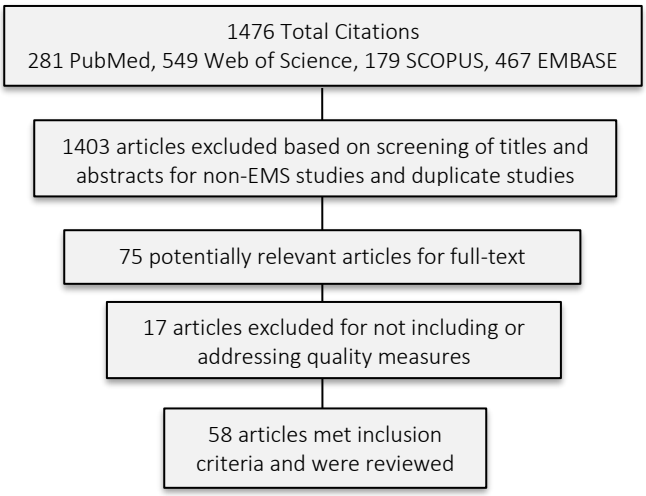
Table 3. Dimensions and Levels of EMS Care

OVERSIGHT	
Agency	Agency medical director is the primary source of oversight in the U.S.
State or Regional	A level above EMS agencies, such as a system of multiple agencies or any regulatory entity. This may include county, regional, or state EMS bodies.
Direct Medical Control	Available on scene or remotely for orders, advice, and support.
Indirect Medical Control	Protocols to guide care, education, agencies' policies all developed prior to the patient encounter. These can be developed at an agency, regional, or state level.
RESPONSE	
Agency	EMS provider organizations. These may be an aggregate of an organization's personnel or the EMS agency as a whole. Many are focused on time components in the response.
Personnel	A team of more than one EMS personnel or an ambulance vehicle or single EMS personnel, e.g. a single emergency medical technician or single paramedic. Quality measures for individual providers generally focus on protocol adherence and include standard peer review.
SYSTEMS OF CARE	
Patient and/or Condition	Patient outcome measures assessing the entire system of care. This has been part of trauma systems since their inception and is key to stroke and cardiac arrest. Focuses on each component of care related to ultimate outcome. Includes 9-1-1 call centers, dispatch, agencies, providers, and hospitals.

APPROACH

For peer-reviewed academic literature, the following databases were searched between March 2016 and May 2016 by title and abstract (1) PubMed, (2) Web of Science, (3) SCOPUS, (4) EMBASE **(Figure 5)**. We restricted the search to English-language articles published between 1966 and 2016 **(Appendix 1)**.

Figure 5. Flowchart of Systematic Review Process.



Title review was performed by three evaluators to eliminate duplicate titles, titles not referring to EMS, and articles that did not address the measurement of quality in EMS. If it was unclear from the title of the article, the abstract was retrieved and the same review process was applied. Articles that were retained after title and abstract review were compiled into Dedoose, a qualitative analysis tool.[36] At this stage the sample was divided between two evaluators, and an initial review was conducted to determine whether the articles were on the topic of EMS and quality measurement **(Appendix 2)**.

This stage included discussions between the three evaluators to ensure each was using the same method for reviewing the articles. After this stage 17 articles were excluded for not being on the subject of EMS or for not including description of quality measurement.

Using a data extraction template **(Appendix 3)** the retained articles were analyzed on several levels, including: article type (original, review, and/or conference proceeding); measure type (structure, process or outcome); measure level (oversight, agency, personnel, and patient); and finally, the specific measure itself. Following review and coding, the extraction form and codes were evaluated by two reviewers to ensure consistency and agreement.

Table 4. Sources of Grey Literature

1. U.S. DOT National Highway and Traffic Safety
2. U.S. DHS Federal Emergency Management Agency
3. U.S. DHHS Office of Assistant Secretary for Preparedness and Response
4. National Association of State EMS Officials
5. National EMS Management Association
6. National Association of County and City Health Officials
7. National Association of EMS Physicians
8. National Association of Emergency Medical Technicians
9. National Emergency Medical Services Association
10. National Association of EMS Educators

To search and review grey literature relevant to EMS quality measurement and oversight, a list of the EMS regulatory bodies and key professional societies active in the area of EMS was compiled with input from federal and state subject matter experts **(Table 4).**

Each agency or organization's website was visually searched for subpages labeled with the terms quality improvement, reports, assessments, white papers, briefings, or synonymous phrases. For each agency or organization website that offered search functionality, separate searches were run for the following terms: ["medical direction", "medical control", "pre-hospital care", "quality", "measure"]. We restricted the targeted search to the English language of grey-literature resources available on the Internet produced between 1996 and 2016.

Following each search, the results were visually searched by title for relevance to EMS oversight and quality measurement; this was determined by requiring the titles to contain the following or synonymous terms: EMS, paramedic, pre-hospital, out-of-hospital, ambulance, quality, performance, measurement, and improvement.

FINDINGS

SYSTEMATIC REVIEW OF ACADEMIC LITERATURE

Of the 58 peer-reviewed studies that met our inclusion criteria, 48 were original research, 10 were reviews, 46 included process measures, 36 included outcome measures; just 19 included structure measures. Most studies applied quality measures at the personnel level (40) followed by the agency (28), patient (28), and oversight levels (5). Counts for the number of articles in the final sample that include a specific measurement level measure type (structure, process, and outcome) are presented below **(Table 5).**

Table 5. Summary of Academic Literature by Type of Article, Measure Types, and EMS Levels

Article Type	Number of Articles
Original	48
Review	10
Type of Measurement*	
Structure	19
Process	46
Outcome	36
Level of Measurement*	
Oversight	5
Agency	28
Personnel	40
Patient and/or Condition	28

** These frequencies refer to measures; each article may apply multiple measures but application of type or level is counted no more than once per article.*

SYSTEMATIC REVIEW OF GREY LITERATURE

From the 10 targeted websites, 115 grey-literature resources met our criteria: 34 were EMS oversight from the federal government, 57 were from state EMS leadership and management organizations, four were identified at the local level, 13 from clinical membership organizations, and seven from EMS educator organizations **(Table 6).**

Table 6: Results of Grey-Literature Search

Source	Number of Documents
Government Agencies	
U.S. DOT National Highway and Traffic Safety	27
U.S. DHS Federal Emergency Management Agency	4
U.S. DHHS Office of Assistant Secretary for Preparedness & Response	3
Practitioner or Professional Organizations	
National Association of State EMS Officials	54
National EMS Management Association	3
National Association of County and City Health Officials	4
National Association of EMS Physicians	10
National Association of Emergency Medical Technicians	3
National Emergency Medical Services Association	0
National Association of EMS Educators	7
Total	115

SYNOPSIS OF ANALYSES

The goal of this systematic review and environmental scan was to assess the current state of EMS quality measurement from a systems perspective and to evaluate characteristics and practices associated with high-quality EMS oversight. In the peer-reviewed literature we found that most studies measured quality at the individual EMS provider level, while agency-level quality measures were typically aggregations or averages of these measures applied to the entire EMS agency (e.g., average response time or protocol compliance rates). At the system of care level, quality measures were typically related to patient survival or condition-specific clinical measures (e.g., time to return of spontaneous circulation). Oversight was the least-covered level of EMS care, consistent with the IOM's cited lack of an evidence-base for EMS oversight and suggesting that this research area needs to be developed further. In contrast to the peer-reviewed literature, the grey literature is ahead, containing more information on EMS oversight and quality improvement and can serve as a foundation for guiding the research and policy agenda for best practices in EMS oversight and quality measurement.

In general, the main function of oversight is to set practice standards and hold provider agencies and their personnel accountable for providing appropriate care. In the peer-reviewed literature measurement at the oversight level was generally related to medical direction and the needed infrastructure for agencies

to ensure protocol compliance and report on quality measurement. Medical direction of daily EMS care is provided indirectly by protocols. Certain procedures or medications may only be given with a direct online order. Protocols include guidelines for assessment of complaints and specific treatment of certain conditions. When protocol deviations occur, the reasons are generally reported to be subjective assessments of patient need, for instance when a patient with nausea and epigastric pain is treated as an abdominal complaint when they are actually having an acute myocardial infarction (AMI).[37] Oversight may support or discourage staff discretion and make clear when deviation is and is not appropriate, thus allowing for objectively necessary deviations from protocol.[28,38-39] We found no articles assessing the quality of direct medical control.

EMS agencies typically deliver care according to the protocols set forth by the oversight entity but are also responsible for maintaining the quality of care provided by their personnel. This often requires the practice of chart review, which has been shown to reduce the number of cases requiring remediation, increase the proportion of charts rated as clinically acceptable, reduce the proportion of misplaced endotracheal tubes, and increase the appropriate administration of aspirin.[22]

The peer-reviewed literature suggests that oversight requires not only involvement in quality improvement through medical direction but also through creating quality monitoring and improvement infrastructure. Dunford (2002) recommends that oversight agencies create statewide quality improvement programs.[40] This is best done through a uniform dataset and consistent reporting language from local EMS agencies to oversight authorities.[40-41] Mandating uniformity in data reporting may allow for more transparent oversight and quality assurance. There have been efforts toward this goal, most prominently, the National EMS Information System (NEMSIS), which serves as a standardized repository of pre-hospital EMS data, but is dependent on good quality data being entered into the system.[42]

Also, the peer-reviewed literature indicated that oversight can provide the leadership and coordination necessary for quality improvement (QI). For example, Kingsbury (2014) recommended standardized and coordinated approaches to ST-Elevation Myocardial Infarction (STEMI) care to help decrease the variation in the use of resources, improve coordination of care and access to percutaneous coronary intervention (PCI), and as a result, improve patient outcomes.[43] Many states have adopted systems of care programs for disease and injury states using this approach. The development of inter-organizational relationships between agencies and acute care providers can also improve patient outcomes and personnel satisfaction.[44] Collaboration between agencies and hospitals through regular communication and coordination has been shown to be associated with lower AMI mortality rates.[44]

Both the grey and peer-reviewed literature indicated that traditional pre-hospital care quality measurement has focused almost exclusively on response times.[45-46] Although response time may indicate high-quality process and structure, evaluating best practices in structure and process in their own right is necessary because response times may be a function of factors outside the EMS system itself, population density and transportation infrastructure among them. Response times have been shown to be correlated with improved patient outcomes, but given that the rapid arrival of poor-quality care may not benefit a patient, quality improvement apart from response times are essential. QI approaches such as the use of

clinical safety charts, education sessions, and leadership engagement in quality improvement show improved EMS agency performance on key indicators and the recording of QI data.[47]

Based on the peer-literature review, job satisfaction and organizational commitment of personnel were found to be associated with stronger organizational communication practices within EMS agencies. [46] Workplace satisfaction is known to improve productivity and reduce turnover.[48] The length of time an emergency medical technician has been with an agency also predicts performance on condition-specific measures such as time to intubation, proper CPR, increased patient survival after out-of-hospital cardiac arrest (OHCA), and reduced patient-reported pain.[38, 49-50]

Peer-reviewed articles focused on quality measurement for individual EMS personnel, and teams of personnel staff studied teamwork and team composition as they related to performance. Many of these studies found that communication and team composition are important in reducing errors and improving efficiency.[51] Consistent, formal channels to voice concerns and opinions can support effective communication.[51] Regarding the composition of ambulance teams, those teams that included advanced life support (ALS)-capable paramedics were found to provide higher quality OHCA treatment compared to basic life support (BLS)-only units, although no patient outcome differences resulted.[40,52-53] There is a lack of research and quality measurement of the attributes of EMS systems that promote better patient outcomes.

Articles that included patient quality measurement were perhaps the most diverse due to patient outcomes being the primary outcome of most research in pre-hospital care.[28,38-40,53,54-57] Many proposed or explored measures were either specific to a narrow type of treatment (e.g. cardiac arrest or STEMI) or limited to descriptions of a single population or small group of patients and their outcomes.[28,38-40,53,54-57] Although the articles covering patient-level quality were diverse, the patient-level measures themselves were narrow in scope and included such items as patient satisfaction and other patient outcomes (e.g., survival to hospital admission or discharge).[40,53,55,56]

The grey literature, being more practitioner-focused, complemented the academic literature's lack of practice-oriented information regarding EMS oversight and systems-level quality measurement. Sources of grey literature related to EMS practice and quality measurement were derived from leading field experts and government agencies responsible for quality performance and oversight (e.g., National EMS Advisory Council (NEMSAC), FEMA, and state and regional EMS oversight authorities).

The grey literature suggests that high quality oversight entails: (1) involvement from multiple stakeholders of EMS practice (e.g., federal and state agencies, educational and professional credentialing programs, and regulatory authorities); (2) statewide and regional EMS Continuous Quality Improvement (CQI) programs; (3) implementation of disease-specific (e.g., cardiac arrest or stroke) emergency response quality improvement measures; (4) advancement of an EMS "systems approach"; (5) establishing network building opportunities; (6) adopting national quality improvement standards; (7) developing strategic plans and coordinated statewide initiatives for Continuous Quality Improvement (CQI); (8) developing self-assessment tools for regional EMS authorities related to key areas of oversight and performance; (9) instituting accreditation, training, and credentialing standards; (10) implementing statewide education

and quality improvement training programs; and (11) strong agency commitment to Quality Improvement.

The grey literature review revealed the value of enhanced EMS performance and oversight in improving healthcare delivery systems.[58] A multi-level, multi-sectoral *systems approach* offers federal, state, and regional EMS authorities with practice models for comprehensive EMS reform,[58-65] and evidence-based guidelines for promoting and implementing pre-hospital care and evaluation.[58-65] A number of resources provided key principles and practical resources for designing and implementing high quality performance and oversight measures for EMS systems and are detailed in the resource guide in **(Appendix 4)**. [58-65]

TARGETED DOCUMENTS

NHTSA REASSESSMENT OF MICHIGAN EMS (2007)

The 2007 National Highway Traffic and Safety Agency (NHTSA) Reassessment of Michigan (MI) EMS was requested by what was then the Michigan Department of Community Health and the Michigan Office of Highway Safety Planning.[66] NHTSA developed an evaluation format whereby MI EMS Office staff convened 25 presenters to provide in-depth briefings on MI EMS and trauma care and review progress since their 1991 assessment. The NHTSA Reassessment used these presentations to review and make recommendations for improving 11 essential components of EMS systems: (1) Regulation and Policy; (2) Resource Management; (3) Human Resources and Training; (4) Transportation; (5) Facilities; (6) Communications; (7) Trauma Systems; (8) Public Information and Education and Prevention; (9) Medical Direction; (10) Evaluation; and (11) Emergency Preparedness. The following 11 subsections summarize those NHTSA findings as related to the structure and performance of MCAs.

EMS systems need legislation that provides a lead EMS agency with the authority to plan and implement appropriate rules and regulations for each component of the EMS system. It should have a consistent established funding source necessary to carry out its legislative mandates. NTHSA found that Michigan has comprehensive enabling legislation for a lead EMS agency to govern its EMS system, but it requires additional financial and staff support to meet its statutory obligations.

NHTSA recommended obtaining funding to support the state EMS Office; increasing its staffing to centralize the EMS functions of the office; considering the feasibility of reinstating a certificate of need (CON) program for ground and air EMS units; developing an evaluation process of the MCAs; and instituting a formal state EMS medical director.

NHTSA stated that central coordination and current knowledge of system resources are necessary to maintain coordinated responses and resource utilization. Toward this end NHTSA recommended developing and implementing a process to review and update the state EMS plan at least once every five years. In addition, it is recommended that the Michigan EMS Office develop and implement a comprehensive study/survey, which will identify the overall needs of the EMS system, conduct a demographic study of the individuals providing services, review utilization of resources including personnel and equipment, and track the effectiveness of protocol based procedures utilized in the field.

NHTSA's recommendation for the state was to create and fund the position of state EMS/trauma medical director. This position would provide medical oversight to the EMS office and provide oversight guidance, including QI priorities, directly to the MCAs. The MCAs should be accountable to the state EMS/trauma medical director. Other NHTSA recommendations include continuing consolidation of protocols and requirements so the same protocols, standards, and destination protocols exist throughout each region. A mechanism should be identified to fund the proposed regional MCAs infrastructure, including compensation for medical direction.

NHTSA recommends statewide evaluation programs to plan, implement, and monitor EMS delivery. This is best done using a uniform, statewide, out-of-hospital data collection system that captures minimum data necessary to measure compliance with standards. Data should be consistently and routinely provided by agencies and MCAs to the EMS Office by providers and the Michigan EMS office should perform routine analysis of this data.

NHTSA suggested that Michigan use pre-established standards, criteria, and outcome parameters to evaluate resource utilization, scope of services, effectiveness of policies and procedures, and patient outcomes. A comprehensive, medically directed, statewide quality improvement program should be established to assess and evaluate patient care, including a review of processes (i.e. a review of outcomes and of how EMS system components are functioning). The quality improvement program should include an assessment of how the system is currently functioning according to the performance standards, identification of system improvements that are needed to exceed the standards, and a mechanism to measure the impact of the improvements once implemented.

NHTSA reported that due to lack of staffing in the EMS office, there has been no evaluation of the individual MCAs and their ability to perform their required duties. This has since been addressed through the 2011 MCA Evaluation Survey, although the lack of staffing was an issue still raised by stakeholders in study Phase 3. In addition, the state has delegated a number of functions to contractors (e.g. ambulance and education program inspections), but there was no evidence given of any evaluation of the performance of those contractors. NHTSA recommended that the state create and fund the position of state EMS/trauma medical director who would set the plan and priorities for a statewide QI system. The MCAs should be evaluated regarding their ability to provide their statutory responsibilities and progress on state EMS plans and initiatives. The state should require hospitals participating in the MCA to provide outcome data to the MCA and the state.[66]

MEDICAL CONTROL AUTHORITY EVALUATION TOOL

In 2012, the MCA evaluation tool was administered by the Michigan Department of Health and Human Services (MDHHS) in order to assess the strengths and weaknesses of Michigan MCAs.[5] This tool evaluated MCA designation and organization, medical directorship, granting of medical control (due process), protocol development, quality improvement, pharmacy, communications systems, and participation in related community activities.

NEMSIS

The NEMSIS Project is an effort to create a national EMS database. Currently, over 90 percent of U.S. states and territories have a NEMSIS compliant data system in place, albeit with varying levels of sophistication.[42] Many states are currently working to revise data elements, improve data capture, and ensure compliance with version 3 NEMSIS dataset standards. NEMSIS provides a set of performance variables that may be used to build performance assessments for some of the most commonly encountered conditions in the pre-hospital setting: acute myocardial infarction (AMI), ST-segment elevation myocardial infarction (STEMI), acute stroke, and severe trauma. The Phase 1 grey and peer-reviewed literature suggest that the use of these data variables can promote the development and standardization of performance measurement, leading to enhanced benchmarking and sharing of best practices. These measures can be used to monitor trends in pre-hospital conditions and progress in reducing condition specific poor outcomes.

EMS COMPASS

The EMS Compass Initiative is a national effort funded by the National Traffic Safety Administration (NHTSA) Office of EMS and led by the National Association of State EMS Officials.[4] EMS Compass engages stakeholders to develop performance measures informed by the National Quality Strategy Domains prioritized by the U.S. Department of Health and Human Services: (1) clinical process/effectiveness; (2) patient and family engagement; (3) patient safety; (4) care coordination; (5) population/public health; and (6) efficient use of healthcare resources. As of December 2, 2016, the EMS Compass Initiative had released 14 candidate measures in the areas of hypoglycemia, medication error, pediatric respiratory cases, seizure, stroke, trauma, trauma pain, and vehicle operations safety. These measures have not been widely tested yet using the NEMSIS version 3 dataset standard.

INSTITUTE OF MEDICINE REPORT
STRATEGIES TO IMPROVE CARDIAC ARREST: A TIME TO ACT (2015)

The Institute of Medicine (IOM), now named the National Academy of Medicine (NAM), recognizes EMS response as a key factor in improving population health outcomes. In its 2015 report, *Strategies to Improve Cardiac Arrest: A Time to Act*, the IOM recommends developing best practices in EMS coordination and oversight.[66] Although the report is written specifically about cardiac arrest, its recommendations are applicable to EMS in general:

"Today's EMS systems are better equipped to respond to disasters and complex medical needs—such as cardiac arrest—than in decades past. However, the field as a whole continues to exhibit signs of fragmentation, an absence of system-wide coordination and planning, and a lack of federal, state, and local accountability. To better ensure collaboration and to minimize the negative effects of disconnected institutional authorities on cardiac arrest care, it is important to understand the roles that the federal government, states, and local communities play in the oversight and evaluation of EMS system performance and how they may better work together...."

IOM says that an absence of a data registry that captures high-quality and complete demographic data regarding race and ethnicity and socioeconomic factors makes it challenging to gather and evaluate evidence on disparities in cardiac arrest incidence, treatment, and outcomes. In regard to race/ethnicity, IOM states that the lack of data completeness may be in part because of challenges in collecting accurate and unbiased data: race and ethnicity relies on visual assessment by EMS providers or patient self-reporting, the latter of which may be unattainable due to the patient's condition. Research supports the notion that patient demographic factors—in addition to EMS and health system processes and geographic characteristics— impact patient outcomes. These variables are necessary to allow for accurate statistical adjustments in measuring patient outcomes of interest. IOM suggests that a method is needed for checking completeness and accuracy for this and other types of reporting. [66]

IOM reports that EMS systems are largely local-level operations, suggesting that EMS protocols and their quality measures should exhibit nuance according to local and community needs. Many counties and local municipalities determine EMS system structure and develop training programs on triage, treatment, and transport protocols as well as on implementing EMS interventions, based on local needs and available resources. At the local level, the size and population density of the areas served by EMS agencies vary greatly, as do the resources available to local EMS agencies to treat those populations. Local EMS agencies may be responsible for towns and municipalities, or entire counties. In terms of resources, not all areas have access to enhanced 9-1-1 services, and the number of local medical directors varies considerably among states. Differences in the regions and populations affect EMS performance. Rural EMS systems are often responsible for larger and less densely populated areas compared to systems in urban centers, resulting in longer transport distances and response times that negatively affect patient outcomes. Yet areas with urban sprawl, where traffic hazards and delays are common, are also associated with longer response times. In urban centers, EMS response times can also be delayed when patients arrest in the upper floors of high-rise buildings.[66]

Analysis of MI-EMSIS Data

MI-EMSIS data for the years 2010–2015 were analyzed with the goals of: 1) determining trends of missingness for key reported variables over the years (2010–2015) of the dataset at the incident level; 2) identifying variation in missingness of key reported variables at the MCA level for the most recent year of data (2015); 3) identifying variation in missingness of key reported variables by data reporting software for the most recent year of data (2015); 4) determining variation in missingness at the agency level for the most recent year of data (2015); and 5) identifying variables that may be more consistently missing across the data years for all localities.

BACKGROUND

Within the last decade, the amount of data produced and consumed has grown exponentially, creating a phenomenon referred to by many as "big data". [67] This data has the potential to inform decisions across many sectors both public and private. In healthcare, data has generally been an administrative byproduct of performing patient-care, operating facilities, and receiving reimbursement for services. [68] These data from administrative claims, medical charts—and in more recent years, electronic health records—have provided valuable data for researchers and policymakers. The use of such data has been shown to improve the quality of patient-care. [69-70] In recognition of this, the deliberate collection and use of data for quality improvement in health systems has developed, but the ability of organizations to assure its quality has not kept pace.[71-72] This is an issue in pre-hospital care as well, perhaps even more so, given that many individual agencies and providers constitute pre-hospital systems, a challenge that has been recognized in multiple studies and policy reports.[73-74] The most prominent pre-hospital quality reporting dataset, the National EMS Information System (NEMSIS), is an effort to manage these issues by serving as a standardized national repository of pre-hospital EMS data. [74-75]

In the preliminary stages of dataset development, the most basic measure of its quality is its completeness, i.e. lack of invalid-values or missing data. An analysis of dataset completeness has been previously conducted on NEMSIS to observe trends in null-values between the years 2008 and 2012.[75] That analysis found that those data elements traditionally found on EMS patient care reports with finite code sets were most often non-missing and valid in the 2012 NEMSIS dataset (e.g., patient gender). However, current categorical elements attempting to characterize patient information that were previously documented as narrative (e.g., provider's impression of the patient's condition), were more often missing or invalid, displaying up to 60 percent use of null values.

Given these observations in NEMSIS, we expected and found similar results in MI-EMSIS. What distinguishes this analysis of MI-EMSIS from that of NEMSIS, aside from being state-specific, was our analysis at the MCA level. Understanding variation in data reporting at the MCA level allows policymakers and MDHHS to provide guidance and resources at a level large enough to leverage economies of scale while still being small enough to allow nuance and a more involved, hands-on approach to quality improvement where desired.

APPROACH

Eighteen variables were chosen for our analysis of missingness based on their clinical significance, relevance to public health, and importance for evaluating quality. The proportion of missing or invalid values for these 18 variables were assessed over the years 2010–2015 stratified by (1) incident, (2) agency, (3) software platform, and (4) MCA.

Table 7 lists and describes each variable, its type, and criteria for being designated as missing and/or invalid. In summary, any blank values were counted as missing, data entered must be done so validly (e.g., zip codes must be 5 digits with no letters, age must not be negative, etc.). Due to the importance of these variables and the fact that they must have a valid entry for their incident to be usable in quality improvement, those reported as *Not Applicable, Not Available, Not Recorded,* and *Not Reported* were also deemed missing and/or invalid. Analyses of proportions missing were performed in SAS Statistical Analysis Software.

Table 7. MI-EMSIS Analysis Variables

Variable Type	Variable	Description	Missing and/or Invalid Criteria
Stratifiers	MCA	New variable created by linking agency numbers to MCA designation list	Not Assessed
	Software Name (E1.3)	Software used to report data to MI-EMSIS	Not Assessed
	EMS Agency (E2.1)	EMS Agency registration number	Not Assessed
Demographics	Age (E6.14)	Age of patient	Blank or value less than 0 or greater than 115
	Gender (E6.11)	Gender of patient	Blank or Not Applicable, Not Available, Not Recorded, Not Reported
	Race (E6.12)	Race/Ethnicity of patient	Blank or Not Applicable or Not Available or Not Recorded or Not Reported
Location	Patients Home Zip (E6.8)	Zip code of patient's home	Blank or more or less than 5 digits, or any alphanumeric characters

	Incident Zip Code (E8.15)	Zip code of incident location	Blank or more or less than 5 digits, or any alphanumeric characters
	Destination Name (E20.1)	Name of patient's destination facility	Blank
	Destination Code (E20.2)	Type of destination	Blank
Clinical Narrative	Chief Complaint Narrative (E9.5)	Provider's narrative of patient's chief complaint	Blank
	Provider Primary Impression (E9.15)	Provider's primary impression narrative	Blank
	Medication Allergies (E12.8)	Patient's reported medication allergies	Blank
	Medical Surgical History (E12.10)	Patient's medical/surgical history	Blank
	Current Medication Name (E12.14)	Patient's current medications	Blank
Vital Signs	SBP (E14.4)	Patient's Systolic Blood Pressure	Blank or alphanumeric or anything other than two or three digits
	DBP (E14.5)	Patient's Diastolic Blood Pressure	Blank or alphanumeric or anything other two or three digits
	Pulse Rate (E14.7)	Patient's pulse rate	Blank or alphanumeric or, greater than 300, or less than 5
	Pulse Oximetry (E14.9)	Patient's pulse oximetry	Blank or negative or less than two digits or greater than 100 or with decimal points
	Respiratory Rate (E14.11)	Patient's respiratory rate	Blank or more than two digits or alphanumeric characters are invalid
	Body Temperature (E14.20)	Patient's body temperature	Blank is missing, negative is invalid, less than two digits is invalid

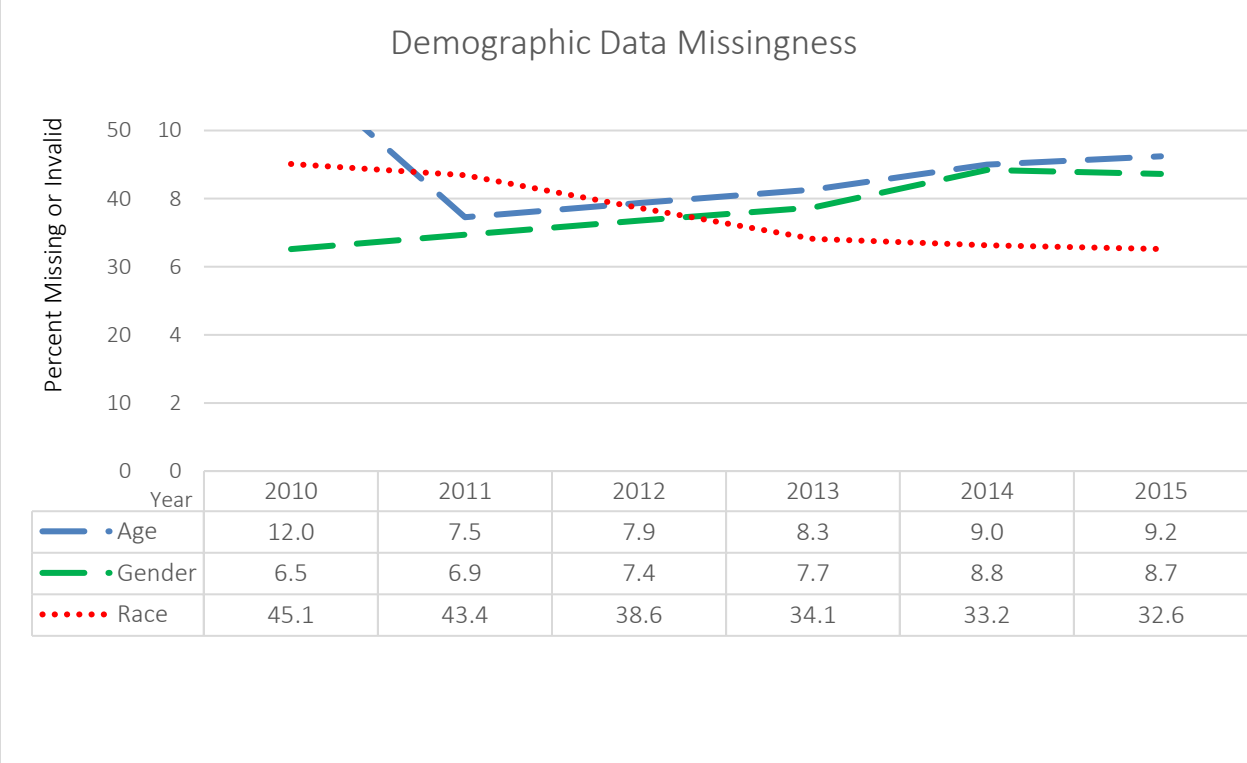
FINDINGS

INCIDENT LEVEL ANALYSES

DEMOGRAPHIC DATA MISSINGNESS

Demographic data missingness is plotted in **Figure 6.** The demographic variables of *Age* and *Gender* are plotted on the inner vertical axis that ranges from 0-10 percent missing or invalid. *Age* was missing or invalid for 12 percent of incidents in the year 2010, before decreasing to a low of 7.5 percent in 2011 and slowly increasing to 9.2 percent of incidents for 2015. Gender started at a low of 6.5 percent missing/invalid for the year 2010 and slowly increased to be missing or invalid for approximately 8.7 percent of incidents in 2015. *Race* is plotted on the outer vertical axis that ranges from 0-50 percent. *Race* was missing or invalid for 45.1 percent of incidents in 2010 and slowly decreased to a missingness of 32.6 percent.

Figure 6. Demographic Data Missingness at the Incident Level: age and gender are plotted on the inner vertical axis ranging from 0-10% missing or invalid values. Race is plotted on the outer vertical axis ranging from 0-50% missing or invalid values.

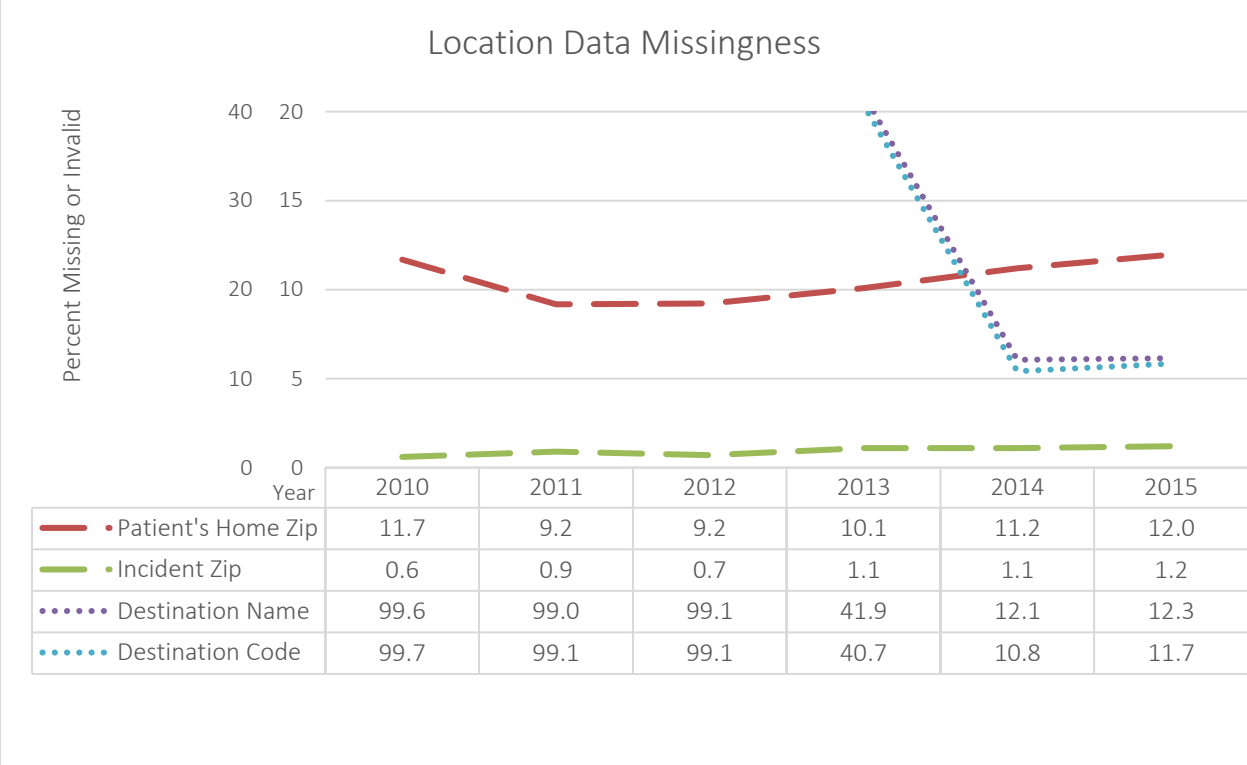


	2010	2011	2012	2013	2014	2015
Age	12.0	7.5	7.9	8.3	9.0	9.2
Gender	6.5	6.9	7.4	7.7	8.8	8.7
Race	45.1	43.4	38.6	34.1	33.2	32.6

LOCATION DATA MISSINGNESS

The location variables of *Patient's Home Zip* and *Incident Zip* are plotted on the inner vertical axis of **Figure 7**, ranging from 0-20 percent missing or invalid. *Patient's Home Zip* was missing or invalid for 11.7 percent of incidents in 2010, 9.2 percent in the years 2011 and 2012, and slowly increased to missing or invalid for 12 percent of incidents in 2015. *Destination Name* and *Destination Code*, are plotted on the outer vertical axis that ranges from 0-50 percent; these variables were missing for virtually all (99.1-99.7 percent) incidents reported through the years 2010–2012, before both quickly decreasing to approximately 40 percent of incidents in 2013 and stabilizing around 10.8-12.3 percent in 2014–2015.

Figure 7. Location Data Missingness at the Incident Level: patient home zip and incident zip are plotted on the inner vertical axis ranging from 0-20% missing or invalid values. Destination name and destination code are plotted on the outer vertical axis ranging from 0-50% missing or invalid values.

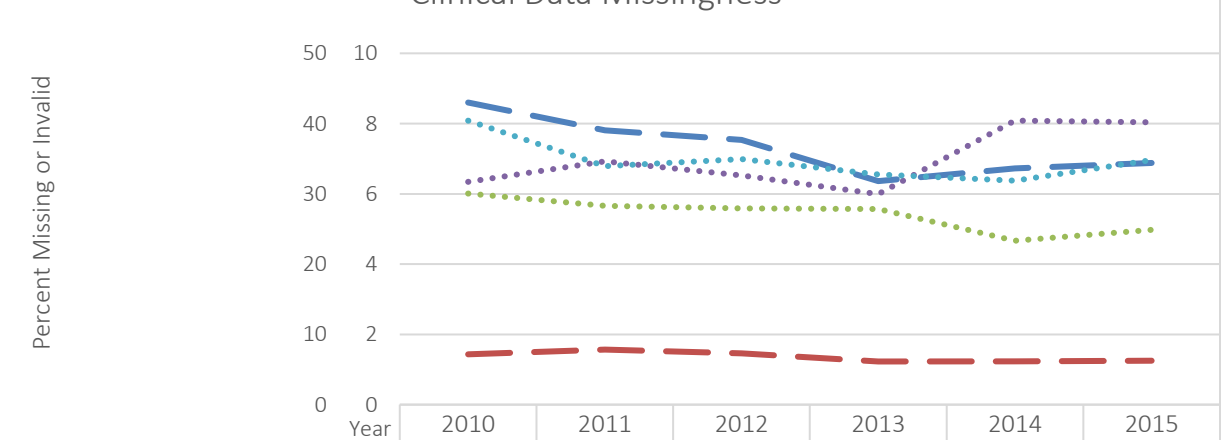


	2010	2011	2012	2013	2014	2015
Patient's Home Zip	11.7	9.2	9.2	10.1	11.2	12.0
Incident Zip	0.6	0.9	0.7	1.1	1.1	1.2
Destination Name	99.6	99.0	99.1	41.9	12.1	12.3
Destination Code	99.7	99.1	99.1	40.7	10.8	11.7

CLINICAL DATA MISSINGNESS

The clinical variables of *chief complaint narrative* and *provider primary impression* are plotted on the inner vertical axis of **Figure 8** ranging from 0-10 percent missing or invalid. *Chief Complaint Narrative* was missing or invalid for 8.6 percent of incidents in 2010, while slowly decreasing to about 6.9 percent of incidents in 2015. *Provider's Primary Impression* was consistently missing for 1.2-1.4 percent of cases from 2010 to 2015. The clinical narrative variables of *Medication Allergies, Medical Surgical History*, and *Current Medication Name* are plotted on the outer vertical axis ranging from 0-50 percent missing or invalid. *Medication Allergies* remained at 27.8-30 percent missing or invalid between the years 2010 and 2013 before decreasing quickly to 23.3 percent missing or invalid in 2014 and slightly increasing to 24.9 percent missing or invalid in 2015. *Medical Surgical History* remained at 30-31.7 percent missing or invalid between the years 2010 and 2013 before increasing quickly to 40.4-40.2 percent in 2014 and 2015, respectively. *Current Medication Name* was missing or invalid for 40.4 percent of incidents in 2010 before decreasing to 33.9 percent missing or invalid in 2011 and remaining steadily between 33.9% missing and 34.8% missing or invalid between 2011 and 2015.

Figure 8. Clinical Data Missingness at the Incident Level: chief complaint narrative and provider primary impression are plotted on the inner vertical axis ranging from 0-10% missing or invalid values. Medication allergies, medical surgical history and current medication name are plotted on the outer vertical axis ranging from 0-50% missing or invalid values.

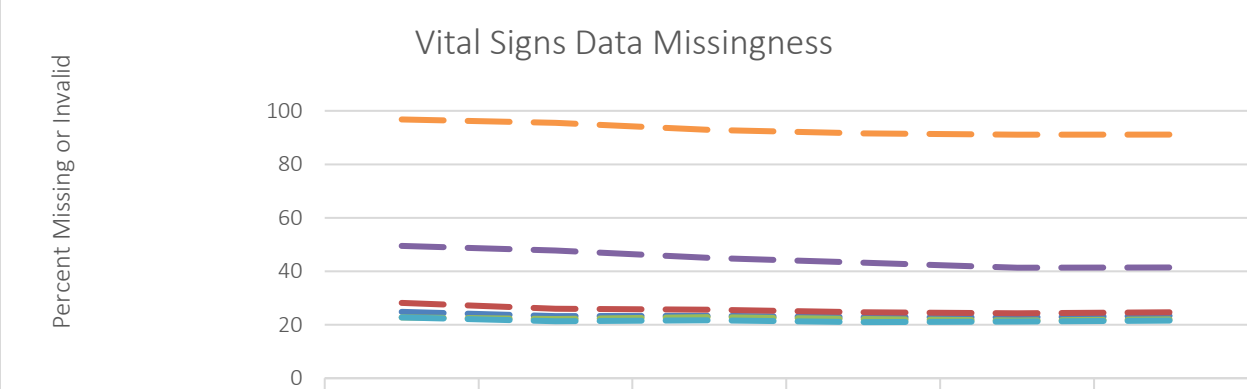


	2010	2011	2012	2013	2014	2015
Chief Complaint Narrative	8.6	7.8	7.5	6.4	6.7	6.9
Provider Primary Impression	1.4	1.6	1.5	1.2	1.2	1.2
Medication Allergies	30.0	28.3	27.9	27.8	23.3	24.9
Medical Surgical History	31.7	34.6	32.6	30.0	40.4	40.2
Current Medication Name	40.4	33.9	34.9	32.8	31.9	34.8

VITAL SIGNS DATA MISSINGNESS

The vital signs variables of *Systolic Blood Pressure* (*SBP), Diastolic Blood Pressure (DBP), Pulse Rate, Pulse Oximetry, Respiratory Rate,* and *Body Temperature* are plotted on the vertical axis of **Figure 9** ranging from 0-50 percent missing or invalid. *Body Temperature* decreased in missingness from 96.8 percent in 2010 to 91.1 percent in 2015, but was consistently missing or invalid for over 90 percent of incidents from 2010–2015 and does not appear in the plotted area. *SBP* was missing or invalid for 24.8 percent of incidents in 2010 and percent missing ranged between 22.7 and 23.3 from 2011 to 2015. *DBP* was missing or invalid for 28.2 percent of incidents in 2010, and percent missing ranged between 24.3 and 25.9 from 2011 to 2015. *Pulse Rate* and *Respiratory Rate* showed little change in missing or invalid values over time, both missing between 21.0 and 22.9 across time points. *Pulse Oximetry* missing or invalid rates generally decreased over time, with a high 49.5 percent in 2010 down to rates of 41.3 and 41.5 percent in 2014 and 2015.

Figure 9. Vital Signs Data Missingness at the Incident Level: SBP, DBP, pulse rate, pulse oximetry, and respiratory rate are vertical axis ranging from 0-50% missing or invalid values. Body temperature was consistently missing for over 90% of incidents and does not appear on the plotted area.

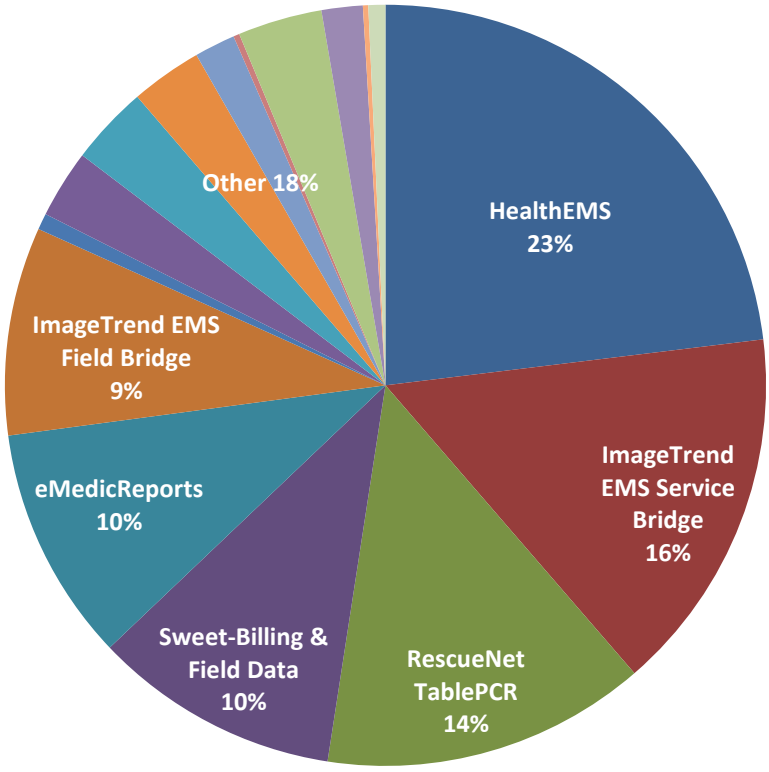


Year	2010	2011	2012	2013	2014	2015
SBP	24.8	23.2	23.3	22.9	22.7	23.3
DBP	28.2	25.9	25.6	24.6	24.3	24.7
Pulse Rate	22.7	22.2	22.9	22.2	21.6	22.0
Pulse Oximetry	49.5	47.8	45.0	43.2	41.3	41.5
Respiratory Rate	22.7	21.4	21.7	21.0	21.2	21.6
Body Temperature	96.8	95.6	92.9	91.5	91.1	91.1

SOFTWARE-LEVEL ANALYSES

In 2015, 28 software platforms were used, but just six of them accounted for 82 percent of the data entered **(Figure 10)**. Given that platforms can be more or less compatible with MI-EMSIS, we expected, and indeed observed, variation in missingness by these platforms in our results **(Figures 11-14).**

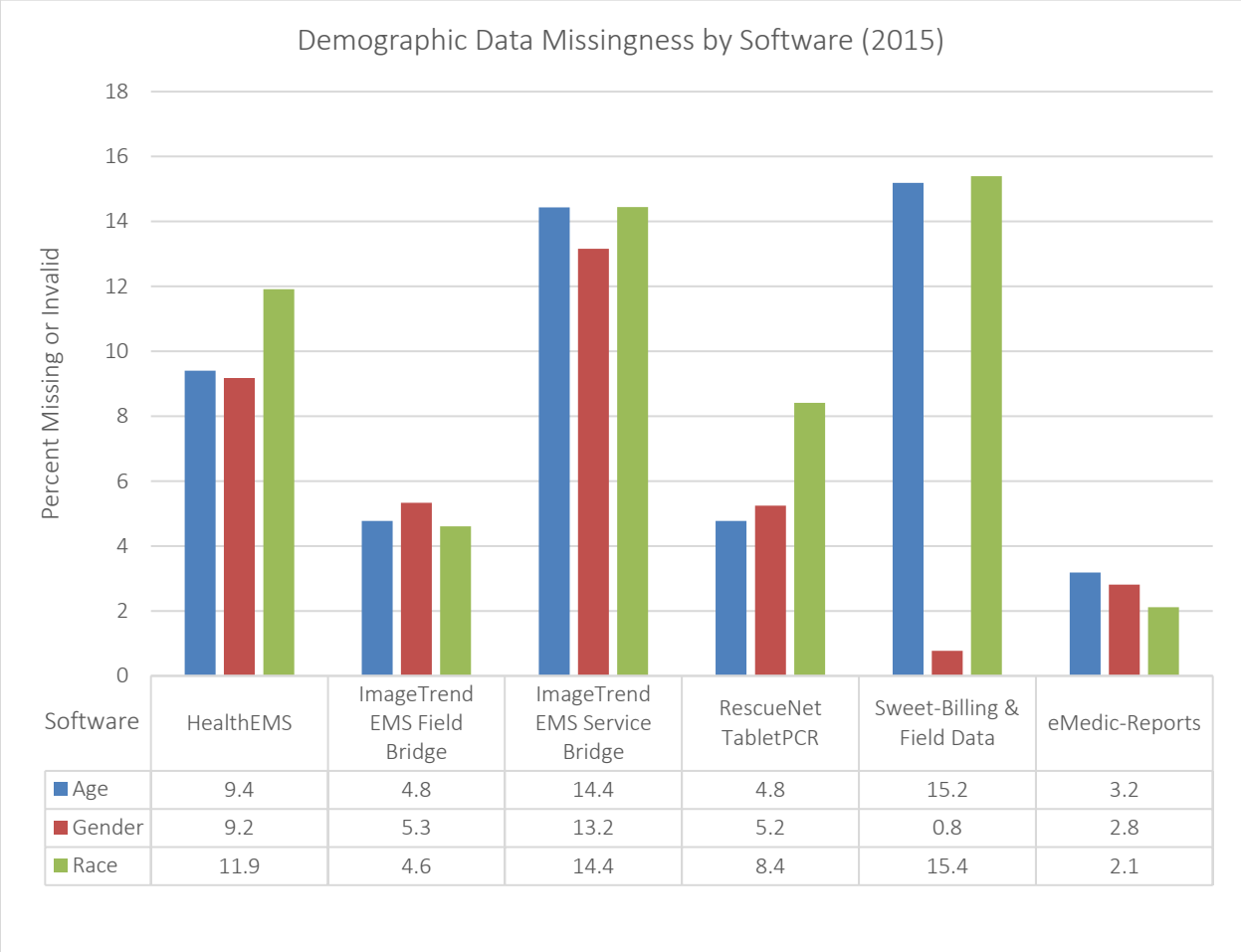
Figure 10. Top 6 Most Used Software Platforms in 2015: these platforms account for 82% of the data entered into MI-EMSIS.



DEMOGRAPHIC DATA MISSINGNESS

For demographic variables **(Figure 11)**, *eMedicReports* displayed the lowest rates of missingness for *age* and *race*, while *Sweet-Billing & Field Data* showed the lowest rates of missing for *gender*.

Figure 11. Demographic Data Missingness by Software for 2015

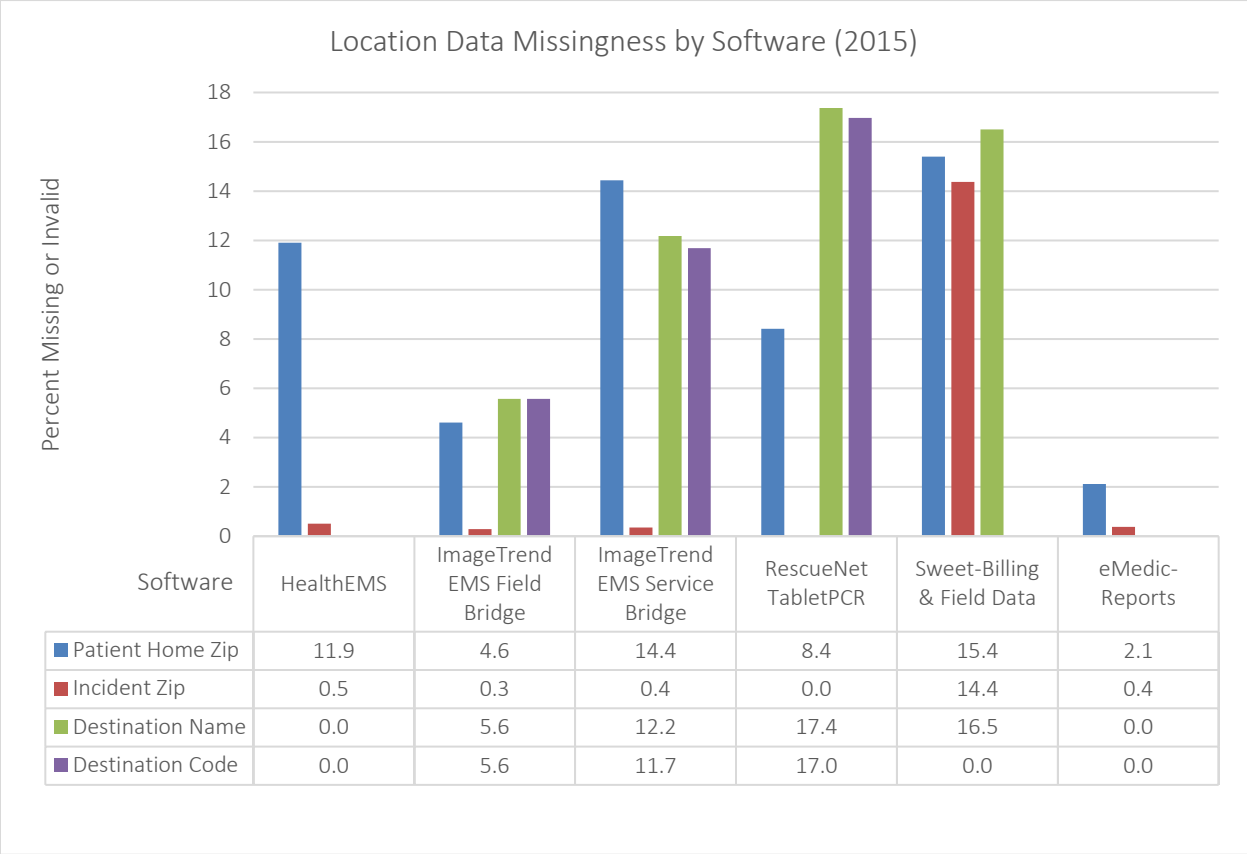


Software	HealthEMS	ImageTrend EMS Field Bridge	ImageTrend EMS Service Bridge	RescueNet TabletPCR	Sweet-Billing & Field Data	eMedic-Reports
Age	9.4	4.8	14.4	4.8	15.2	3.2
Gender	9.2	5.3	13.2	5.2	0.8	2.8
Race	11.9	4.6	14.4	8.4	15.4	2.1

LOCATION DATA MISSINGNESS

For location data variables **(Figure 12)**, *eMedicReports* exhibited the lowest rates of missing or invalid values for all variables except *Incident Zip*, which was exhibited by *RescueNet TabletPCR*.

Figure 12. Location Data Missingness by Software for 2015

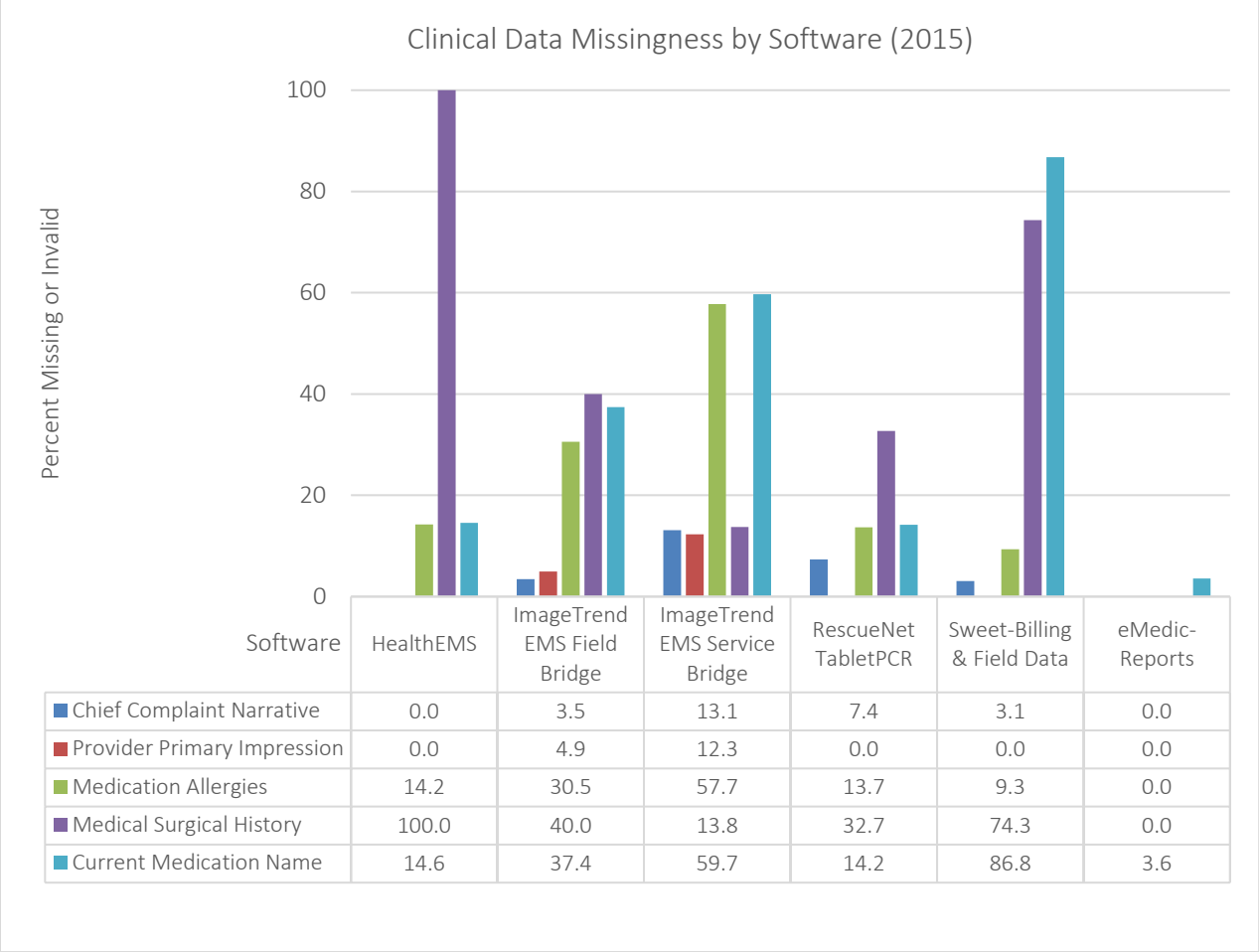


Software	HealthEMS	ImageTrend EMS Field Bridge	ImageTrend EMS Service Bridge	RescueNet TabletPCR	Sweet-Billing & Field Data	eMedic-Reports
Patient Home Zip	11.9	4.6	14.4	8.4	15.4	2.1
Incident Zip	0.5	0.3	0.4	0.0	14.4	0.4
Destination Name	0.0	5.6	12.2	17.4	16.5	0.0
Destination Code	0.0	5.6	11.7	17.0	0.0	0.0

CLINICAL DATA MISSINGNESS

For clinical data variables **(Figure 13)**, *eMedicReports* exhibited the lowest rate of missing or invalid values for all variables.

Figure 13. Clinical Data Missingness by Software for 2015

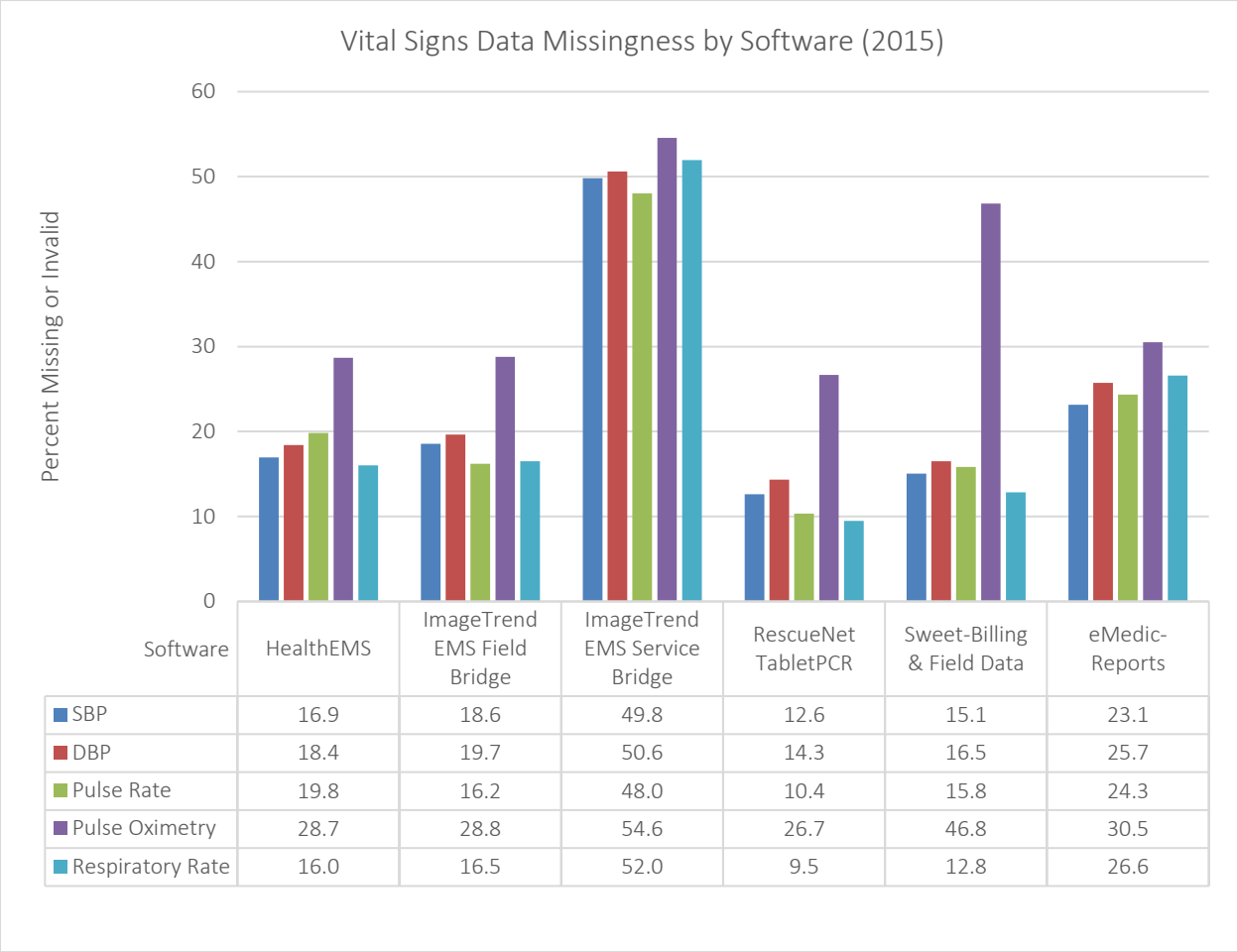


Software	HealthEMS	ImageTrend EMS Field Bridge	ImageTrend EMS Service Bridge	RescueNet TabletPCR	Sweet-Billing & Field Data	eMedic-Reports
Chief Complaint Narrative	0.0	3.5	13.1	7.4	3.1	0.0
Provider Primary Impression	0.0	4.9	12.3	0.0	0.0	0.0
Medication Allergies	14.2	30.5	57.7	13.7	9.3	0.0
Medical Surgical History	100.0	40.0	13.8	32.7	74.3	0.0
Current Medication Name	14.6	37.4	59.7	14.2	86.8	3.6

VITAL SIGNS DATA MISSINGNESS

For vital signs data **(Figure 14)**, *RescueNet TabletPCR* exhibted the lowest rates of missing or invlaid values for every category of vital signs data.

Figure 14. Vital Signs Data Missingness by Software for 2015



Software	HealthEMS	ImageTrend EMS Field Bridge	ImageTrend EMS Service Bridge	RescueNet TabletPCR	Sweet-Billing & Field Data	eMedic-Reports
SBP	16.9	18.6	49.8	12.6	15.1	23.1
DBP	18.4	19.7	50.6	14.3	16.5	25.7
Pulse Rate	19.8	16.2	48.0	10.4	15.8	24.3
Pulse Oximetry	28.7	28.8	54.6	26.7	46.8	30.5
Respiratory Rate	16.0	16.5	52.0	9.5	12.8	26.6

AGENCY-LEVEL ANALYSES

811 MI EMS agencies reported data to MI-EMSIS between the years 2010–2015. **Tables 8-11** present descriptive statistics for the proportion of missing or invalid values at the agency level. Means and standard deviations are based on averaging percentages (of missing or invalid data elements) that come from agencies with different sample sizes (i.e. number of incidents). Because of this, the standard deviation measures variability can arise not only from the variability in reporting, but also variability arising from heteroscedasticity (i.e. non-constant variability) in the data from the use of percentages with different sample sizes.

Table 8. Agency-Level Demographic Data Missingness Descriptive Statistics (2015)

	Age	Gender	Race
Mean	17.9	17.3	18.8
Median	6.8	5.8	7.3
Standard Deviation	26.4	27.2	27.5
Minimum	0.0	0.0	0.0
Maximum	100.0	100.0	100.0

Table 9. Agency-Level Location Data Missingness Descriptive Statistics (2015)

	Patient Home Zip	Incident Zip	Destination Name	Destination Code
Mean	18.8	0.8	16.5	17.9
Median	7.3	0.0	4.4	4.3
Standard Deviation	27.5	6.9	27.8	29.7
Minimum	0.0	0.0	0.0	0.0
Maximum	100.0	100.0	100.0	100.0

Table 10. Agency-Level Clinical Data Missingness Descriptive Statistics (2015)

	Chief Complaint Narrative	Provider Primary Impression	Medication Allergies	Medical Surgical History	Current Medication Name
Mean	16.7	6.0	53.0	27.2	67.7
Median	2.9	0.0	50.0	5.0	86.2
Standard Deviation	30.3	15.4	39.6	38.6	35.3
Minimum	0.0	0.0	0.0	0.0	0.0
Maximum	100.0	100.0	100.0	100.0	100.0

Table 11. Agency-Level Vital Sign Data Missingness Descriptive Statistics (2015)

	Systolic Blood Pressure (SBP)	Diastolic Blood Pressure (DBP)	Pulse Rate	Pulse Oximetry	Respiratory Rate	Body Temperature
Mean	54.8	55.8	52.4	59.4	57.3	95.2
Median	52.9	54.5	46.3	58.3	63.7	100.0
Standard Deviation	36.2	35.7	36.6	34.2	37.4	10.2
Minimum	0.0	0.0	0.0	0.0	0.0	17.7
Maximum	100.0	100.0	100.0	100.0	100.0	100.0

MCA LEVEL ANALYSES

There are 61 MI MCAs, shown below on **Figure 15** and labeled in **Table 12**. **Figures 16-33** on the following pages display the proportion of missing and or invalid values at the level of the MCA by variable, through the use of heat maps. A detailed table of MCA level MIEMSIS analyses can be found in **Appendix 5**.

Figure 15. Map of Michigan Medical Control Authorities

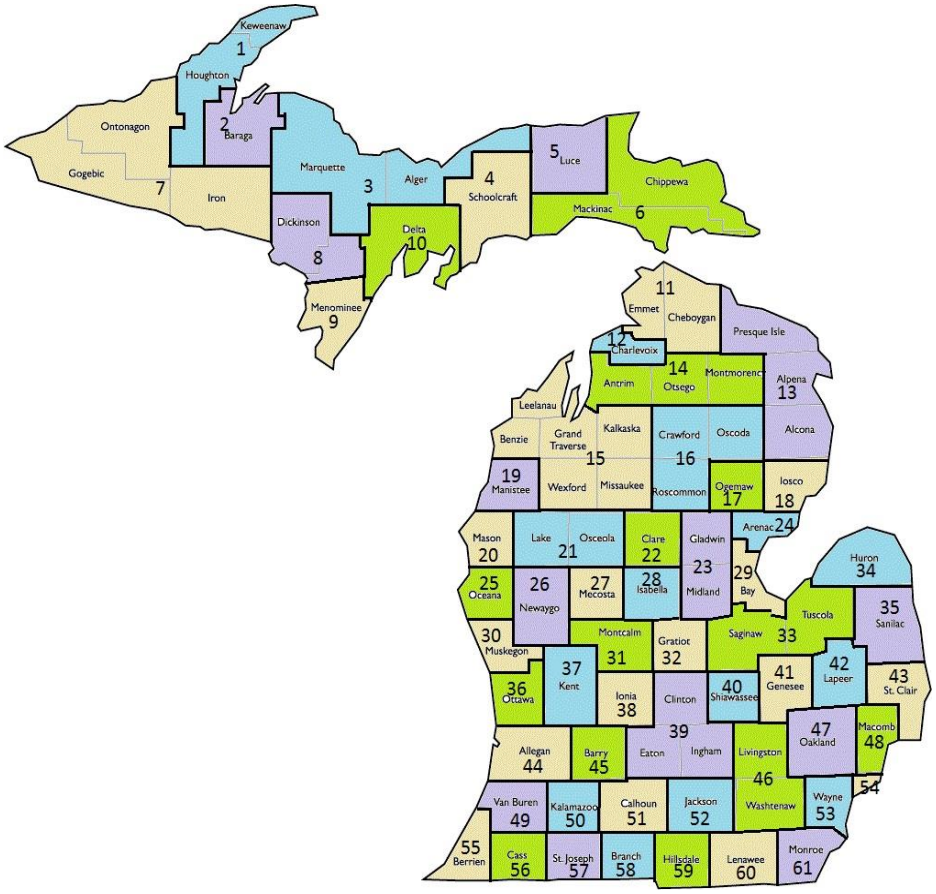


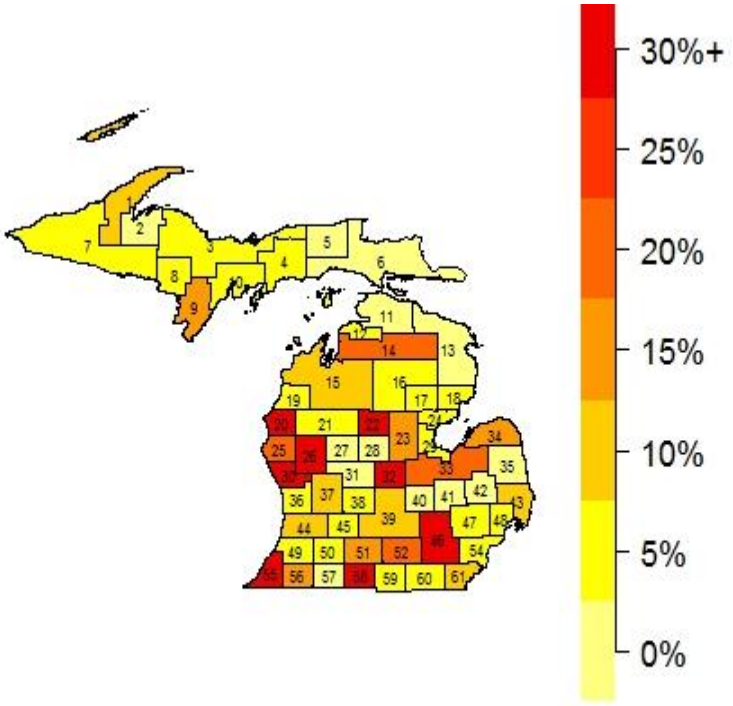
Table 12. Michigan EMS Medical Control Authorities

1. Keweenaw, Houghton	11. Northern Michigan	21. Lakola	31. Montcalm	41. Genesee	51. Calhoun
2. Baraga	12. Charlevoix	22. Clare	32. Gratiot	42. Lapeer	52. Jackson
3. Marquette, Alger	13. North East Michigan	23. Midland, Gladwin	33. Saginaw Valley	43. St. Clair	53. Wayne
4. Schoolcraft	14. Otsego	24. Arenac	34. Huron	44. Allegan	54. Detroit East
5. Luce	15. North West Regional	25. Oceana	35. Sanilac	45. Barry	55. Berrien
6. Eastern UP	16 North Central	26. Newaygo	36. Ottawa	46. Washtenaw, Livingston	56. Cass
7. Ontonagon, Gogebic, Iron	17. Ogemaw	27. Mecosta	37. Kent	47. Oakland	57. St. Joseph
8. Dickinson	18. Iosco	28. Isabella	38. Ionia	48. Macomb	58. Branch
9. Bay Area	19. Manistee	29. Bay County	39. Tri-County	49. Van Buren	59. Hillsdale
10. Delta	20. Mason	30. Muskegon	40. Shiawassee	50. Kalamazoo	60. Lenawee
					61. Monroe

AGE

Figure 16. Age Missingness at the MCA Level: See Table 12 for MCA names (MCA 53 and 54 are represented by MCA 54)

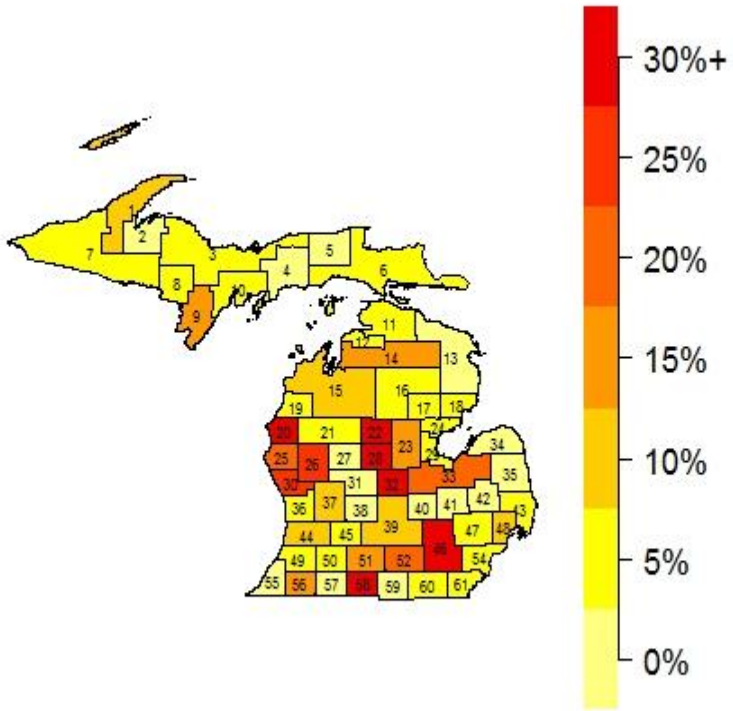
At the MCA level, we see that there are numerous MCAs with greater than 30 percent missing or invalid values for age. Seven MCAs exhibit greater than 30 percent missing or invalid values for this variable: 20, 22, 26, 30, 32, 46, 55, and 58.



GENDER

Figure 17. Gender Missingness at the MCA Level: See Table 12 for MCA names (MCA 53 and 54 are represented by MCA 54)

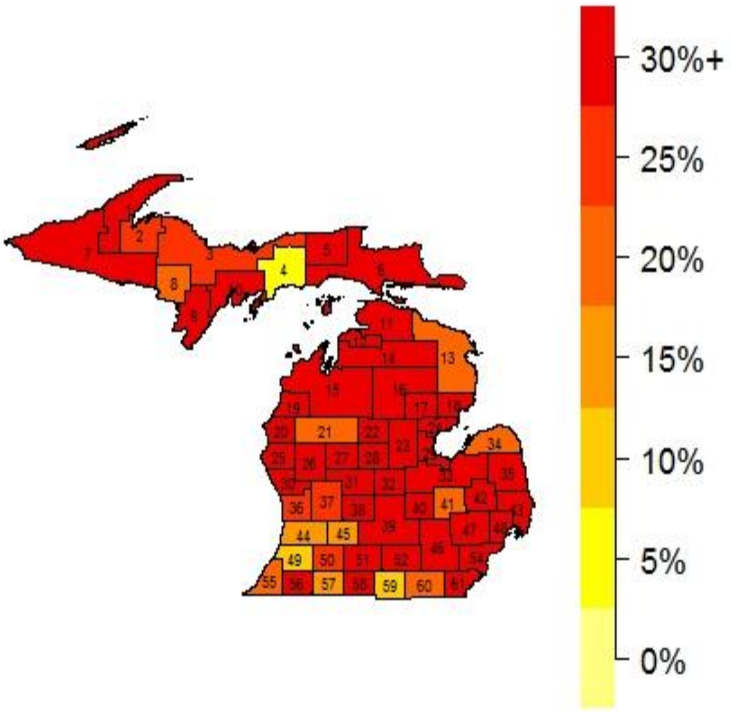
At the MCA level, missing or invalid values for Gender appear to vary greatly. Most MCAs exhibit 5 percent or less missing or invalid values for gender. Five MCAs exhibit greater than 30 percent missing or invalid values: 20, 22, 28, 46, and 58.



RACE

Figure 18. Race Missingness at the MCA Level: See Table 12 for MCA names (MCA 53 and 54 are represented by MCA 54)

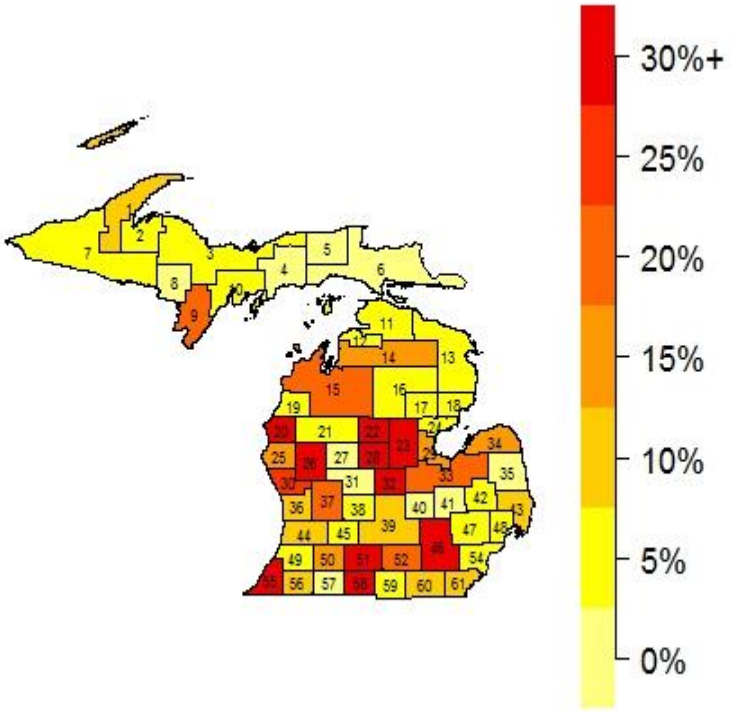
At the MCA level, there appears to be little variation in missing or invalid values for race. The majority of MCAs exhibit a proportion of 30 percent or greater missing or invalid values for race.



PATIENT HOME ZIP

Figure 19. Patient Home Zip Missingness at the MCA Level: See Table 12 for MCA names (MCA 53 and 54 are represented by MCA 54)

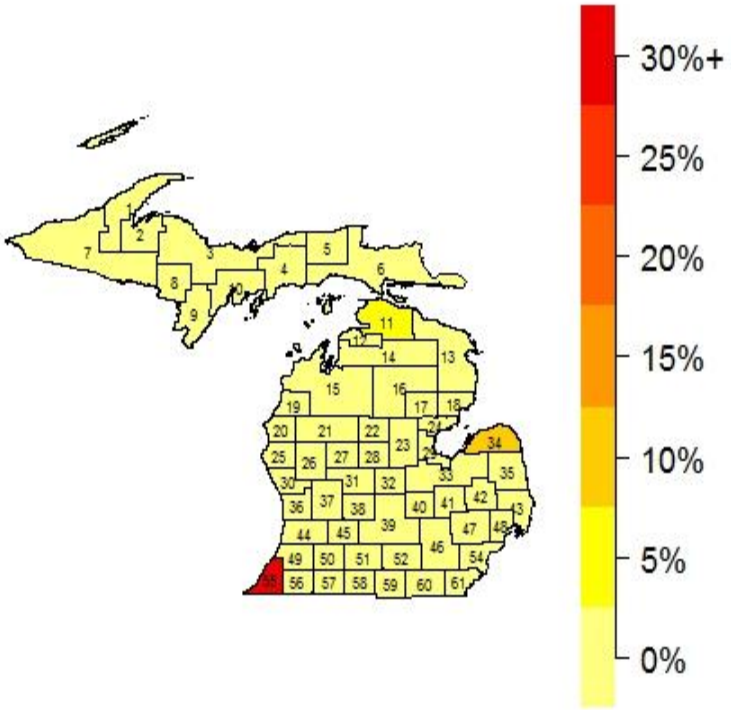
There is wide variation in missing or invalid values for patient home zip when considered at the MCA level. Some MCAs exhibits very low rates of missing or invalid values while others exhibit greater than 30 percent missing or invalid values.



INCIDENT ZIP

Figure 20. Incident Zip Missingness at the MCA Level: See Table 12 for MCA names (MCA 53 and 54 are represented by MCA 54)

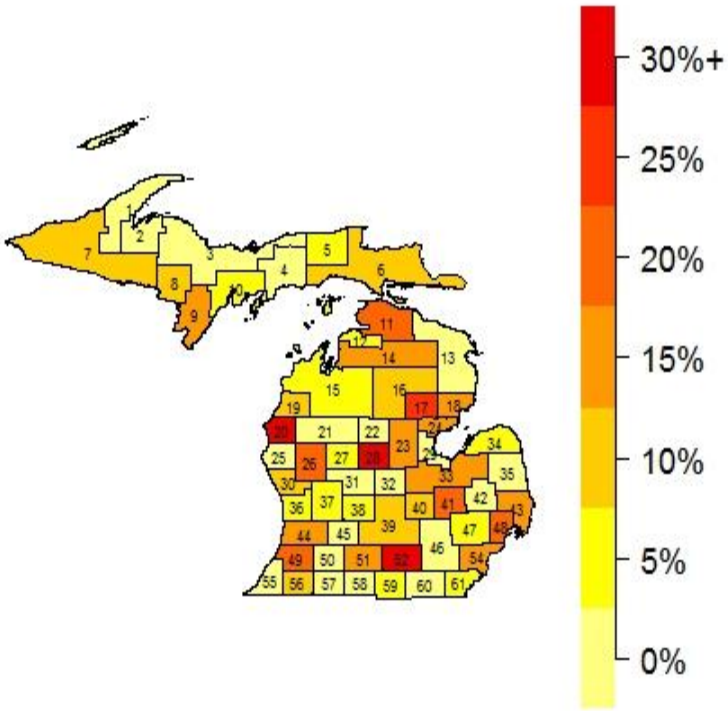
Incident zip at the MCA level is missing or invalid less than 5 percent in all but three MCAs: 11, 34, and 55.



DESTINATION NAME

Figure 21. Destination Name Missingness at the MCA Level: See Table 12 for MCA names (MCA 53 and 54 are represented by MCA 54)

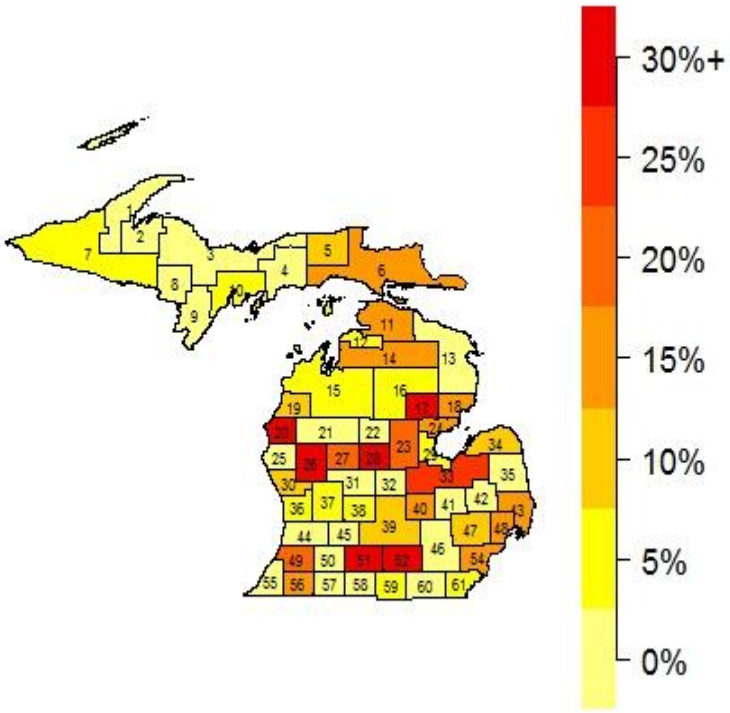
Destination facility name exhibits large variation across the spectrum of less than 5 percent to greater than 30 percent missing or invalid values.



DESTINATION CODE

Figure 22. Destination Code Missingness at the MCA Level: See Table 12 for MCA names (MCA 53 and 54 are represented by MCA 54)

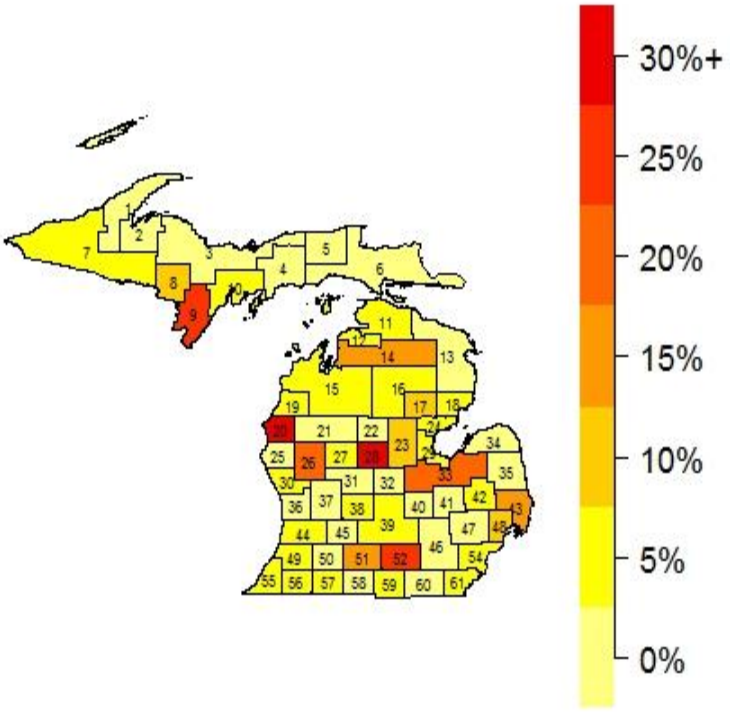
Destination code exhibits large variation across the spectrum of less than 5 percent to greater than 30 percent missing or invalid values.



CHIEF COMPLAINT NARRATIVE

Figure 23. Chief Complaint Narrative Missingness at the MCA Level: See Table 12 for MCA names (MCA 53 and 54 are represented by MCA 54)

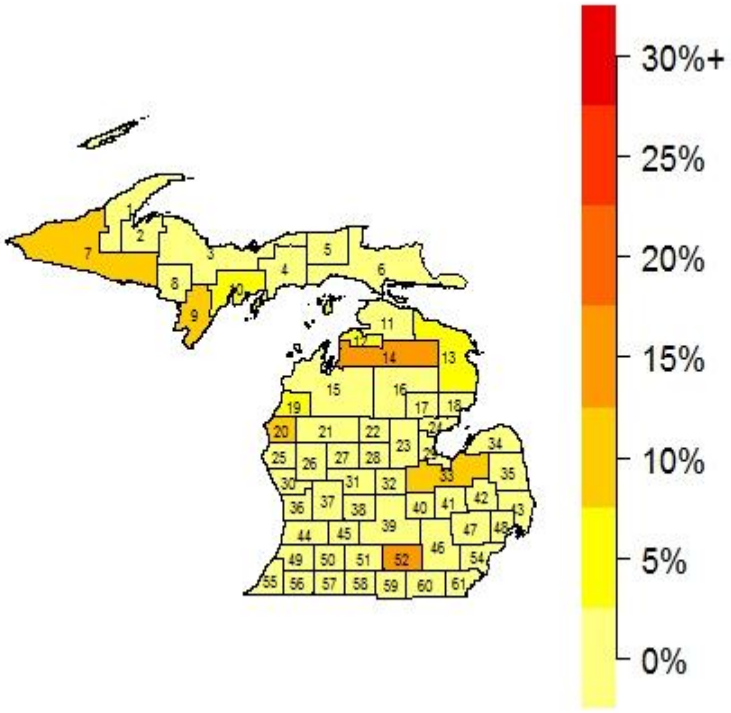
Chief complaint narrative is relatively well documented, exhibiting missingness for less than 10 percent of incidences in most MCAs. Few MCAs exhibit missing or invalid values greater than 25 percent: 9, 20, 28, and 52.



PROVIDER PRIMARY IMPRESSION

Figure 24. Provider Primary Impression Missingness at the MCA Level: See Table 12 for MCA names (MCA 53 and 54 are represented by MCA 54)

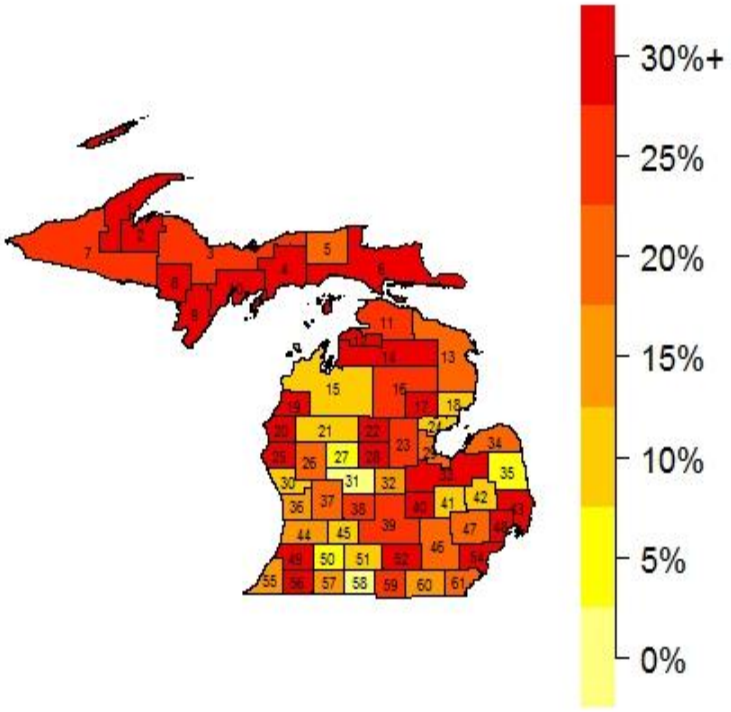
Provider primary impression is relatively well documented, exhibiting missingness for less than 5 percent of incidences in all but five MCAs.



MEDICATION ALLERGIES

Figure 25. Medication Allergies Missingness at the MCA Level: See Table 12 for MCA names (MCA 53 and 54 are represented by MCA 54)

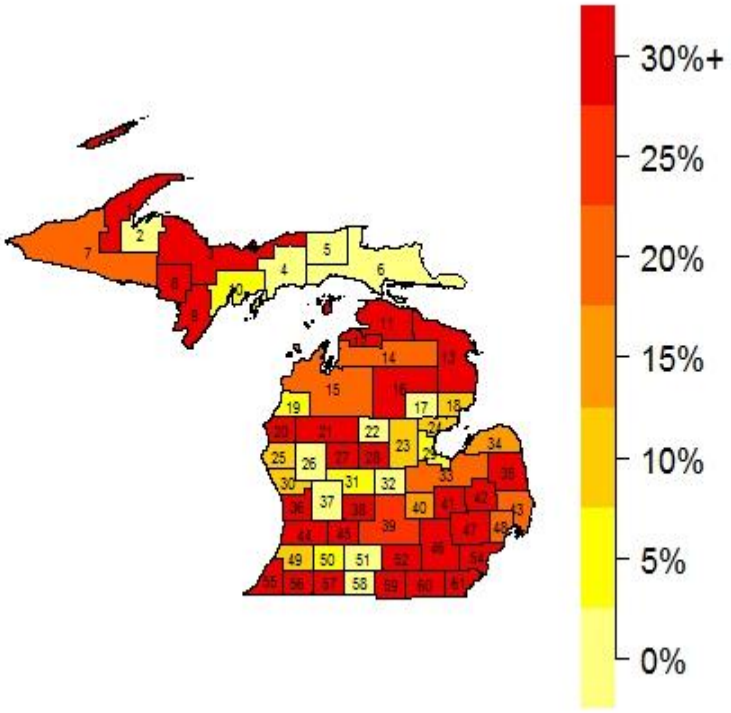
At the MCA level, medication allergies exhibit significant proportions of missing or invalid values across all MCAs; few MCAs exhibit missing or invalid values for less than 5 percent of incidents: 31, 35, 50, and 58.



MEDICAL SURGICAL HISTORY

Figure 26. Medical Surgical History Missingness at the MCA Level: See Table 12 for MCA names (MCA 53 and 54 are represented by MCA 54)

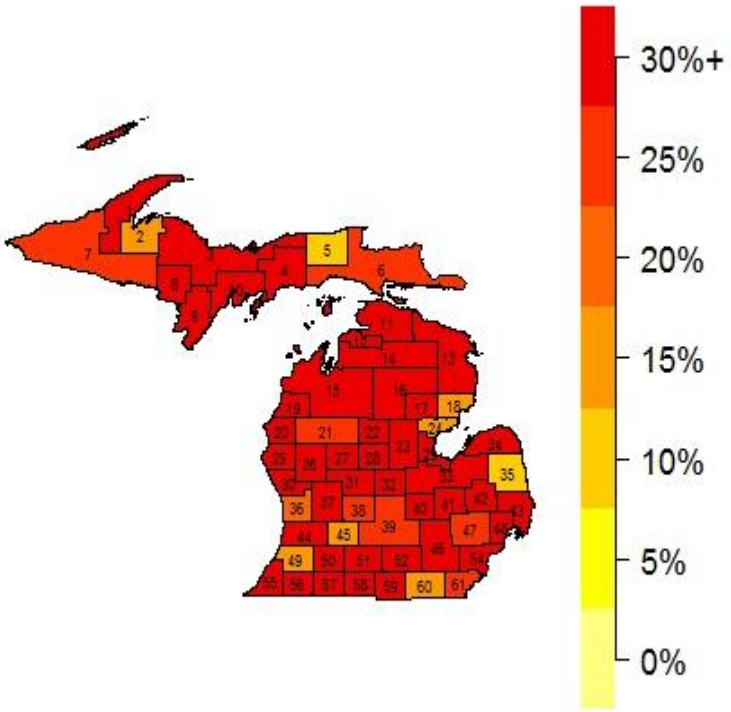
Medical and surgical history exhibits extensive variation in missing or invalid values at the MCA level, with some MCAs exhibiting less than 10 percent missing while others exhibit greater than 20 percent missing or invalid values.



CURRENT MEDICATION NAME

Figure 27. Current Medication Name: See Table 12 for MCA names (MCA 53 and 54 are represented by MCA 54)

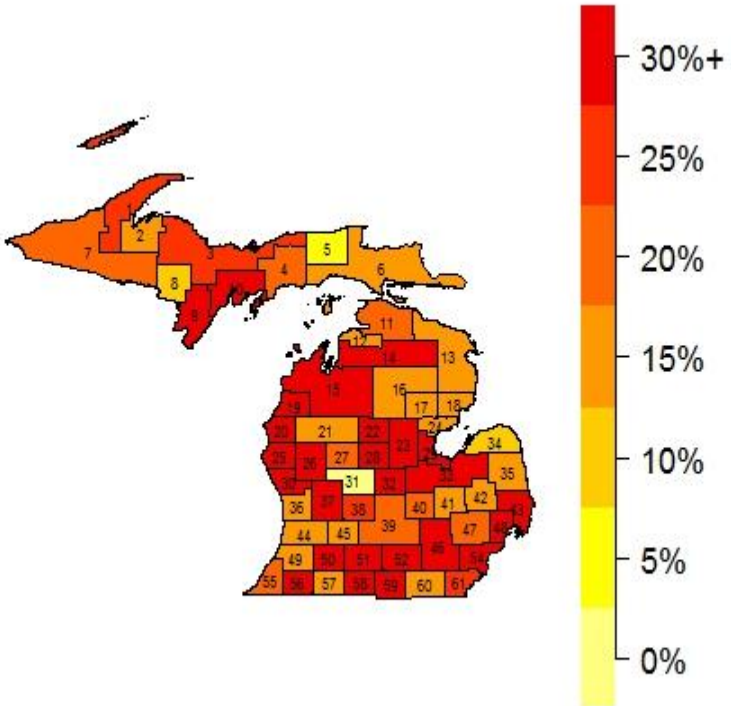
Current medication name is missing or invalid for nearly all MCAs for greater than 20 percent of incidences.



SYSTOLIC BLOOD PRESSURE

Figure 28. Systolic Blood Pressure Data Missingness at the MCA Level: See Table 12 for MCA names (MCA 53 and 54 are represented by MCA 54)

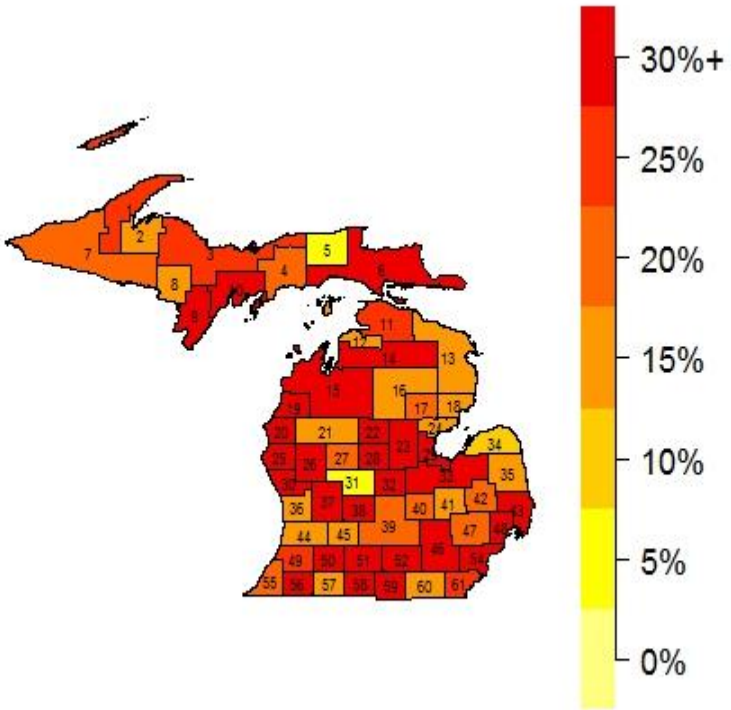
Systolic blood pressure is missing or invalid for the vast majority of MCAs for greater than 20 percent of incidents. Only two MCAs (MCAs 5 and 31) report less than 10 percent missing or invalid values for this variable.



DIASTOLIC BLOOD PRESSURE

Figure 29. Diastolic Blood Pressure Data Missingness at the MCA Level: See Table 12 for MCA names (MCA 53 and 54 are represented by MCA 54)

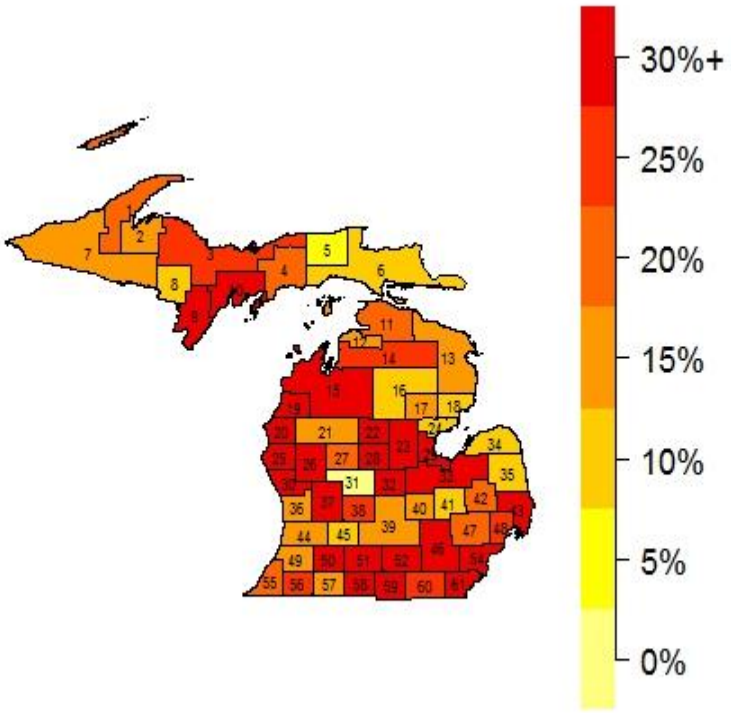
Diastolic blood pressure is missing or invalid for the vast majority of MCAs for greater than 20 percent of incidents. Only two MCAs report less than 10 percent missing or invalid values for this variable: 5 and 31.



PULSE RATE

Figure 30. Pulse Rate Data Missingness at the MCA Level: See Table 12 for MCA names (MCA 53 and 54 are represented by MCA 54)

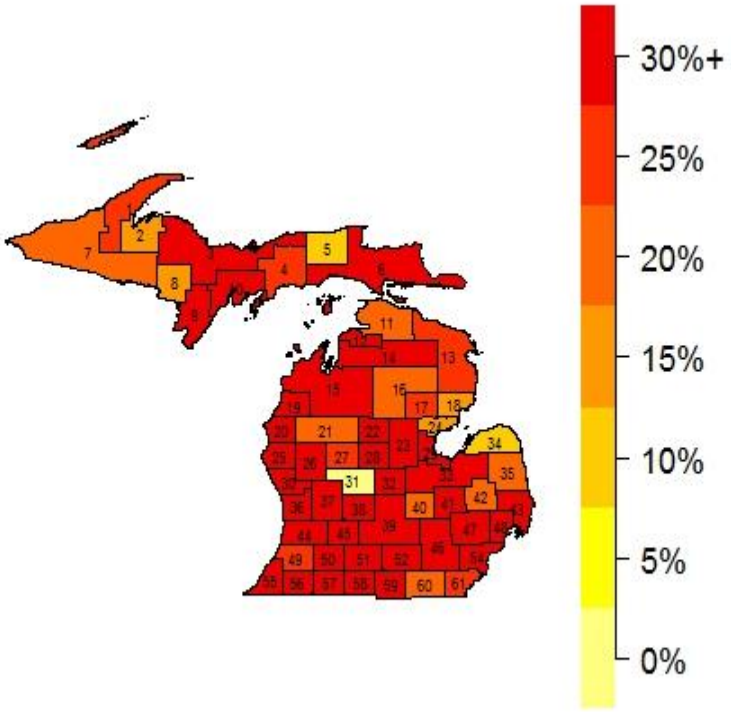
Pulse rate data is missing or invalid at a significant level for the majority of MCAs. Only two MCAs exhibit less than 10 percent missing or invalid values: 5 and 31.



PULSE OXIMETRY

Figure 31. Pulse Oximetry Data Missingness at the MCA Level: See Table 12 for MCA names (MCA 53 and 54 are represented by MCA 54)

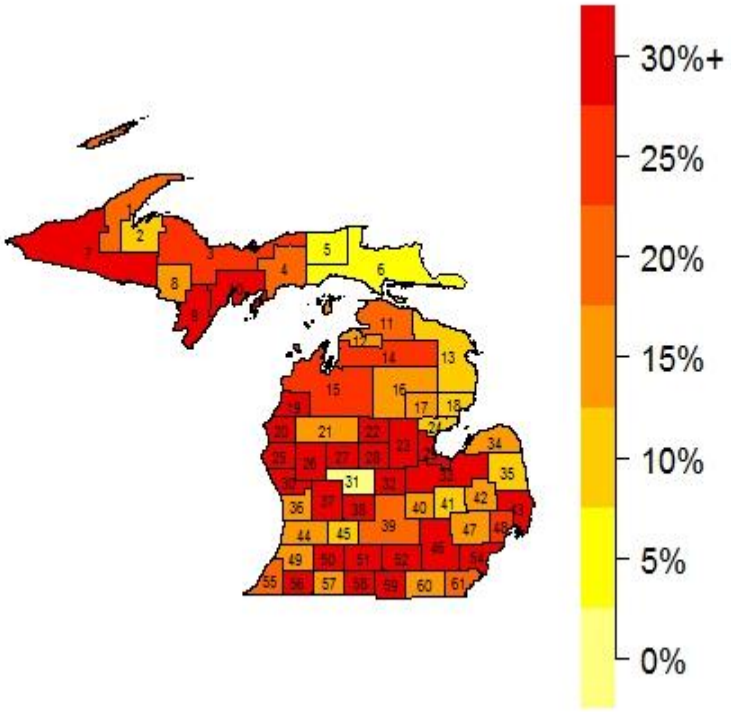
Pulse oximetry data is missing or invalid for greater than 30 percent of incidences at the MCA level for the vast majority of MCAs. Only MCA 31 exhibits less than 5 percent missing or invalid values.



RESPIRATORY RATE

Figure 32. Respiratory Rate Data Missingness at the MCA Level: See Table 12 for MCA Names (MCA 53 and 54 are represented by MCA 54)

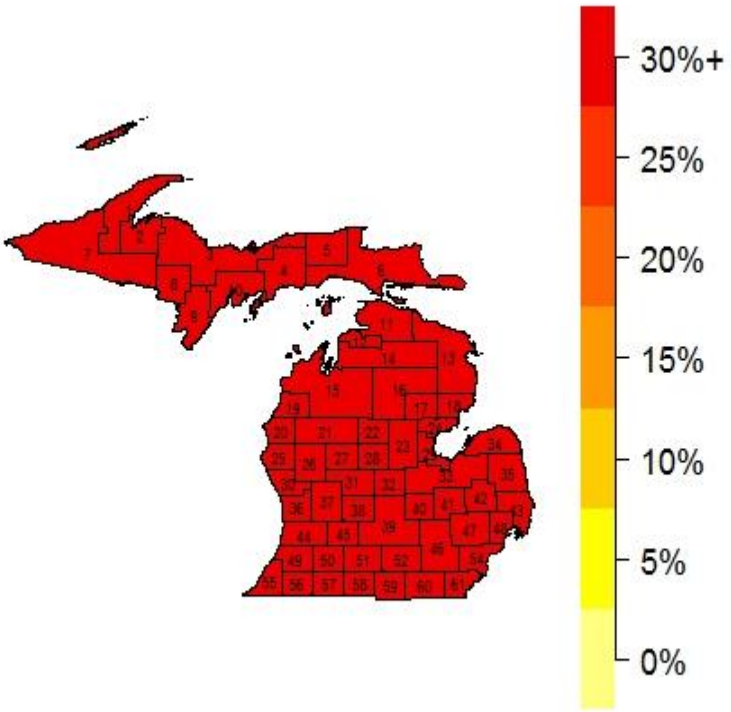
Respiratory rate data varies greatly in missing or invalid values from less than 5 percent in MCA 31 to greater than 30 percent in the majority of MCAs.



BODY TEMPERATURE

Figure 33. Body Temperature Data Missingness at the MCA Level: See Table 12 for MCA Names (MCA 53 and 54 are represented by MCA 54)

Body temperature data is missing or invalid at the MCA level across all MCAs for more than 30 percent of incidences.



SYNOPSIS OF ANALYSES

Our analyses show no consistent trend across the variables studied in regard to missing or invalid values from 2010 to 2015. Most variables showed consistent trajectories in data reporting, with little changes in the proportions of missing or invalid values, with the exception of relatively large decreases in the proportion of missing or invalid values for *Race*, *Destination name*, and *Destination Code*.

Of the 16 variables included in this analysis, only five exhibited less than 10 percent missingness in the year 2015: *Chief Complaint Narrative*, *Providers Primary Impression*, *Incident Zip Code*, *Gender*, and *Age*, while only *Incident Zip Code* and *Provider's Primary Impression* exhibited less than 5 percent missingness. Analyses with this level of missingness would likely not pass peer review and would in all likelihood be treated cautiously by quality improvement professionals. Precise measurement of patient outcome variables that account for sources of potential confounding or bias is essential for advancing the current understanding of the effectiveness of pre-hospital care delivery. Such data are also needed in order to guide future quality improvement initiatives.

At the agency-level we noticed that average (mean) rates of missing or invalid values by agency for the year 2015 were consistently larger than missing or invalid values for the same variables at the incident level, suggesting there are many agencies with very high levels of missingness that are raising the average rate of missingness. Supporting this is the observation that standard deviations (a measure for variation in data) for missingness are very large—around 15 to 37. Also, minimum and maximum range from 0–100, suggesting that some agencies report completely while some do not report at all. MI-EMSIS, like other datasets, faces challenges related to data entry and reporting originating from the contributing EMS agencies. So it is critical that all agencies report accurate and valid data. If agencies have different definitions or internal protocols for data entry, comparative analyses of these data may not be appropriate.

It is important to note that the observed proportions of missing and invalid data vary across different variables in MI-EMSIS and vary based on all stratifiers: agency, MCA, and software. The proportion of missing data is directly related to the quality of statistical inferences. This means that datasets with large amounts of missingness may be unusable. Although there are no formally established cutoffs in the literature regarding acceptable proportions of missing data, there are assertions that analyses would be biased when missingness is greater than 10 percent and largely inconsequential if less than 5 percent. [76-77] Several different approaches are taken to address missingness in large datasets. Techniques referred to as single or multiple imputation attempt to "mimic" missing data by providing an "informed guess" at a missing data point by substituting the blank value with a mean value, or the results of a regression equation or even multiple simulations of other observed values.[78] Multiple imputation, and other more simplistic approaches such as list wise deletion and mean imputation, rely on the data being "missing at random". Missingness can be addressed using values for variables (e.g. covariates) from other observations in the dataset. However, for datasets with high proportions of missingness imputation approaches can produce seriously misleading inference, particularly when the proportion missing is high.[78]

In the year 2015, 28 software platforms were used but just six platforms accounted for 82 percent of this data. Of these six, incidents reported through the platform *eMedicReports* exhibited the lowest levels of missing/or invalid data for most but not all variable. Assuming the agencies using this platform are not substantially different from those using other platforms, we may assume that *eMedicReports* is more usable and/or has fewer compatibility issues with MI-EMSIS. Given variation in missingness by software platforms, we believe there may be different extents of data-mapping issues between different software platforms and MI-EMSIS.

Because the MI-EMSIS dataset does not contain an MCA variable, the analysis of missingness at the MCA level was not readily doable. The study team created a new variable for MCA using a list provided by MDHHS of agencies and their corresponding MCAs. Incorporating an MCA ID and Trauma Region ID for all incidents in MI-EMSIS will make the dataset usable for MCA-level quality improvement efforts, providing both the state and local MCAs information to guide oversight. Given that there appear to be some MCAs that significantly underreport certain variables, investing in the capability to analyze MI-EMSIS data at the MCA level will allow evaluation of missingness to determine if it is the result of software usability, data-mapping, data entry, and/or data entry QA issues.

The adoption of electronic data collection in the pre-hospital setting can only support quality improvement if its entry is complete. These analyses should be used to pinpoint areas requiring improvement by EMS agencies and MCAs. A collaboration should occur through state MCA leaders, EMS agency data managers, software developers, and the state MI-EMSIS data manager to develop standard data entry protocol, data validation rules, definitions, and the resolution of any data-mapping issues.

Stakeholder Interviews

Through information gleaned from the environmental scan (Phase 1) and analysis of MI-EMSIS (Phase 2) we developed a guide for focus groups and key informant interviews to be conducted with key stakeholders in Michigan, including emergency medical technicians (EMTs), MCA leadership, hospital administrators and leadership, emergency room directors, EMS agency leadership staff, and others. We conducted four focus groups of 5 to 13 participants each, and 10 key informant interviews. The recruitment strategy for focus group and one-on-one interview participants and the composition of focus groups was decided on with input from MDHHS partners and in a manner that ensured representation from an array of MCAs across the state. The goals of these focus groups and one-on-one interviews were to: 1) Determine the facilitators and barriers of successful EMS oversight to inform MCA structure and performance quality; 2) identify factors that may be important to MCAs in specific localities (e.g. Upper Peninsula vs. metropolitan areas); and 3) identify challenges to more reliable and valid data collection and reporting through MI-EMSIS.

BACKGROUND

The literature that exists on EMS oversight generally provides outlines of what oversight should do (e.g., provide quality improvement infrastructure, medical direction, encourage regionalized coordination, and standardize care). The importance of these factors to effective EMS oversight is generally recognized, but how they are carried out in practice and what factors facilitate them, as the IOM reported, is less well known.

Given that EMS oversight is a relatively less-understood level of pre-hospital care and involves complex relationships within and between multiple stakeholders—for example, state and local governments, hospitals, transport agencies, and first responders—we used a combination of semi-structured interviews and focus groups with EMS oversight personnel, providers, and other stakeholders to determine the facilitators and barriers of successful EMS oversight.

APPROACH

Four 90-minute focus groups of 5-13 participants, and ten 60-minute one-on-one interviews with leadership and staff from MCAs, EMS agencies, and hospitals representing diversity in performance, community setting, geographic region, and professional roles, were conducted in Michigan. The interviews and focus groups transcripts were then analyzed using a rapid analysis technique, a team-based method of ethnographic inquiry using triangulation and iterative data analysis to develop actionable information from an insider's perspective to inform policy.[79-80]

PARTICIPANT SELECTION

Participants were selected purposefully to ensure representation from urban, rural, and suburban settings; bottom- and top-performance (with input from MDHHS based on the state's perception of MCA performance through dashboard metrics such as the degree of MCA engagement with the state); professional roles (MCA medical or executive directors, quality improvement or EMS coordinators, and paramedics); and the various regions of the state (based on the state's eight trauma regions). State trauma regions comprise local MCAs that coordinate as a network to oversee regional preparedness and provide trauma care oversight.[81] Sampling based on trauma regions allowed for the representation of geographically distinct areas as well as providing rapport between focus groups members, and providing a shared understanding of their region's practices, needs, and relationships, all of which can contribute to reducing common barriers to discussion among participants in focus groups.

Using a publicly available MCA directory published by MDHHS, potential participants were contacted by email and phone using semi-structured recruitment scripts. From those expressing interest, final key-informant **(Table 12)** and focus group **(Table 13)** participants were chosen in a manner that assured representative diversity of community settings, performance, professional roles, and geographic areas. Anonymity was assured and an incentive payment was included for participants.

Table 13. Stakeholder Focus Groups			
	MCAs	Roles	Community Setting
1.	HEMS Detroit-East Macomb Washtenaw-Livingston Genesee	2 Executive Directors 1 Medical Director 4 EMS Coordinators 2 Paramedics 1 QI Coordinator	Urban and Suburban
2.	Calhoun Kalamazoo Branch Cass	4 Executive Directors 5 EMS Coordinators 2 QI Coordinators 1 Medical Director 1 Paramedic	Suburban and Rural
3.	Tuscola Alpena Osceola Ottawa Kent	2 Executive Directors 2 Paramedics 1 EMS Coordinator 1 Medical Director 1 QI Coordinator	Suburban and Rural
4.	Eastern UP Schoolcraft Marquette-Alger Manistique Gogebic/Ontonagon	2 Executive Directors 1 Medical Director 1 EMS Coordinator/Paramedic 1 EMS Coordinator	Rural

Table 14. Stakeholder Interviews		
	Roles	Community Setting
1.	Medical Director	Suburban
2.	Executive Director	Suburban
3.	Medical Director	Rural
4.	QI Coordinator	Rural
5.	Executive Director	Suburban
6.	Executive Director	Suburban
7.	QI Coordinator	Rural
8.	QI Coordinator	Urban
9.	Medical Director	Rural
10.	Medical Director	Urban

DATA COLLECTION AND PROCESSING

Three study members served as the moderator for four focus groups and 10 one-on-one interviews. Interview and focus group guides were developed to be open-ended regarding successful EMS oversight in general while later covering particular areas pertinent to EMS oversight such as quality improvement efforts and relationships with pre-hospital EMS providers and hospitals. The complete interview and focus group guide is available in the appendix **(Appendix 6).**

Due to the small numbers of persons that make up these oversight organizations, the professional positions of participants, and the sensitive nature of discussing identifiable relationships, we needed to assure complete anonymity for participation. To do this, we did not refer any comments to specific individuals and report all focus group discussions on an anonymous basis.

DATA ANALYSIS

After the conclusion of each interview or focus group a rapid analysis technique was utilized to analyze the transcripts and iteratively revise the interview and focus group guides as indicated. This involved taking each transcript and extracting key-informant responses into a structured rapid-analysis template in the form of generalized statements and illustrative quotes **(Appendix 7)**. After extracting into individual rapid analysis templates for each transcript, all extracted statements from all rapid analysis templates

were consolidated into a matrix in Microsoft Excel as described by Miles, Huberman, and Saladna.[82] This matrix was synthesized to eliminate duplicative statements and then summarized to report results.

FINDINGS

From stakeholder interviews and focus groups we identified facilitators and barriers to MCA success in the following seven areas:

1. Organizational Structure
2. Leadership
3. Relationships & Communication
4. Competition & Collaboration
5. Quality Improvement Culture & Practice
6. Resources
7. Community-Specific Needs

Participants from top-performing MCAs identified factors within these areas as associated with success which many bottom-performing MCAs identified as lacking in their organization. Furthermore, we found that some factors within these areas associated with successful MCAs were applicable universally, whereas others required community-specific consideration (e.g., urban vs. rural).

ORGANIZATIONAL STRUCTURE

Organizational structure referred to the sub-components of MCAs and the various roles within them. This included discussions around various committees, their relationships with one another, and the relationships between various roles within the MCA. It was found that separate but synchronous medical directorship and administrative directorship facilitated effective EMS oversight. Administrative directors allowed medical directors to focus on protocol compliance while administrative directors could focus on issues of long-term quality improvement and operations. For larger MCAs, such as those in urban areas or for those with the available resources to do so, dedicated quality improvement coordinators were deemed very effective in handling daily QI efforts while administrative directors could dedicate time to overseeing and executing the MCA's larger strategy.

Another finding that emerged was the issue of representation in the various committees (e.g. quality improvement or protocol compliance committees). A lack of representation of any stakeholder group, such as first responders, or a particular professional role, such as paramedics, reduced buy-in and engagement from these stakeholders. In addition to professional roles, the hierarchical position of the representatives was also discussed; the inclusion of field staff such as paramedics was important to receive information from the field regarding barriers and how to best implement protocol; the inclusion of representatives in leadership positions gave the committee executive decision-making ability.

In addition to the composition of the membership of these committees, the type and meeting frequencies of various committees was also raised. It was reported that a combination of regular and ad hoc

committees were necessary to be a stable yet nimble oversight agency. Examples of this included the permanence of quality improvement committees and the ad hoc nature of a committee created for the sole purpose of implementing recent legislation in the state requiring the inclusion of the opiate-based drug Naloxone in all EMS drug boxes. It was suggested that while many types of committees such as quality improvement or protocol compliance were applicable across different regions, some could require adaptations in structure and practice given their respective EMS provider types, patient populations, and geographies. Stakeholders noted that it would be very helpful if MDHHS were to clarify the best organizational models for MCAs but stopped short of supporting prescriptions for their organization given possible community-specific needs and barriers.

LEADERSHIP

Leadership referred to those personnel directing the oversight organization and the leadership of their stakeholders such as hospitals or EMS agencies. It was commonly reported that staff turnover was a key challenge in this area. When persons once occupying a position did not occupy it any longer or were replaced by other persons there were often reductions in long-term strategic ability and operation.

In addition to this there were many discussions of the necessary characteristics of MCA leaders. It was often stated that collaborative administrative leaders were most effective in generating “buy-in” from agencies being overseen and other stakeholders; they also set the “tone” for an MCA's organizational culture, especially regarding quality improvement. It was reported that impartiality, willingness to learn, and a strong command of the issues are essential to effective leadership.

Participants expressed that the MCA medical directors, needed to be a physician, ideally with pre-hospital care experience and should be accessible to field staff offline for information regarding unusual circumstances or complicated patients. The importance of medical directors being aware of EMS field operations was expressed often, especially in situations that necessitate deviation from protocol. Some stakeholders suggested that MDHHS should consider creating regional medical directorships to be shared between several MCAs, especially in areas with few experts.

RELATIONSHIPS & COMMUNICATION

Relationships referred to interorganizational interactions and cultures. It was reported that long-lasting relationships fostered collaboration. Involving different stakeholders in protocol development supported a positive working relationship between oversight and overseen provider organizations. Other facilitators of positive relationships included transparency and inclusion in the oversight body’s committees even in a non-voting role. In the area of relationships, it was reported that transparency in decision- and rule-making was important both within the MCA and with respect to an MCA's relationship with overseen EMS agencies.

Communication referred to when stakeholders considered the feedback of other stakeholders, and when or how this information was received or recognized. It was reported that a combination of formal and informal communication between oversight and EMS agencies fostered collaboration and performance.

Formal communication events such as conferences and quarterly meetings can provide venues for setting long-term strategies, and regional collaborations, as well as information-sharing. Informal, frequent communication can assure quality operations and preempt future issues between providers, or between providers and the oversight agency. Some stakeholders recommended that MDHHS promote regional MCA councils that meet a few times a year as a way of promoting cross MCA collaboration and coordination.

COMPETITION & COLLABORATION

Competition and collaboration referred to when stakeholders within an MCA (such as its various agencies or hospitals) vied for market-share, pursued organization-specific interests, or put aside these differences to cooperate on initiatives. Competition between agencies and hospitals was often cited as a barrier to collaboration in protocol development or regionalized quality improvement initiatives. Regarding the management of this competition and collaboration by oversight agencies stakeholders reported that there was no role for MCAs in managing competition between agencies, and that the focus should be "on citizens" and setting standards and applying them evenly across the board. Participants recognized that creating an MCA guidebook with their input may provide helpful information for promoting collaboration across MCAs. Ultimately, there was consensus that MCAs must treat all agencies similarly and in a fair and even manner. The application of protocol, rules, and bylaws equally and without any bias was reported as being essential to successful oversight.

QUALITY IMPROVEMENT CULTURE & PRACTICE

Quality Improvement referred to either a) efforts by MCA staff to improve their own MCA/oversight operations, b) efforts by MCA staff to improve EMS agencies, or c) efforts by agencies to improve their own quality. It was reported that most quality improvement exists at the EMS agency-level and that few formal quality improvement processes existed at the oversight or integrated pre-hospital systems level.

MCA stakeholders reported that they underwent no external evaluations outside the MDHHS MCA Evaluation Survey. Participants expressed that because no information was received from MDHHS after the survey was completed, there was no way to use the survey to improve their operations. It was often suggested that the performance of MCAs be assessed in terms of fulfilling their oversight duties and improving protocol compliance and patient outcomes in their areas.

At the intersection of MCAs and EMS agencies, it was reported that less punitive oversight encouraged transparency and quality improvement partnerships between MCAs and EMS agencies. This type of relationship reportedly encourages EMS agencies to self-report problems that arise. EMS agency stakeholders suggested that MCAs should be clear about practice guidelines, but leave operational decisions to agencies.

In terms of evaluating and improving MCA quality, stakeholders requested a "system of care" approach that evaluated all the pieces of the MCA's care delivery system, such as how calls were being handled, first responders were being instructed, and how hospital outcomes were being evaluated, etc.

Participants suggested a "statewide report card" based on metrics such as timeframe for complaints, protocol compliance, other components related to patient outcomes, and whether/and how MCAs are measuring and reporting these. Also, an accreditation process was suggested to ensure that MCAs are "meeting the letter of the law" while allowing variation based on local needs and resources. An external review of MCAs based on clear performance measures was also suggested.

Many stakeholders voiced complaints regarding the inability to receive real-time patient outcomes data from hospitals for QI. This was something they report previously having the capability to do when paper run sheets were used. Some EMS agency stakeholders reported that MDHHS and MCA emphasis has shifted to data reporting and less on feedback. In reference to MI-EMSIS, MCA stakeholders reported that for MCAs to be able to conduct high-quality oversight, functional quality improvement databases and uniform definitions were required. Stakeholders suggested that MDHHS provide a dictionary of terms and concepts to aid in correct and consistent data entry.

In addition to data entry issues, differences in the functionality and availability of data fields were reported to be contingent upon the choice of software used by EMS providers for data entry to MI-EMSIS. This variation was perceived to impact data completeness reportedly due to data-mapping issues, and limited the ability of MCAs to perform quality improvement using MI-EMSIS. Reducing this variation in data entry software used was suggested as a solution but some participants indicated that platform choice should be that of the agency's, not the state or MCA. MCA stakeholders report that there is "no teeth" to the requirement to comply with MI-EMSIS data input but MDHHS can still guide software compatibility improvement or education on data entry. Furthermore, stakeholders suggested that MI-EMSIS ultimately had no relevance to MCAs because it has no capacity to run MCA level reports and does not achieve the original goal of following a patient from EMS dispatch to final hospital-based outcomes.

RESOURCES

Resources referred to any discussion of infrastructure, money, funding schemes, budgeting, or related topics. The ability of personnel to commit time, effort, and focus to oversight was contingent upon the local MCAs availability of resources. Given a lack of resources, many personnel participated in the MCA on a volunteer or part-time basis. It was reported that variation in MCAs both in terms of regional needs and resources made benchmarking standards difficult.

Much of this resource variation was reportedly associated with rural and urban status or the general socioeconomic status of the MCA. If an MCA included fewer hospitals, or more resource deprived hospitals, it was deemed to be more difficult to generate the funds to invest in MCAs. This limits their ability to budget for personnel or finance QI initiatives. Tied in with the issue of budgeting for personnel and financing QI initiatives and evaluations, many MCA stakeholders reported that they lacked the infrastructure for engaging in oversight such as up-to-date dispatch technology, communications systems, computer technology, and the personnel to maintain them. For example, in the context of MI-EMSIS, data reporting is time-consuming, it also takes proper information technology infrastructure to enter correct data entry. Participants expressed that when MCAs lack these resources it is difficult for them to determine why certain agency software platforms upload seamlessly to MI-EMSIS and others do not.

Stakeholders suggested that MDHHS should communicate the value of MCAs to the leadership of hospitals in order to encourage funding or provide some model or mandate for hospitals to financially support MCAs. While some participants wanted the state to provide funding for MCAs, others argued against state/federal funding because often there are "strings attached" and they may not allow for wide variation and tailored needs of MCAs. Some participants expressed that state-funding would mean bureaucracy, loss of control, and loss of community connections that may degrade existing relationships. Some participants expressed that funding should come collaboratively from all stakeholders. Possible alternate funding sources for MCAs that participants suggested: CMS, private industry, and foundations.

COMMUNITY SPECIFIC FACTORS

Many but not all community specific factors fit into the previously discussed themes. Depending on the nature of 9-1-1 dispatch policy in an area, MCAs may be unable to monitor or improve EMS dispatch. Other community specific issues arise in rural areas where many EMS agencies take over the MCA role of oversight, but this presents conflicts of interest (e.g., MCA staff reviewing their own run reports). To better satisfy community specific needs, some stakeholders strongly supported the use of EMS certificate of need programs, similar to those used for hospitals, and that MCAs should determine the specific needs of their local population.

A particular issue in rural areas are the use of volunteer medics that may only do two runs a year, in this context more direct access to the medical director becomes crucial. Participants expressed that state centralized protocols need to take these types of local needs and challenges into consideration. Further illustrating these needs, long distances between patient pickup and hospitals in rural areas results in longer travel times. Coupled with limitations on drug box items, long travel times may result in the inability to provide a time-sensitive treatment to a patient. Because many of these areas, such as rural ones do not have high numbers of cases, requesting an addendum often proves unsuccessful.

Many MCA stakeholders in the Upper Peninsula (UP) report that temporary staff from "downstate" do not know their prehospital protocols but their temporary status does not support the time investment required to educate them. Given this, these MCAs heavily rely on medical direction over long distances. This increased need of medical director attention can be better facilitated from a medical director that is a local physician because they may better establish relationships with local EMS staff. Participants further expressed the need for "homegrown" paid MCA staff who understand their local needs and challenges and increase personal investment and decrease their turnover.

SYNOPSIS OF ANALYSES

Overall qualitative data indicated that EMS and MCA stakeholders perceived successful MCAs as those with successful patient outcomes, administered by highly competent and engaged directors, those that applied protocols fairly and consistently among participating EMS agencies, those that were well resourced and utilized paid positions, and those that collaborated with stakeholders and their leadership. Barriers to success included less infrastructure, leadership and staff turnover or insufficient staffing, unilateral decision-making without including voice of key stakeholders, variation across MCAs in funding, and leadership that was uninformed or did not involve all key stakeholders. Regarding the promotion of these practices, participants advocated for the use of quarterly regional meetings and annual medical control conferences but asked for an "authority" to help accurately identify what truly are best practices so that they may be disseminated to MCAs across the state.

There was consensus that satisfying the statutorily required elements of MCAs was essential, but not sufficient for an MCA to be highly effective. These themes and their insights should be used to develop an MCA guidebook, and inform the development of MCA quality measures and related state policy. For example, it was reported that MCAs needed regular committees for items such as protocol development, professional reviews, and quality improvement while still being prepared for atypical issues as they arise such as the ongoing opioid epidemic and subsequent legislation for pre-hospital providers to carry specific medication for treating opioid overdose. This belies a recommendation that MCAs have a process or members for the convening of ad hoc committees to address new legislation or epidemiologic trends as they occur (e.g., rise in motor vehicle trauma or drug overdoses) related to pre-hospital care. More detailed recommendations based on results of qualitative analysis are included in the synthesis and recommendations chapter.

Synthesis and Recommendations

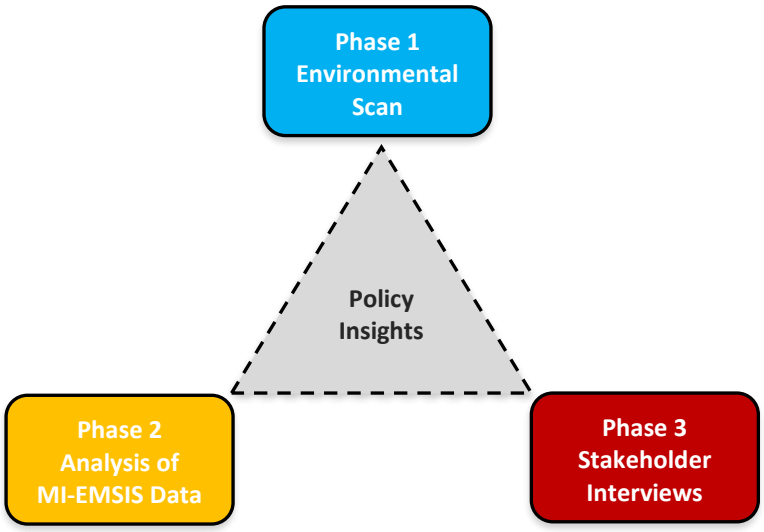
SYNTHESIS

As mentioned previously, the Institute of Medicine recognized persistent knowledge gaps regarding best practices for EMS oversight and recommended improving our understanding of the respective and potential roles of governments, communities, and healthcare providers in improving EMS. This project puts Michigan at the forefront of filling this knowledge gap and informs MCA structure and performance quality measurement and related policy through triangulating results from the following three phases:

Phase 1: Environmental Scan
A systematic review of peer-reviewed and grey literature to evaluate existing quality measures of EMS oversight.

Phase 2: Analysis of MI-EMSIS Data
Quantitative descriptive analysis of the level of missingness of reported variables in the Michigan EMS Information System (MI-EMSIS).

Phase 3: Stakeholder Interviews
Qualitative analysis of focus groups and key informant interviews with EMS stakeholders representing diversity in performance, community-setting, geographic region, and professional roles.



Triangulated results suggest that high-quality EMS oversight occurs through the following seven areas: organizational structure, leadership, relationships & communication, resources, competition & collaboration, community specific factors, and quality improvement culture & practice. In the following seven sections we propose policy recommendations related to each area.

RECCOMENDATIONS

ORGANIZATIONAL STRUCTURE

Interviewed MCA stakeholders reported that separate but synchronous medical directorship and administrative directorship facilitated more effective EMS oversight. Administrative directors allowed medical directors to focus on protocol compliance while administrative directors could focus on issues of long-term quality improvement and operations. Given this and the pre-existing literature's emphasis on the importance of dedicating expertise and effort to administrative requirements and QI efforts we recommend that:

> **Recommendation 1: Promote an MCA organizational structure that includes both an administrative director and medical director.**

Another finding that emerged was the issue of representation in the various committees (e.g. quality improvement or protocol compliance committees). A lack of representation of any stakeholder group, such as first responders, or a particular professional role, such as paramedics, reduced buy-in and engagement from these stakeholders. In addition to professional roles, the hierarchical position of the representatives was also found to be of importance; the inclusion of field staff such as paramedics was important to receive information from the field regarding barriers and how to best implement protocol; the inclusion of representatives in leadership positions gave the committee executive ability. Given this we recommend:

> **Recommendation 2: Encourage MCA boards to include representation from all key stakeholders.**

It was commonly reported by stakeholders that staff turnover was a key challenge in this area to retaining continuity in MCA operation. The literature also suggested that more experienced staff were better familiar with protocol and its implementation.

> **Recommendation 3: Identify and promote strategies to help MCAs retain staff and promote the development of training materials for replacement staff to mitigate the effects of turnover.**

LEADERSHIP

It was often stated that collaborative administrative leaders were most effective in generating "buy-in" from agencies being overseen and other stakeholders; they also set the "tone" for an MCA's organizational culture, especially regarding quality improvement. For all leaders it was reported that impartiality, willingness to learn and a strong command of the issues are essential.

> **Recommendation 4: Advocate for MCA leadership to have demonstrated ability and/or actively develop key leadership traits: Informed and engaged leadership that is collaborative, open to different perspectives, and able to balance multiple priorities effectively.**

Medical directors, needed to be physicians, ideally with pre-hospital care experience and should be accessible to field staff offline for information regarding unusual circumstances or complicated patients. The importance of medical directors being aware of EMS field operations was expressed often, especially in situations that necessitate deviation from protocol. Some stakeholders suggested that MDHHS should consider creating regional medical directorships to be shared between several MCAs, especially in areas with few experts.

> **Recommendation 5: Promote cross-MCA medical directorship in regions with limited number of expert individuals.**

RELATIONSHIPS & COMMUNICATION

Literature and stakeholders encourage hospitals and EMS providers to have respectful working relationships in order to foster collaboration. Knowing the leadership of neighboring MCAs is one way to enable this collaboration as well as regional QI efforts and information-sharing. Although it can be challenging to engage first-responders and EMS simultaneously or insist on their collaboration, efforts must still take place. Formal communication events such as regional conferences and quarterly meetings can provide venues for developing these relationships. In addition to formal events, informal frequent communication between leaders within and between different MCAs can assure quality operation and preempt future issues.

> **Recommendation 6: Promote regional MCA conferences for MCA leaders to coordinate and collaborate, especially in regions where such conferences are currently not held.**

COMPETITION & COLLABORATION

Competition amongst agencies and hospitals was cited by stakeholders as a barrier to collaboration in protocol development and regionalized quality improvement initiatives. Most stakeholders though report being able to put aside competitive interests and “focus on citizens”. Participants suggested MDHHS guidance through suggestions for promoting collaboration across MCAs may be useful. Ultimately, regarding competition, there was consensus that MCAs must treat all agencies similarly and in a fair and even manner. The application of protocol, rules, and bylaws, equally and without any bias, was reported as being essential to successful oversight.

> **Recommendation 7: Promote MCA protocols that are agency type neutral and that can be applied in a fair and even manner across agencies.**

The grey literature suggested that high quality oversight and EMS improvement needs to include all stakeholders: educational and professional credentialing programs, regulatory authorities, EMS providers, and hospitals. A systems approach is necessary to improve care, systems level protocols should be developed to improve EMS response and care delivery across the EMS response spectrum (community, first response, EMS, hospital).

Recommendation 8: Advocate for MCAs to further develop their relationships with EMS training programs across the state and promote partnerships between these educational institutions and the state's EMS agencies and professional organizations.

QUALITY IMPROVEMENT CULTURE & PRACTICE

Existing literature such as the IOM Report on Cardiac Arrest[1] and our own environmental scan show that there are few quality measures at the EMS oversight level. This finding was corroborated with stakeholder interviews and focus groups that reported few formal quality improvement processes exist at the MCA or integrated pre-hospital systems level. The literature and stakeholders report that most EMS quality improvement exists at the agency level. There is consensus in the literature that oversight agencies can play a leading role for EMS QI. Stakeholders often expressed interest in QI guidance from MDHHS.

Recommendation 9: Develop an MCA Self-Assessment Toolkit with specific structure and performance measures and suggested best practices.

Many stakeholders reported that they did not receive the results of the 2011 MDHHS MCA Evaluation Tool but expressed great interest in learning of its results. That evaluation rightly followed NHTSA recommendations in evaluating MCAs according to how well they satisfy their standards set forth by MDHHS. We would recommend that this survey be reformatted and delivered electronically every year to support continuous quality improvement. The questions should be reformatted to allow for scaled responses rather than only open-ended responses. The results of these evaluations should evaluate success as a measure of degree and not a binary pass/fail evaluation, these results should be made available to all MCAs.

Recommendation 10: Reformat and build upon 2011 MDHHS Evaluation of Michigan MCAs as an electronic survey of core statutorily required elements of MCAs and additional best practices related to the facilitators and barriers found in this report.

According to existing literature and stakeholder input, EMS quality improvement program should include an assessment of how the system is currently functioning according to the performance standards, identification of system improvements that are needed to exceed the standards, and a mechanism to measure the impact of the improvements once implemented.

Recommendation 11: Develop regional EMS quality improvement programs that assess and evaluate EMS care, including a review of system component processes and outcomes.

Recommendation 12: Develop and disseminate an MCA Guidebook with actionable insights for successful MCA strategies and operations.

PRE-HOSPITAL DATA REPORTING AND MI-EMSIS

The peer-reviewed literature suggests that oversight requires not only involvement in quality improvement through medical direction but also through creating quality monitoring and improvement infrastructure and statewide quality improvement programs.[40] This is best done through a uniform dataset and consistent reporting language from local EMS agencies to oversight authorities.[40-41] Mandating uniformity in data reporting may allow for more transparent oversight and quality assurance. There have been efforts toward this goal, most prominently, the National EMS Information System (NEMSIS), which serves as a standardized repository of pre-hospital EMS data, but is dependent on good quality data being entered into the system.[42]

NHTSA recommends statewide evaluation programs to plan, implement, and monitor EMS delivery. This is best done using a uniform, statewide, out-of-hospital data collection system that captures minimum data necessary to measure compliance with standards. Data should be consistently and routinely provided by agencies and MCAs to the Bureau of EMS Trauma and Preparedness by providers and the Bureau should perform routine analysis of this data. As the IOM stated, an absence of a data registry that captures high-quality and complete demographic data regarding race and ethnicity and socioeconomic factors makes it challenging to gather and evaluate evidence on disparities in cardiac arrest incidence, treatment, and outcomes. This is an issue that applies to all conditions treated by EMS. If these variables were more complete, MCAs and the state could take steps to assess and improve equity in the availability of EMS.

> **Recommendation 13: Develop MI-EMSIS data entry and reporting protocol, including uniform pre-hospital data element definitions, to increase reporting and reduce variation in completeness.**

Since the MI-EMSIS dataset does not contain an MCA variable, the analysis of missingness at the MCA level was not readily doable. The study team created a new variable for MCA using a list provided by MDHHS of agencies and their corresponding MCAs. Incorporating an MCA ID and Trauma Region ID for all incidents in MI-EMSIS will make the dataset usable for MCA-level quality improvement efforts, providing both the state and local MCAs information to guide oversight. Participants in focus groups also expressed the need to be able to pull data at the MCA-level for QI purposes.

> **Recommendation 14: Incorporate MCA ID and Trauma Region ID for all incidents in MI-EMSIS so that MCA level analyses can be run and used by MCA as a quality improvement tool.**

> **Recommendation 15: Promote and lower barriers to pre-hospital care quality improvement and innovation by making MI-EMSIS data available for public use.**

Given that there appear to be some MCAs that significantly underreport certain variables, investing in the capability to analyze MI-EMSIS data at the MCA level will allow evaluation of missingness to determine if it is the result of software usability, data-mapping, data entry, and/or data entry QA issues.

> **Recommendation 16: Consider promoting the use of data reporting software known to data-map properly with MI-EMSIS.**

Stakeholders report that data mapping issues reportedly exist when exporting agency data to the state repository. Currently, the proportion of missing and invalid values for essential data elements make MI-EMSIS unusable for quality improvement. The adoption of electronic data collection in the pre-hospital setting can only support quality improvement if its entry is more complete. These analyses should be used to pinpoint areas requiring improvement by EMS agencies and MCAs. A collaboration should occur through state MCA leaders, EMS agency data managers, software developers, and the state MI-EMSIS data manager to develop standard data entry protocol, data validation rules, definitions, and the resolution of any data-mapping issues.

Recommendation 17: MDHHS should collaborate with MCA and EMS agency stakeholders to investigate and resolve sources of data-incompleteness and data-mapping.

RESOURCES

Literature and stakeholder input suggest that disparities in financial, human, and physical resources (e.g., staff, technology or work-spaces) can limit oversight abilities. Much of this resource variation was reportedly associated with rural and urban status. Furthermore, if an MCA included fewer hospitals, or more resource deprived hospitals, it is reportedly more difficult to generate the funds to invest in MCAs.

Stakeholders suggested that MDHHS should mediate with hospitals so that they understand the value of MCAs to encourage funding or provide some model or mandate for hospitals to financially support MCAs, and for the state to provide funding to MCAs. Some argued against state/federal funding because often there are "strings attached" and they may not allow for wide variation and tailored needs of MCAs and because bureaucracy, loss of control, and loss of community connections may degrade existing relationships. Many participants expressed that funding should come collaboratively from all stakeholders. Possible alternate funding sources for MCAs that participants suggested: CMS, private industry, and foundations. A mechanism should be identified to fund the proposed regional MCAs infrastructure, including compensation for medical direction.

Recommendation 18: Explore methods of providing adequate and consistent MCA funding through agencies, hospitals, foundations, and private industry.

COMMUNITY SPECIFIC FACTORS

Many counties and local municipalities determine EMS system structure and develop training programs on triage, treatment, and transport protocols as well as on implementing EMS interventions, based on local needs and available resources. At the local level, the size and population density of the areas served by EMS agencies vary greatly, as do the resources available to local EMS agencies to treat those populations. Local EMS agencies may be responsible for towns and municipalities, or entire counties. In terms of resources, not all areas have access to enhanced 9-1-1 services, and the number of local medical directors varies considerably among states. Differences in the regions and populations affect EMS performance. Rural EMS systems are often responsible for larger and less densely populated areas

compared to systems in urban centers, resulting in longer transport distances and response times that negatively affect patient outcomes. Yet areas with urban sprawl, where traffic hazards and delays are common, are also associated with longer response times. In urban centers, EMS response times can also be delayed when patients arrest in the upper floors of high-rise buildings.[66] Considering these community specific needs would not detract from protocol consolidation, because as NHTSA recommended the continuing consolidation of protocols and requirements can be done in a way that allows nuance by region. Our stakeholder interviews confirmed community specific needs.

Recommendation 19: Promote consistency of protocols across regions while allowing for differences in protocols based on local needs and challenges.

Recommendation 20: Institute a statewide drug box with regional differences based on need.

Next Steps

This report, *Quality Measurement of Medical Control Authorities: A Mixed-Methods Study to Inform Quality Measures for Medical Control Authority Structure and Performance*, provides policy recommendations for the State of Michigan around key MCA performance measures. Through triangulating evidence from existing literature, an analysis MI-EMSIS, and stakeholder focus groups and interviews we identified seven areas for successful MCA oversight:

- Structure
- Leadership
- Relationships & Communication
- Competition & Collaboration
- Quality Improvement Culture & Practice
- Resources
- Community Specific Factors

There was reported variation in how well, if at all, MCAs addressed these areas. Next steps should develop these identified areas into actionable insights and strategies for MCA leaders in the form of a guidebook. The MCA Guidebook should include (1) actionable insights, (2) a toolkit of strategies to improve MCA performance, and (3) an MCA Self-Evaluation Rubric. Additional MCA Guidebook content should include an overview of MCA policy in the State of Michigan, methods for MCA leaders to foster positive interagency relationships, quality improvement initiatives and cultures, how to identify issues and organize ad hoc committees, methods of collecting data to reduce MI-EMSIS missingness in order to evaluate the impact of MCA policies on patient outcomes, how to secure buy-in from stakeholders to enhance MCA performance, and avenues for acquiring needed MCA resources.

This guidebook can transition our understanding of *what* characteristics of successful MCAs are into *how* MCA leaders can facilitate success, while considering local community variation in needs and challenges. The combination of insights, strategies, and an evaluation rubric can provide the guidance necessary for MCAs to self-evaluate and assure effective medical control.

To develop this guidebook, we propose the following objectives:

1. **Develop actionable insights and strategies for MCA leadership**, through developing previously identified practices and resources of successful MCAs, in collaboration with an MCA community advisory board (CAB).
2. **Identify community-specific preferences, needs, challenges, and priorities** regarding proposed strategies through a survey of all MCAs.
3. **Arrive at a consensus set of strategies for successful MCA performance**, i.e. a "tool-kit" for MCA leaders through a survey of all MCAs, input from the MCA CAB, and expert review through a Modified-Delphi expert panel.
4. Using a community based participatory research (CBPR) approach; we will accomplish the study objectives through the following related tasks. The project workflow is depicted in **Figure 34**.

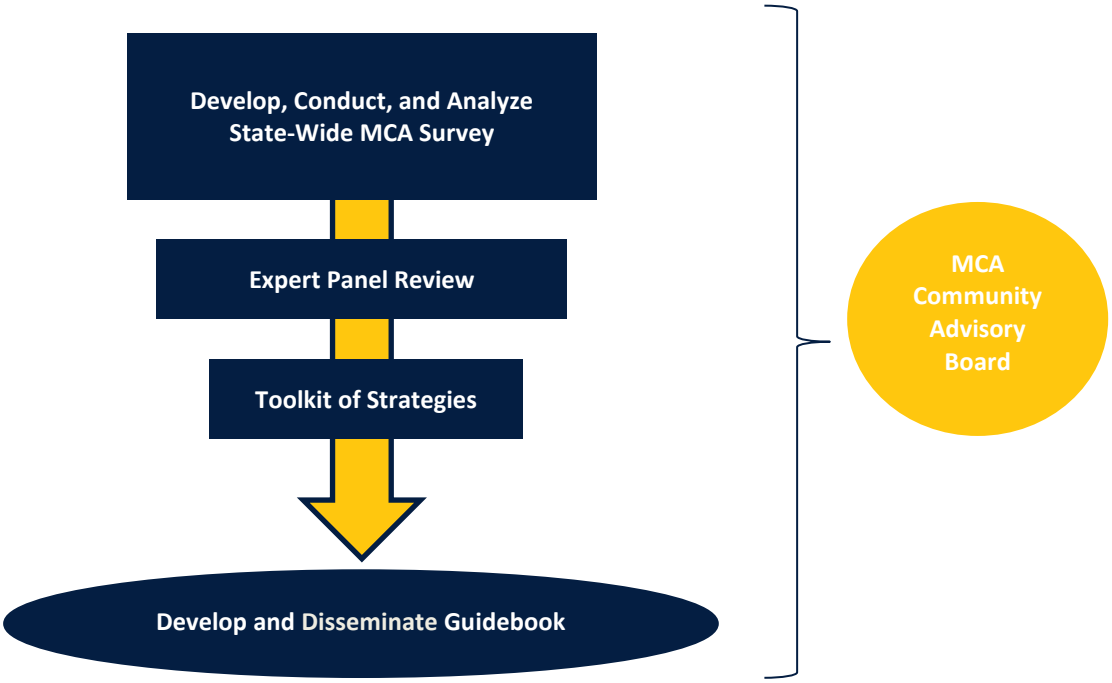


Figure 34. Next Steps Project Overview. The proposed project utilizes a community-based participatory research approach through developing and receiving input from an MCA Community Advisory Board throughout all stages, and incorporating survey-identified community needs and challenges. The inclusion of stakeholder priorities and preferences will provide insights and strategies that are deemed as most important to operating and improving MCAs. The results of the above will inform the development and dissemination of a comprehensive MCA Guidebook.

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Appendices

APPENDIX 1: SYSTEMATIC REVIEW SEARCH DETAILS

Search Engine	Search Terms
PubMED	((((((Emergency Medical Service*[Title/Abstract] OR Paramedic[Title/Abstract]) OR Prehospital[Title/Abstract]) OR Pre-hospital[Title/Abstract]) OR out-of-hospital[Title/Abstract]) OR out of hospital[Title/Abstract] OR ambulance[Title/Abstract]) OR EMS[Title/Abstract]) AND quality[Title/Abstract] AND performance[Title/Abstract] AND ("1966/03/09"[PDAT] : "2016/03/05"[PDAT]) AND ("2006/01/01"[PDat] : "2016/03/05"[PDat])
Web of Science	(from Web of Science Core Collection) TOPIC: (("emergency medical service*" OR paramedic OR prehospital OR pre-hospital OR out-of-hospital OR "out of hospital" OR ambulance OR ems) AND quality AND performance) ... TOPIC: (("emergency medical service*" OR paramedic OR prehospital OR pre-hospital OR out-of-hospital OR "out of hospital" OR ambulance OR ems) AND quality AND performance) Timespan: 1966-2016. Indexes: SCI-EXPANDED, SSCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI.
SCOPUS	TITLE-ABS((emergency medical service* OR paramedic OR prehospital OR pre-hospital OR out-of-hospital OR out of hospital OR ambulance OR ems) AND (quality AND performance)) AND DOCTYPE(ar OR re) AND SUBJAREA(MULT OR MEDI OR NURS OR VETE OR DENT OR HEAL OR MULT OR ARTS OR BUSI OR DECI OR ECON OR PSYC OR SOCI) AND PUBYEAR > 1966 AND PUBYEAR < 2016 AND (LIMIT-TO(LANGUAGE,"English"))
EMBASE	'emergency medical service*':ab,ti OR paramedic:ab,ti OR prehospital:ab,ti OR 'pre hospital':ab,ti OR 'out of hospital':ab,ti OR ambulance:ab,ti OR ems:ab,ti AND quality:ab,ti AND performance:ab,ti AND [english]/lim

APPENDIX 2: CODEBOOK

Title	Description
0. Irrelevant Article	(not EMS or no quality measures)
1. Article Type	This is used to mark what type of article this is
— 1.1 Original Article	This is used to mark original articles that are not review articles
— 1.2 Review Article	This is used to mark if an article is a literature review article
2. Type of Measure	
— 2.1 Outcome	Outcome contains all the effects of healthcare on patients or populations, including changes to health status, behavior, or knowledge as well as patient satisfaction and health-related quality of life.
— 2.2 Process	Process is the sum of all actions that make up healthcare. These commonly include diagnosis, treatment, preventive care, and patient education but may be expanded to include actions taken by the patients or their families.
— 2.3 Structure	Structure includes all the factors that affect the context in which care is delivered. This includes the physical facility, equipment, and human resources, as well as organizational characteristics such as staff training and payment methods.
3. Level of Measure	The level at which the measure describes quality.
— 3.1 Oversight Agency	A level above EMS agencies, perhaps multiple agencies or any oversight structure that exists and is spoken of in the article.
— 3.2 EMS Agency	Agency-level measures or recommendations. This may be an aggregate of an agency's personal or teams.
— 3.3 EMS Personnel	One or more EMS personnel or an ambulance vehicle.
— 3.4 Patient or condition specific	A measure at the level of an illness or condition in a specific patient or the patient as a whole.
4. Proposed Measure	These are measures that were not used in the study or article or were explicitly not uncovered by a review article. It may be described as a "gap" in quality measurement. This should be coded concurrently with '3. Level of Measure'.
5. Recommendations	Recommendations regarding the measurement of EMS/EMS oversight agencies.

APPENDIX 3: SYSTEMATIC REVIEW DATA EXTRACTION TEMPLATE

Citation	Article Type	Measure Level(s)	Measure Type(s)	Measure(s) and Tool(s)
Ailsby RL., Transportation of the Critically Ill and Injured Can Fam Physician. 1987 Jul;33:1661-4.	Original Article Canada	Patient	Outcome	1. Blood Loss 2. Pulse Rate
Aringhieri R, Carello G, Morale D. Supporting decision making to improve the performance of an Italian Emergency Medical Service. Annals of Operations Research. 2016 Jan 1;236(1):131-48.	Original Article Italy	Agency	Process	1. Percentage of Agency's responses served within the LAW time.
Aufderheide TP, Yannopoulos D, Lick CJ, Myers B, Romig LA, Stothert JC, Barnard J, Vartanian L, Pilgrim AJ, Benditt DG. Implementing the 2005 American Heart Association Guidelines improves outcomes after out-of-hospital cardiac arrest. Heart Rhythm. 2010 Oct 31;7(10):1357-62.	Original Article USA	Personnel Patient Agency	Process Outcome	1. Average ambulance response time, 2. Survival to hospital discharge, 3. Proper treatment protocol (Effective compression intervals, CPR timing, etc),
Bayley R, Weinger M, Meador S, Slovis C. Impact of ambulance crew configuration on simulated cardiac arrest resuscitation. Prehospital Emergency Care. 2008 Jan 1;12(1):62-8.	Original Article USA	Patient Personnel	Outcome	Cardiac Arrest Resuscitation errors: 1. Errors of omission, addition, 2. Or sequence (failure to administer drug, performance of extra defibrillation, intubation before defibrillation, etc).

Bowron JS, Todd KH. Job stressors and job satisfaction in a major metropolitan public EMS service. Prehospital and disaster medicine. 1999 Dec 1;14(04):32-5.	Original Article USA	Personnel Agency	Structure Process	EMS Staff (EMT and Paramedic) Reported Measures 1. Quality of training provided by ambulance service 2. Quality of interactions with hospital clinicians 3. On-line communications 4. Dispatching 5. Relationship with supervisors 6. Standing orders as presently employed by the ambulance service
Braun O. EMS system performance: the use of cardiac arrest timelines. Annals of emergency medicine. 1993 Jan 31;22(1):52-61.	Original Article USA	Agency	Process	1. Average time to treatment 2. Average time to patient
Cady G, Scott T. 1995 almanac. EMS in the United States. 1995 survey of providers in the 200 most populous cities. JEMS: a journal of emergency medical services. 1995 Jan;20(1):76-82.	Original Article USA	Personnel Agency	Process Structure	1. Response time, 2. Presence of QI practices, 3. Employment of Quality management Directors
Callaham M, Madsen CD. Relationship of timeliness of paramedic advanced life support interventions to outcome in out-of-hospital cardiac arrest treated by first responders with defibrillators. Annals of emergency medicine. 1996 May 31;27(5):638-48.	Original Article USA	Patient Personnel	Process Outcome	1. Response time 2. Survival to hospital discharge, 3. Time from medic arrival to intubation, 4. Time from medic arrival to administration o first ALS drugs, 5. Time from medic arrival to first pulse, 6. Time from first pulse to ED arrival
Carriere J, Bourque C. The effects of organizational communication on job	Original Article	Agency	Structure	1. Internal Communication Practices (of agency) via Communication Audit Survey.

satisfaction and organizational commitment in a land ambulance service and the mediating role of communication satisfaction. Career Development International. 2009 Feb 20;14(1):29-49.	Canada	Personnel		2. Satisfaction with internal communication via Communication Satisfaction Survey 3. Job Satisfaction (Likert) via Minnesota Satisfaction Questionnaire 4. Commitment to organization (EMS Agency) via Affective Organizational Commitment Scale.
Chen TT, Ma MH, Chen FJ, Hu FC, Lu YC, Chiang WC, Ko PC. The relationship between survival after out-of-hospital cardiac arrest and process measures for emergency medical service ambulance team performance. Resuscitation. 2015 Dec 31;97:55-60.	Original Article Taiwan	Personnel Patient	Outcome Process Structure	1. Survival to discharge 2. EMS Response time 3. Pre-hospital return of spontaneous circulation 4. Scene time 5. Time from scene arrival to scene departure 6. Transport time from arrival to hospital arrival 7. Presence of ALS-level paramedics
Citerio G, Galli D, Cesana GC, Bosio M, Landriscina M, Raimondi M, Rossi GP, Pesenti A. Emergency system prospective performance evaluation for cardiac arrest in Lombardia, an Italian region. Resuscitation. 2002 Dec 31;55(3):247-54.	Original Article Italy	Personnel Patient	Process Outcome	1. Interval between call and activation of ambulance 2. Interval between call and departure of the ambulance 3. Interval between call and arrival on scene of ambulance 4. Interval between call and arrival at the hospital 5. Death on scene 6. Death at ED 7. Death at hospital discharge 8. Death at 1 month
Coster, J, Irving A, Turner J, Siriwardena N, Wilson R., How should we measure ambulance service performance? European Journal of Emergency Medicine, 2014; 21(6): 458	Conference proceedings Review Article/Delphi study	Agency Personnel Patient	Process Outcome	1. Time to definitive care 2. Pain score 3. Patient Survival 4. Patient Safety 5. Correct identification of call urgency

	United Kingdom			6. Patient experience 7. Proportion of ambulance service calls referred for telephone advice who "recontact" with ambulance service within 24 hours 8. Proportion of patients given analgesia who report having pain 9. Endotracheal intubation 10. Wound infection 11. Compliance with training 12. Completion of patient records 13. Time spent on scene
Dantas RA, Torres GD, Salvetti MD, Dantas DV, Mendonça AE. Instrument for assessing the quality of mobile emergency pre-hospital care: content validation. Revista da Escola de Enfermagem da USP. 2015 Jun;49(3):380-6.	Original Article Brazil	Agency Personnel	Structure Process	Instrument of "Quality Assessment on Pre-hospital Care (QA-PHC)". 1. Ambulance Conservation Status 2. Physical Structure 3. Comfort in the Ambulance 4. Availability of material resources 5. User/staff safety 6. Continuous education 7. Safety demonstrated by the team 8. Access 9. Welcoming 10. Humanization 11. Response time 12. Customer privacy 13. Guidelines on care 14. Relationship between professionals and customers 15. Opportunity for customers to make complaints 16. Multi-professional conjunction/actuation.

Daudelin DH, Kulick ER, D'Amore K, Lutz JS, Barrientos MT, Foell K. The Massachustess Emergency Medical Service Stroke Quality Improvement Collaborative, 2009-2012. Preventing Chronic Disease 2013; 10:130126. DOI: http://10.5888/pcd10.130126	Original Article USA	Personnel	Process	1. Stroke Screening Performed 2. Blood Glucose Tested 3. Time last-known-well documented 4. Time of symptom discovery documented 5. Stroke pre-notification to hospital
David G, Harrington SE. The quality of emergency medical services. Leonard Davis Intitute of Health Economics Issue Brief. 2011 Nov;17(3):1-4.	Review Article USA	Personnel	Process	1. Response Time 2. Total Pre-hospital time
Dunford J, Domeier RM, Blackwell T, Mears G, Overton J, Rivera-Rivera EJ, Swor R. Performance measurements in emergency medical services, Prehospital Emergency Care. 2002 Jan 1;6(1):92-8.	Review Article USA	Oversight Agency Patient Personnel	Structure Process Outcome	1. Facilities, 2. Equipment, 3. Provider training and knowledge base 4. Staff credentialing. 5. Multi-casualty event response plan 6. Defibrillation Capability 7. Extrication capability 8. Appropriate steps for treatment 9. Call Processing Time 10. Transport Time 11. Travel Time 12. Staffing 13. Patient Care protocol compliance 14. Survival 15. Change in physiologic status 16. Pain relief 17. Patient satisfaction 18. Deployment 19. Road Structure Coverage Capability 20. Patient Outcomes

				21. Employee illness and injury 22. Employee turnover 23. Quality program 24. System user opinion
Dyson K, Bray J, Smith K, Bernard S, Finn J. A systematic review of the effect of emergency medical service practitioners' experience and exposure to out-of-hospital cardiac arrest on patient survival and procedural performance. Resuscitation. 2014 Sep 30;85(9):1134-41.	Review Article USA	Personnel Patient	Outcome Structure Process	1. Out of Hospital Cardiac Arrest Survival 2. Proper ETI Placement 3. Practitioner career experience (in general) 4. Practitioner exposure to ETI (previous experience in performing ETI)
Ebbs P, Middleton PM, Bonner A, Loudfoot A, Elliott P. Do clinical safety charts improve paramedic key performance indicator results?(A clinical improvement programme evaluation). Emergency medicine journal: EMJ. 2012 Jul;29(7):596-7.	Original Article Australia	Agency	Structure Process Outcome	1. Use of Clinical Safety Charts 2. Presence of education strategies: education sessions, staff-meetings, reading material. 3. Senior management and leadership engagement. 4. The percentage of emergency cases where two full sets of vital signs were recorded on the patient healthcare record.
El Sayed MJ. Measuring quality in emergency medical services: a review of clinical performance indicators. Emergency medicine international. 2011 Oct 15;2012.	Review Article Lebanon	Agency Patient Personnel	Structure Process Outcome	1. Facility conditions 2. Equipment conditions 3. Staffing levels 4. Knowledge base of providers 5. Staff credentials 6. Presence of medical protocols. 7. Medication Administration 8. Transport to appropriate facility 9. Response times 10. Out of hospital cardiac arrest survival 11. Patient Satisfaction 12. Improvement in pain score

Fischer M, Kamp J, Riesgo LG, Robertson-Steel I, Overton J, Ziemann A, Krafft T, EED Group. Comparing emergency medical service systems—A project of the European Emergency Data (EED) Project. Resuscitation. 2011 Mar 31;82(3):285-93.	Original Article USA, Germany, Spain, United Kingdom	Patient Agency	Process Structure Outcome	1. Supply of EMS Care: Unit hours of professional emergency life support available per 100,000 inhabitants. 2. Response time (% within 480 seconds) for high priority response. 3. Annual number of responses for which an EMS unit is dispatched to a perceived life-threatening emergency per 100,000 inhabitants. 4. EMS Demand: Rate of "First Hour Quintet" incidents (Cardiac arrest, severe respiratory failure, severe trauma, stroke and chest pain) per 100,000 inhabitants 5. Level of care provided by EMS system: Rate of ALS interventions (e.g. drug application, infusion, tracheal intubation, assisted ventilation) per 100,000 inhabitants. 6. Organization 7. Funding 8. Dispatch Technology 9. Provided unit hours 10. Type and number of vehicles 11. Numbers of and qualifications of EMS personal. 12. Survival Rates for conditions
Henderson AC. Examining policy implementation in health care: rule abidance and deviation in emergency medical services. Public Administration Review. 2013 Nov 1;73(6):799-809.	Original Article USA	Oversight Personnel	Process	1. Rule Deviation 2. Rule Abidance 3. Medical Direction's attitude towards protocol deviation and abidance by personnel.
Hopkins CL, Burk C, Moser S, Meersman J, Baldwin C, Youngquist ST. Implementation of	Original Article	Personnel	Process	1. Return of spontaneous circulation 2. Call to dispatch time

Pit Crew Approach and Cardiopulmonary Resuscitation Metrics for Out-of-Hospital Cardiac Arrest Improves Patient Survival and Neurological Outcome. Journal of the American Heart Association. 2016 Jan 26;5(1):e002892.	USA	Patient	Outcome	3. EMS response time 4. Call to defibrillation time
Ji R, Wang D, Liu G, Shen H, Wang Y, Li H, Schwamm LH, Wang Y. Impact of macroeconomic status on prehospital management, in-hospital care and functional outcome of acute stroke in China. Clinical Practice. 2013 Nov;10(6):701-12.	Original Article China	Personnel	Structure Process	1. Transportation mode to hospital 2. Time from symptom onset to hospital arrival
Joyce SM, Dutkowski KL, Hynes T. Efficacy of an EMS quality improvement program in improving documentation and performance. Prehospital Emergency Care. 1997 Jan 1;1(3):140-4.	Original Article USA	Personnel	Process	1. Response time (Arrival-Dispatch times) 2. Scene time (Depart-arrival times) 3. Transport time (Hospital-depart times) 4. Documentation of chief Complaint 5. Documentation of mechanism of Injury 6. documentation history 7. documentation of vital signs 8. documentation of physician examination 9. protocol or standing order documented 10. protocol followed or deviation justified 11. all appropriate treatment fields completed 12. triage and transport elements 13. disposition 14. transport destination 15. outcome recorded 16. release at scene 17. appropriate signatures obtained
Kingsbury KJ, Natarajan MK, Forsey A, Oakes GH, Bakar-Irwin S. A Provincial Approach To	Conference Proceeding	Patient	Outcome	1. Morbidity 2. Mortality

Improving Stemi Care In Ontario. Canadian Journal Of Cardiology. 2014 Oct 1;30(10):S81.	Original Article Canada	Agency	Process	3. Care within the recommended timeline.
Ko PC, Chen WJ, Lin CH, Ma MH, Lin FY. Evaluating the quality of prehospital cardiopulmonary resuscitation by reviewing automated external defibrillator records and survival for out-of-hospital witnessed arrests. Resuscitation. 2005 Feb 28;64(2):163-9.	Original Article Taiwan	Patient	Outcome	1. Return of spontaneous circulation 2. Survival to hospital admission
Krarup NH, Lassen JF, Clemmensen P, Trautner S, Hansen TM, Johnsen SP, Terkelsen CJ. Out-of-Hospital Cardiac Arrest: Differences in the Quality of Care Provided by Emergency Medical Services with Advanced Versus Basic Life Support Capabilities---a Nationwide Study. Circulation. 2014 Nov 25;130(Suppl 2):A112-.	Conference Proceeding Original Article Denmark	Patient Personnel	Structure Outcome	1. Transthoracic impedance measurements of CPR 2. No Flow Fraction (the fraction of time during resuscitation where the patient is without circulation) 3. Return of spontaneous circulation 4. Cerebral performance category 5. ALS-capability of crew
Landman AB, Spatz ES, Cherlin EJ, Krumholz HM, Bradley EH, Curry LA. Hospital collaboration with emergency medical services in the care of patients with acute myocardial infarction: perspectives from key hospital staff. Annals of emergency medicine. 2013 Feb 28;61(2):185-95.	Original Article USA	Agency	Structure	1. Hospital respect for EMS personnel 2. Communication and coordination between hospital and EMS agencies/providers. 3. Active engagement of EMS in quality improvement processes 4. Monthly meetings to review care

Mackenzie CF, Hu P, Sen A, Dutton R, Seebode S, Floccare D, Scalea T. Automatic pre-hospital vital signs waveform and trend data capture fills quality management, triage and outcome prediction gaps. In AMIA Annual Symposium Proceedings 2008 (Vol. 2008, p. 318). American Medical Informatics Association.	Original Article USA	Patient	Outcome	1. Pulse oximeter oxygen saturation 2. Validated Heart Rate
Martin-Gill C, Guyette FX, Rittenberger JC. Effect of crew size on objective measures of resuscitation for out-of-hospital cardiac arrest. Prehospital Emergency Care. 2010 Jun 1;14(2):229-34.	Original Article USA	Personnel Patient	Process Structure Outcome	1. Number of paramedics in dispatch team 2. No-flow fraction as measure of CPR effectiveness 3. Time to defibrillation 4. Time to endotracheal intubation 5. Time to establishment of intravenous access 6. Time to medication administration
Mears GD, Pratt D, Glickman SW, Brice JH, Glickman LT, Cabañas JG, Cairns CB. The North Carolina EMS Data System: a comprehensive integrated emergency medical services quality improvement program. Prehospital Emergency Care. 2010 Jan 1;14(1):85-94.	Original Article USA	Oversight Agency	Structure Process	1. Use of reporting system and related quality improvement tools. 2. Timeliness of care
Moody-Williams JD, Krug S, O'Connor R, Shook JE, Athey JL, Holleran RS. Practice guidelines and performance measures in emergency medical services for children. Annals of emergency medicine. 2002 Apr 30;39(4):404-12.	Review Article USA	Patient	Process	Available guidelines are known to improve patient care. There is a lack of evidenced based practice guidelines for pediatric EMS.

Moore L. Measuring quality and effectiveness of prehospital EMS. Prehospital Emergency Care. 1999 Jan 1;3(4):325-31.	Original Article USA	Oversight Agency Personnel	Structure Process Outcome	1. Job Satisfaction 2. Timeliness of Care 3. Patient Satisfaction 4. Quality of training 5. Public confidence in the system 6. Crew and equipment appearance 7. Change in complaints 8. Patient outcomes 9. Quality of calls 10. Internal satisfaction 11. Symptomatic improvement 12. Cost-effectiveness 13. Mutual aid relationships 14. Research activities 15. Vehicle safety 16. Availability of resources 17. Accuracy of 911 communications
Munk MD, White SD, Perry ML, Platt TE, Hardan MS, Stoy WA. Physician Medical Direction andClinical Performance at an Established Emergency Medical Services System. Prehospital Emergency Care. 2009 Jan 1;13(2):185-92.	Original USA	Agency	Process Outcome	1. Chart reviews by medical directors/EMS physicians 2. Number of cases requiring remediation 3. Proportion of charts rated as clinically acceptable, 4. Proportion of misplaced endotracheal tubes 5. Appropriate administration of aspirin
Murphy A, Wakai A, Walsh C, Cummins F, O'Sullivan R., Development of key performance indicators for prehospital emergency care., Emerg Med J. 2016 Apr;33(4):286-92. doi: 10.1136/emermed-2015-204793. Epub 2016 Jan 21.,	Review USA	Patient Personnel	Process Outcome	1. Less than 90 min transport time of patients with STEMI to PCI capable facility with an ECG 2. Rate of recording Face Arm Speech Time (FAST) test for patients with stroke 3. Rate of aspirin administration to patients with acute coronary syndrome

Myers JB, Slovis CM, Eckstein M, Goodloe JM, Isaacs SM, Loflin JR, Mechem CC, Richmond NJ, Pepe PE. Evidence-Based Performance Measures for Emergency Medical Services Systems: A Model for Expanded EMS Benchmarking: A Statement Developed by the 2007 Consortium US Metropolitan Municipalities' EMS Medical Directors. Prehospital Emergency Care. 2008 Jan 1;12(2):141-51.	Original Article USA	Agency Patient	Process Structure Outcome	1. Response Time 2. Survival rate 3. Administration of condition-appropriate drugs 4. Transport time 5. Provision of appropriate medical technology
O'Connor RE, Megargel RE. The effect of a quality improvement feedback loop on paramedic skills, charting, and behavior. Prehospital and disaster medicine. 1994 Mar 1;9(01):35-8.	Original Article USA	Agency	Process Outcome	1. Performing QI feedback loop 2. Trauma scene times 3. Charting completion 4. Resuscitation rates from cardiac arrest 5. Endotracheal intubation success rates 6. Trauma scene times
Olasveengen TM, Wik L, Steen PA. Quality Of Cardiopulmonary Resuscitation Before And During Transport In Out-of-hospital Cardiac Arrest. Circulation. 2007 Oct 16;116(Suppl 16):II_928-.	Original Article USA	Personnel	Process Outcome	1. Supervisor administered CPR performance evaluation 2. Rate of compression per minute
Olasveengen TM, Wik L, Steen PA. Quality of cardiopulmonary resuscitation before and during transport in out-of-hospital cardiac arrest. Resuscitation. 2008 Feb 29;76(2):185-90.	Original Article USA	Personnel	Process	1. Rate of compression per minute 2. Hands-off ratio during CPR performance
Peralta LM. The prehospital emergency care system in Mexico City: A system's performance	Review	Agency	Process	1. Response time performance 2. Clinical quality and sophistication

evaluation. Prehospital and Disaster Medicine. 2006 Apr 1;21(02):104-11.	Mexico	Patient	Outcome	3. Economic efficiency 4. Customer satisfaction
Pozen MW, Berezin MM, Modne L, Riggen R, Davis DD, Hood Jr WB. An assessment of emergency medical technicians' performance as related to seasonal population influx. Journal of community health. 1978 Mar 1;3(3):227-35.	Original Article USA	Personnel	Outcome	EMT misdiagnosis rate
Rahman NH, Tanaka H, Do Shin S, Ng YY, Piyasuwankul T, Lin CH, Ong ME. Emergency medical services key performance measurement in Asian cities. International journal of emergency medicine. 2015 Apr 23;8(1):1.	Original Article China, Korea, Japan	Oversight Agency Personnel Patient	Structure Process Outcome	1. Facilities 2. Equipment 3. Staffing 4. Provider knowledge 5. Credentials 6. Deployment 7. Response times 8. Medical protocols 9. Medication administration 10. Transport to appropriate facility 11. Out of hospital cardiac arrest survival 12. Patient satisfaction 13. Improvement in pain score
Schneider T, Mauer D, Diehl P, Eberle B, Dick W. Does standardized mega-code training improve the quality of pre-hospital advanced cardiac life support (ACLS)?. Resuscitation. 1995 Apr 30;29(2):129-34.	Original Article USA	Personnel	Process	Time intervals from the arrival of the mobile intensive care unit until: 1. First ECG diagnosis 2. First defibrillation 3. Endotracheal intubation 4. First epinephrine administration

Schooley BL, Horan TA. Towards end-to-end government performance management: Case study of interorganizational information integration in emergency medical services (EMS). Government Information Quarterly. 2007 Oct 31;24(4):755-84.	Original Article USA	Agency	Process Outcome	1. Timeliness (process) 2. Quality of care (outcome) 3. End to end performance (process)
Sharifi M, Baraz S, Mohammadi F, Ramezani M, Ali S, Vardanjani E. Patients perception and satisfaction of the ambulance service (115) at Shahrekord, Iran.	Original Article Iran	Patient	Outcome	Patient Satisfaction
Simpson N, Bartley B, Corfield AR, Hearns S. Performance measurement in British helicopter emergency medical services and Australian air medical services. Emergency Medicine Journal. 2011 Feb 3:emj-2010.	Original Article United Kingdom and Australia	Agency Patient	Outcome Process	1. Mortality data at 24 hours (most common) 2. Follow up post 24 hours (rare) 3. Physiological and/or anatomical scoring (e.g. Revised Trauma Score, Injury Severity Score, Rapid Emergency Medicine Score, Simplified Acute Physiology Score) 4. Adverse patient events 5. Use of a clinical support officer for data capture
Siriwardena AN, Shaw D, Donohoe R, Black S, Stephenson J. Development and pilot of clinical performance indicators for English ambulance services. Emergency Medicine Journal. 2010 Apr 1;27(4):327-31.	Original Article United Kingdom	Agency Patient	Outcome Process	Stroke 1. FAST assessment recorded 2. Blood glucose recorded 3. Blood pressure recorded STEMI 4. Aspirin 5. GTN 6. Initial and final pain scores

				7. Analgesia given 8. Morphine or alternate given 9. Prehospital thrombolysis Cardiac Arrest 10. ROSC on arrival at hospital 11. Paramedic in attendance 12. Response time 13. Asthma 14. Respiratory rate recorded 15. PEFR recorded before treatment 16. SpO2 recorded 17. Beta-2 agonist given 18. Oxygen administered 19. Hypoglycemia 20. Blood glucose before and after treatment 21. Treatment for hypoglycemia recorded
Siriwardena AN, Shaw D, Essam N, Togher FJ, Davy Z, Spaight A, Dewey M. The effect of a national quality improvement collaborative on prehospital care for acute myocardial infarction and stroke in England. Implementation Science. 2014 Jan 23;9(1):1.	Original Article United Kingdom	Agency Patient	Process	1. Local quality improvement teams in each ambulance service supported by a national coordinating group 2. Regular meetings between QI teams
Siu VW, Pau Y, Lok PY, Lee LL, Tang SY, Chan JT. An evaluation of compliance and performance following the introduction of the Inter-Facility Transport Triage Guideline. World journal of emergency medicine. 2011;2(2):99.	Original Article Taiwan	Personnel	Process Structural	1. Pre-transport communication 2. Pre-transport triage 3. Transport team configuration 4. Equipment adequacy 5. Mode and frequency of monitoring 6. Preparation of appropriate pharmacological agents 7. Documentation 8. Handover phase

Stewart RD, Burgman J, Cannon GM, Paris PM. A computer-assisted quality assurance system for an emergency medical service. Annals of emergency medicine. 1985 Jan 31;14(1):25-9.	Original Article United Kingdom	Agency	Outcome	1. Quantity of documentation errors resulting in missing but retrievable data 2. Quantity of documentation errors resulting in permanent loss of data 3. Quantity of errors directly affecting patient care
Su S, Shih CL. Modeling an emergency medical services system using computer simulation. International journal of medical informatics. 2003 Dec 31;72(1):57-72.	Original Article Taiwan	Agency	Process Structure Outcome	1. Preparation time 2. Response time 3. Processing time 4. Transport time 5. Caring time 6. Departure time
Swor RA, Hoelzer M. A computer-assisted quality assurance audit in a multiprovider EMS system. Annals of emergency medicine. 1990 Mar 31;19(3):286-90.	Original Article USA	Agency Personnel	Process	1. Run sheet completeness 2. Performance criteria 3. Compliance with protocol
Tobin, John; Stout, Todd. Drowing in Data, Thristing for Knowledge: The benefits of real time & near real time data feedback; JEMS; May 2015.	Review Article USA	Personnel	Process	1. CPR Oxygen saturation, Rate, Depth, Release, recoil, compressor fatigue, transportation, advanced airway placement, EtCO2 monitoring. 2. Dispatch time
Whyte BS, Ansley R. Pay for performance improves rural EMS quality: investment in prehospital care. Prehospital Emergency Care. 2008 Jan 1;12(4):495-7.	Original Article USA	Personnel	Process Outcome	1. Completing run reports within three hours of completion 2. Call to en-route times of less than 90 seconds

				3. Use of aspirin in adults with non-traumatic chest pain 4. ECG performance in adults with non-traumatic chest pain 5. Documentation of pain assessment and intervention in patients with traumatic hip pain 6. Documentation of the time of onset of symptoms in stroke calls
Williams KA, Rose WD, Simon R, Med Teams Consortium. Teamwork in emergency medical services. Air Medical Journal. 1999 Dec 31;18(4):149-53.	Original Article USA	Personnel	Process Outcome	1. Human factor errors 2. Supportive teamwork climate 3. Effective communication 4. Teamwork planning 5. Problem solving 7. Team based errors (free riding, social loafing, Ringlemann effect, risk shift, group think, Abilen paradox)
Youngquist S, Burk C, Reilly D, Baldwin C. The Adoption of Multiple Best Practices to Improve Out-of-Hospital Cardiac Arrest in Salt Lake City, Utah. Circulation. 2014 Nov 25;130(Suppl 2):A204-.	Conference Abstract Original article USA	Patient	Outcome	Cerebral performance category of patient
Zavada CA. Quality assurance: the effects of a prehospital data system on patient care. Journal of the American Medical Record Association. 1982 Oct;53(5):89.	Original USA	Personnel	Process	Algorithm (Treatment Protocol) Compliance

APPENDIX 4: EMS QUALITY IMPROVEMENT RESOURCES GUIDE

PURPOSE OF THE RESOURCE GUIDE: This guide provides an account of study results from the grey literature search regarding existing quality measures related to EMS and EMS oversight in the U.S.. The guide organizes the results of the search by specific identified strategies for EMS oversight and quality improvement. The resource guide includes references and guidance from national EMS advisory boards and professional associations, and federal, state, regional, and local EMS authorities. These resources can be retrieved on the Internet by inserting the name of the referenced resource into an Internet search engine (e.g., Google or Explorer).

STRATEGY 1: ADVANCE EMS "SYSTEMS APPROACH" TO BOLSTER THE STATEWIDE IMPLEMENTATION AND OVERSIGHT OF EVIDENCE-BASED QUALITY IMPROVEMENT PROGRAMMING/MEASURES

INNOVATION: SYSTEM TRANSFORMATION/RESEARCH/BEST PRACTICES MODELS

- ***NEMSMA-EMS 3.0 Realizing the value of EMS in our Nation's Health Care Transformation (2016).*** This report provides vision and direction for EMS system transformation. It provides history of EMS, EMS value added - defines "community paramedicine" or EMS community healthcare.
- ***NHTSA-Progress of Evidence-Based Guidelines for Prehospital Emergency Care (2013).*** This report presents a federally approved quality improvement framework for EMS systems to implement evidence-based guidelines for prehospital emergency care; *Approved by the Federal Interagency Committee on EMS and the National EMS Advisory Council.*

OVERSIGHT: STATE AND REGIONAL SYSTEM LEVEL

- ***NAESMSO-State Emergency Medical Services Systems: A Model (2008)*** offers policy guidance on implementing a "Systems Approach" to EMS response and evaluation. This document can be used to strategically develop and advance quality EMS system-wide benchmarks for MCAs.
- ***NAESMSO-EMS Education Agency for the Future: Systems Approach (2000)***. Provides background and makes a case for an EMS systems approach which can be used to support comprehensive educational assessment and system reform at multiple levels.
- ***NASEMSO-The Organization, Staffing and Function of State and Territorial EMS Offices (2005).*** This is a monograph of survey results from EMS state offices regarding organizational structure and staffing resources.

- ***NHTSA-EMS Agenda Implementation Guide (2010).*** This resource serves as a federally approved implementation guide for EMS systems; targeting community-based solutions for EMS.
- ***NAEMSP-White Paper: Evidence Based System Design (2011).*** This is an evidence-based medical analysis; commissioned by a local medical authority to optimize EMS system design.
- ***NHTSA-Prehospital EMS Essential Services and Public Good in Economic Theory (2014).*** This white paper positions EMS service as public health and safety commodity. It offers states guidance and discusses the key implications of this theory for EMS systems.

STRATEGY 2: ESTABLISH NETWORK BUILDING OPPORTUNITIES FOR MCAs THAT PROMOTES A POSITIVE STATEWIDE QUALITY IMPROVEMENT CULTURE AND INCENTIVIZES REGIONAL HEALTHCARE COALITION BUILDING

INNOVATION: SYSTEM TRANSFORMATION/LEADING RESEARCH/BEST PRACTICES MODELS

- ***NAEMSP National Strategy to Promote Pre-Hospital Evidence Based Guidelines and Evaluation (2015).*** This resource provides national standards and key strategies for advancing evidence–based prehospital care practice guidelines and evaluation measures.

OVERSIGHT: STATE AND REGIONAL SYSTEM LEVEL

- ***US DHHS ASPR-From Hospitals to Healthcare Coalitions Transforming Health Prepared and Response in Our Communities (2016).*** This resource provides an overview of federal programming and funding for the *Hospital Preparedness Program and Emergency Care Partnership Program.*
- ***NAESMSO-EMS Education Agency for the Future: Systems Approach (2000)***. Incorporates an EMS systems approach to support a culture of quality improvement and improved care delivery.
- ***NASEMSO-Alabama Administrative Board Emergency Medical Services Rules for Medical Direction (2016).*** These are administrative rules codifying medical direction for the State of Alabama.
- ***NASEMSO-New York State Statute S 3006. EMS Quality Improvement Program (2016).*** Information for state leadership for the development of a quality improvement program.
- ***NASEMSO-Federal Field EMS Bill Section by Section 112th Congress (2016).*** Federal leadership surrounding EMS quality, innovation and cost-effectiveness.
- **NACCHO-Road Map to Quality Improvement (2012).** This is an implementation guide and resource for promoting a statewide culture to support quality improvement.
- ***NAEMSP-Oakland County Michigan PSRO Standards System Protocols (2013).*** Recognize and showcase MCAs that have achieved a positive, systems level quality improvement culture.

STRATEGY 3: ADOPT NATIONAL QUALITY IMPROVEMENT STANDARDS FOR MCA OVERSIGHT ACROSS VARYING LEVELS OF ADMINISTRATIVE AND CLINICAL RESPONSE (STATE OFFICIALS, MEDICAL DIRECTORS, PARAMEDICS, EMTS, ETC.)

INNOVATION: SYSTEM TRANSFORMATION/RESEARCH/BEST PRACTICES MODELS

- ***NAEMSP-Oakland County Michigan PSRO Standards System Protocols (2013).*** Includes system level protocols for all levels of EMS personnel developed by Oakland County's PSRO.
- ***NAEMSP-EMS Quality Improvement Plan for Santa Clara, CA (2008).*** County level policies and procedures to include measures such as, system organizational structure, interagency relationships, education and licensing, and data collection and evaluation.

OVERSIGHT: STATE AND REGIONAL SYSTEM LEVEL

- ***NEMSMA-Seven Pillars of National EMS-Officer-Competencies (2014).*** Describes the leadership knowledge and operational skill-set needed to be a successful leader within EMS. Presents principles for core competencies in EMS system management at the leadership level.
- ***NACCHO-ASTHO Quality Improvement Plan Toolkit Guidance and Resources to Assist State and Territorial Health Agencies in Developing a Quality Improvement Plan (2014).*** The following is a resource guide and toolkit for assisting state and local health department practitioners in engaging in performance improvement activities.
- ***NHTSA-ASTM Standard Practice for Emergency Medical Dispatch Management (1994).*** This resource provides national standards for emergency medical dispatch management.
- ***NHTSA-Guide for Interfacility Transfers (2016).*** This resource provides federal guidance on interagency transfers using a systems approach for interagency communication.

OVERSIGHT: MEDICAL

- ***NAEMSP-National Policy on Development of Position Statements and Resource Development (2014).*** Provides national policy guidance on EMS physician leadership in EMS systems.
- ***NHTSA-Medical Oversight Guidelines (2016).*** This document provides federal guidance on interfacility patient transfers by medical directors.
- ***NAEMSP-Handbook for EMS Medical Directors (2013).*** This handbook serves as a reference for establishing standards for medical director oversight.
- ***NHTSA-HRSA Guide for Preparing Medical Directors (2001).*** Federal guidelines on medical oversight.

Strategy 4: DEVELOP KEY STRATEGIC PLANNING OBJECTIVES AND COORDINATE STATEWIDE PLANNING INITIATIVES FOR CONTINUOUS QUALITY IMPROVEMENT PROGRAMMING

INNOVATION: SYSTEM TRANSFORMATION/RESEARCH/BEST PRACTICES MODELS

- ***NHTSA-EMS Scope of Practice Model (2014).*** Reports a vision for the future agenda of EMS. Covers history, overview of profession, licensure, and practice models. Can be used as a resource to inform quality measure development.
- ***NHTSA-National EMS Advisory Council-Guiding Principles and Core Issues in EMS System Design Systems Committee Final System Design Template (2009).*** This resource offers federal guidance on EMS system design and quality measures for EMS systems.

OVERSIGHT: STATE AND REGIONAL SYSTEM LEVEL

- ***NHTSA-EMS Performance Measures for Systems and Service (2009).*** This report provides federal guidance to states on quality performance measures for EMS systems.
- ***NASEMSO_NASEMSD Planning Emergency Medical Communication-State Level Planning Guide (1995).*** This plan focuses on factors necessary to ensure proper compatibility, interfacing, and coordination of local EMS communications within a statewide system.
- **NACCHO-ASTHO Quality Improvement Plan Toolkit Guidance and Resources to Assist State and Territorial Health Agencies in Developing a Quality Improvement Plan (2014).** This is a resource guide for quality improvement planning and evaluation in local jurisdictions.
- ***NAESMSO EMS Education Agency for the Future: Systems Approach (2000)***. Provides background and significance for an EMS systems approach which can be used to support the need for comprehensive assessment and system reform at multiple levels.
- ***NASEMSO_NASEMSD Planning Emergency Medical Communication-Local Regional Level Planning Guide (1995)*.** This document contains specific information and direction for use by local planners in preparing detailed second-tier local emergency medical telecommunications plans.
- ***NHTSA-Draft Manuscript for HEMS Evidence-based Guidelines (2016).*** This resource provides federal guidance for implementing evidence-based guidelines for HEMS.

STRATEGY 5: ADAPT NATIONAL, STATE AND LOCAL RESOURCES TO PROMOTE, PLAN, AND DEVELOP A COMPREHENSIVE ASSESSMENT OF MCA OVERSIGHT AND FUNDING METHODOLOGIES

Leadership

INNOVATION: SYSTEM TRANSFORMATION/RESEARCH/BEST PRACTICES MODELS

- ***NAESMSO National EMS Systems Assessment Final* (2011)** provides a national picture of EMS in the U.S.
- ***NAESMSO EMSS: Lead Agency Model (2010).*** This resource provides a model for lead agencies in organizational structure; considers governing authority, regulation, and quality measures.

OVERSIGHT: STATE AND REGIONAL SYSTEM LEVEL

- ***NAESMSO-State Emergency Medical Services Systems: A Model (2008)*** provides a "Systems Approach" assessment tool for states to evaluate EMS leadership and oversight.
- ***NAESMSO EMS Leadership Development Assessment (2013)***. Provides states with a resource for assessing EMS leadership.
- ***NAESMSO EMS Systems: Legislative and Regulatory Content (2010)***. Provides states with a regulatory content guide and self-assessment for governing state law and administrative rule. This resource offers State EMS leaders and policy makers with the necessary constructs to guide the development, regulation, and administrative oversight of EMS systems.
- ***NHTSA-EMS Technology Assessment Template (2008).*** This is an assessment tool for EMS officials to evaluate technology needs of EMS systems.
- ***NHTSA-Online Assessment of System Involvement (2016).*** This is an online self-assessment tool for state EMS officials and state highway safety professionals.

OVERSIGHT: MEDICAL

- ***NASEMSO-National Assessment of EMS Clinical Quality Programs (2016).*** National assessment tool for clinical quality programs.
  NACCHO-Story Board Template (2016). This PowerPoint template is a resource for engaging EMS leadership via the "storyboarding" method of documenting atypical incidents (e.g., deviations from a treatment protocols or standard EMS practices). Storyboarding is an organized way of showcasing the quality improvement process conducted by a team that is working systematically to resolve a specific problem and/or improve a given process.

<u>Funding</u>

OVERSIGHT: STATE AND REGIONAL SYSTEM LEVEL

- ***NASEMSO Funding Assistance Guide: For State EMS Offices (2016).*** This guide provides state officials with information regarding multiple funding opportunities for EMS systems. This document can help identify additional funding sources for MCAs.
- ***NASEMSD Linkages of Acute Care and EMS with State and Local Prevention Programs: Status of State EMS System Funding (2004).*** This document includes an assessment of state EMS system revenue sources that support state EMS office operation and services.
- ***NASEMSO Domestic Preparedness Funding (2016).*** This report provides findings from a national survey of state EMS agencies on the use of funding for domestic preparedness.
- **The Status of EMS Funding (2016).** Survey results of state EMS offices regarding funding sources; including multi-level government and special initiative funding sources.
- ***NASEMSO-Status of State Emergency Medical Service Office Funding and Utilization of Section 402 and 408 Highway Safety Funding (2009).*** This report provides survey results of state EMS offices' use of federal highway safety funds.

Data Reporting and System Integration

OVERSIGHT: STATE AND REGIONAL SYSTEM LEVEL

- **NASEMSO-Incorporation of EMS Patient Care Data in State Data Linkage Programs (2012).** This document discusses state EMS data collection practices and policies, including results from a survey of state EMS offices that evaluate the extent to which EMS patient care records are linked with other record systems in the states.

Regional Priorities

OVERSIGHT: STATE AND REGIONAL SYSTEM LEVEL

- ***NAEMSO State EMS Rural Needs Survey (2004).*** This report captures needs and priorities of rural communities through a national survey of state EMS officials.
- **NASEMSO-NOSORH EMS Leadership Education State by State Compendium: Future of Rural EMS (2015).** This report includes information regarding EMS leadership education by state. The report reveals urban and rural leadership disparities.
- ***NASEMSD Linkages of Acute Care and EMS with State and Local Prevention Programs: Part I Involvement of EMS in Bioterrorism Grant and Planning Efforts (2004).*** National survey results of planning efforts in bioterrorism and the degree of EMS integration with prevention and preparedness.
- ***NASEMSD Linkages of Acute Care and EMS with State and Local Prevention Program: Part II Status of Programmatic State EMS Involvement with Prevention Activities (2004).*** National Survey of planning efforts in state with EMS involvement in local prevention activities.

STRATEGY 6: DELIVER EDUCATION, TRAINING, AND CREDENTIALING TO ENHANCE QUALITY MEASURES AND TO DEVELOP CONTINUOUS QUALITY IMPROVEMENT PROGRAMMING

Quality Improvement Training Resources

OVERSIGHT: STATE AND REGIONAL SYSTEM LEVEL

- ***NAESMSO-EMS Education Agency for the Future: Systems Approach (2000)***. Provides background and significance for an EMS systems approach which can be used to support the need for comprehensive educational assessment and system reform at multiple levels.
- ***EMA-National Emergency Responder Credentialing EMS Job Titles (2008).*** This document describes baseline and additional EMS criteria for the National Emergency Responder Credentialing System.
- ***NASEMSO-Training and Certification of EMS Personnel (2007).*** This is a national snap shot of training and certification practices, including distribution of personnel roles, certification periods, and national registry requirements for credentialing.
- ***NASEMSO-The Status of EMS Office Involvement in EMS Communication (2008).*** This report compiles state practices of dispatch communication using communication system narratives.

National Education Standards and Credentialing for EMS Personnel

OVERSIGHT: AGENCY-LEVEL

- ***NHTSA-National EMS Educational Standards for Advanced EMT Instructional Guidelines (2009).*** This resource provides national instructional guidelines for training Advanced EMTs.
- ***NHTSA-National EMS Educational Standards for Paramedics (2009).*** This resource provides national instructional guidelines for training paramedics.

Educational Standards

OVERSIGHT: STATE AND REGIONAL SYSTEM LEVEL

- ***NHTSA-HRSA EMT Continuing Education National Guidelines (2016).*** This resource provides national guidelines for EMS continuing education.
- ***NHTSA-Module 2: Roles and Responsibilities (2002).*** National guidance for educating EMS personnel.
- ***NEMSMA-Mental Health and Stress in EMS (2016).*** This committee report reveals the mental health and stress concerns of EMS personnel and takes a position on addressing related issues.

OVERSIGHT: AGENCY-LEVEL

- ***NHTSA-HRSA EMT National Standard Curriculum (2016).*** This is national training curriculum for EMTs.

APPENDIX 5. MCA LEVEL MI-EMSIS ANALYSIS TABLE

MCA	Number of Incidents	Age	Gender	Race	Patient Home Zip	Incident Zip	Destination Name	Destination Code	Chief Complaint Narrative	Patient Primary Impression	Medication Allergies	Medical Surgical History	Current Medication Name	SBP	DBP	Pulse Rate	Pulse Oximetry	Respiratory Rate	Body Temperature
1	21,583	12.5	11.3	43.4	12.7	0.0	2.1	2.1	2.3	2.4	57.4	73.9	58.0	25.5	25.6	24.3	28.3	24.2	66.4
2	280	1.5	1.5	29.2	6.2	0.0	1.5	1.5	4.6	1.5	30.8	3.1	15.4	16.9	16.9	15.4	18.5	13.8	100.0
3	80,638	9.4	8.8	29.8	9.7	0.2	3.2	3.3	3.0	2.2	29.3	72.4	30.4	29.0	29.1	25.5	30.3	25.8	88.3
4	6,004	5.6	4.9	8.7	4.4	0.2	3.5	3.6	4.2	3.1	35.4	3.2	57.4	22.3	22.3	21.2	25.3	22.6	84.8
5	7,072	2.2	1.8	43.0	2.1	0.0	7.8	11.5	2.2	1.5	22.0	1.5	10.8	8.9	9.1	6.7	13.0	5.7	43.7
6	30,290	4.6	5.6	74.9	4.9	0.0	14.2	17.7	3.6	1.8	38.4	2.1	26.3	15.9	40.0	10.5	37.8	9.4	84.1
7	11,169	8.1	7.7	46.3	8.5	0.0	11.3	5.4	9.0	12.5	27.3	24.7	25.1	20.9	20.7	19.8	23.6	30.3	75.8
8	27,014	5.6	5.6	21.4	0.2	0.0	10.7	0.8	10.8	0.4	85.0	82.4	84.7	14.4	15.6	13.7	19.2	17.0	66.7
9	16,326	19.2	17.8	46.1	22.9	0.1	19.8	0.9	25.1	11.3	45.3	41.7	46.2	41.8	42.2	40.5	46.0	41.1	98.5
10	1,601	9.7	7.7	74.0	9.1	0.0	6.5	6.5	8.3	8.3	80.5	8.0	80.2	37.2	37.5	34.2	35.7	32.7	83.8
11	24,470	2.8	8.2	37.8	8.3	5.4	22.2	16.1	6.8	0.8	25.2	50.5	56.0	22.4	25.3	23.8	24.3	24.6	95.5
12	18,501	8.4	8.2	34.9	8.7	0.4	6.1	6.1	6.7	6.7	58.5	37.8	61.6	16.9	18.2	15.3	37.0	18.2	95.0
13	93,371	3.5	4.8	23.3	5.0	0.0	1.9	1.4	1.1	9.2	22.1	71.7	35.1	16.1	18.1	15.5	28.6	14.8	95.1
14	23,491	20.2	19.9	50.4	19.9	0.0	18.8	18.8	19.9	19.5	41.4	22.5	47.5	30.9	31.4	29.0	31.9	28.7	95.4
15	120,343	14.7	14.3	36.3	23.1	1.0	7.8	8.6	9.2	2.5	14.6	24.2	36.4	32.2	35.1	30.1	34.6	29.8	90.8
16	35,160	7.6	7.0	56.8	7.5	1.5	14.4	6.0	8.2	4.5	27.3	68.3	54.0	16.1	17.5	14.7	21.0	15.1	81.1
17	25,563	9.4	9.9	48.9	9.1	0.0	26.4	30.1	10.6	0.0	44.0	0.0	41.0	19.1	21.9	17.2	26.2	18.4	93.9
18	541,095	5.5	6.1	37.4	9.9	0.0	19.0	18.4	9.0	0.0	13.9	11.9	16.7	15.2	16.1	12.6	18.7	12.4	96.1
19	26,040	9.4	9.0	44.2	9.6	0.3	12.3	12.5	9.3	8.6	34.4	8.5	36.9	34.5	35.2	33.7	39.7	35.0	85.2
20	2,257	40.8	41.2	94.8	46.9	0.4	41.2	41.2	41.4	14.5	100.0	41.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0

21	79,806	7.7	7.3	24.7	8.1	0.1	4.6	3.1	3.9	0.9	11.9	94.2	28.2	17.1	17.6	15.4	21.8	15.5	87.5
22	5,369	37.3	45.8	96.7	32.0	0.0	0.7	0.7	0.7	1.3	45.8	0.7	100.0	69.3	69.3	69.3	69.9	69.3	100.0
23	10,152	17.7	17.2	93.6	38.1	0.0	18.4	23.6	14.4	0.8	28.9	14.2	78.0	50.9	51.7	45.7	76.4	49.4	98.8
24	539,642	5.4	6.1	37.4	9.9	0.0	19.3	18.3	8.9	0.0	13.8	11.8	16.5	15.0	16.0	12.5	18.6	12.3	96.1
25	19,609	21.2	20.3	30.2	17.3	0.2	1.6	1.6	2.1	1.8	42.8	14.0	43.4	32.4	32.7	31.4	40.7	35.4	82.8
26	5,654	32.9	29.7	90.4	33.0	0.1	23.2	64.1	24.8	1.1	22.6	2.6	95.5	94.1	94.2	92.5	93.7	98.9	99.9
27	31,610	3.4	3.3	39.8	4.0	0.0	9.7	24.4	5.4	1.1	9.2	69.2	70.0	24.5	24.7	22.9	26.1	32.5	89.5
28	3,515	3.4	35.5	99.4	38.8	0.1	35.1	35.1	35.1	0.0	48.7	35.1	100.0	72.9	72.9	67.0	67.9	90.0	100.0
29	123,476	6.1	7.8	51.2	17.9	0.1	4.4	5.7	7.9	2.6	20.8	7.4	41.2	34.7	35.6	33.6	43.3	32.9	98.2
30	48,432	32.1	28.2	40.5	29.4	0.1	10.0	10.0	9.8	0.0	13.6	14.4	98.2	72.1	73.0	57.7	63.6	71.2	99.1
31	29,191	0.0	0.0	32.5	0.0	0.0	0.6	0.0	0.1	0.0	0.3	5.4	71.6	3.4	6.6	2.2	4.4	0.4	83.5
32	750	34.7	63.3	75.5	65.1	0.0	0.9	0.9	1.9	3.0	17.8	1.7	78.7	84.0	84.4	82.7	86.8	83.3	99.8
33	30,301	22.4	21.1	54.3	21.4	0.3	19.8	27.2	24.0	14.9	48.9	20.2	72.9	57.7	58.3	54.0	57.5	65.7	88.0
34	25,921	17.4	3.2	20.0	17.0	14.5	7.6	10.1	4.2	0.9	24.7	15.3	36.1	13.2	13.6	13.2	13.2	16.0	95.3
35	130,626	3.0	2.7	32.7	3.6	0.4	2.4	2.4	1.9	1.8	9.3	78.3	11.0	15.8	16.4	13.1	20.3	13.6	94.8
36	334,506	8.4	8.1	27.1	12.0	0.8	5.3	5.0	3.1	0.6	18.9	58.1	21.0	18.7	19.7	15.9	33.3	18.8	91.7
37	166,392	12.0	10.7	25.4	20.5	0.0	5.9	5.8	2.4	2.1	21.4	3.7	65.0	52.6	55.1	38.0	62.7	45.8	96.8
38	42,271	6.0	4.7	30.6	5.7	0.4	6.8	6.8	5.9	0.9	28.1	80.3	28.5	28.7	30.7	27.4	35.7	31.2	84.2
39	329,124	10.1	11.6	40.4	10.9	0.3	12.9	13.0	8.7	1.1	28.1	26.1	28.0	22.2	24.2	19.8	37.4	21.6	94.2
40	50,268	3.5	3.3	40.5	4.0	0.1	10.6	15.1	3.8	2.0	39.9	15.5	43.9	20.2	21.3	16.8	23.3	15.8	95.8
41	408,787	0.7	1.3	22.4	1.0	0.2	23.2	3.4	1.7	0.4	11.2	59.1	84.0	16.0	18.0	14.2	59.0	11.4	99.3
42	58,823	2.2	2.4	33.9	7.2	0.1	3.7	2.3	7.2	2.0	11.8	90.9	43.2	18.4	20.6	20.3	21.3	16.5	96.7
43	56,609	10.6	9.3	39.3	13.4	0.7	15.6	17.5	17.9	0.8	43.5	20.6	58.2	49.8	50.6	45.8	60.7	43.6	96.9
44	483,965	13.3	13.5	18.0	13.9	0.2	15.2	1.0	9.4	0.3	15.6	39.7	44.0	18.0	19.1	15.5	55.7	15.5	96.7
45	201,231	7.9	7.7	19.0	10.0	0.2	3.8	4.1	2.7	0.0	14.2	84.0	17.8	15.9	18.0	13.4	45.8	13.6	96.9
46	167,748	36.5	40.1	55.5	35.8	0.3	3.2	3.3	3.4	0.2	21.5	65.4	53.1	52.1	52.8	53.7	56.1	54.9	98.5
47	1,226,660	6.8	6.7	32.9	9.8	0.3	9.5	11.2	3.9	0.0	23.2	49.6	25.2	20.3	22.1	22.7	34.2	19.7	77.0
48	371,400	9.2	12.2	58.3	8.2	0.4	20.4	16.9	13.5	3.6	32.1	23.5	59.5	31.7	33.0	29.5	58.9	29.5	97.3
49	24,484	5.5	6.4	10.7	5.9	0.0	23.1	24.6	5.3	0.4	60.1	14.9	16.0	19.8	25.8	17.9	29.0	16.9	91.8
50	132,993	7.8	7.8	26.1	18.5	0.1	0.3	3.7	0.6	0.2	9.9	5.1	78.6	33.3	35.4	33.6	52.6	36.3	98.2

51	44,989	16.0	16.8	79.7	33.4	0.0	19.9	81.3	17.1	0.5	10.3	3.7	84.8	79.6	81.5	77.1	85.2	80.6	96.9
52	67,166	21.7	21.6	41.3	23.9	0.1	30.2	39.3	25.3	19.8	79.2	66.9	76.0	51.1	56.6	44.3	50.6	44.0	96.3
53	580,684	5.8	7.8	54.4	7.0	0.2	16.3	16.3	7.6	2.2	33.8	63.4	39.2	34.5	35.0	32.5	38.8	32.9	96.8
54	1,356,255	5.8	6.2	22.2	8.9	0.1	15.6	18.8	8.9	0.6	36.7	17.6	10.5	13.7	14.8	11.4	49.4	11.1	94.9
55	102,507	70.1	3.6	24.9	70.0	66.6	3.7	2.8	9.9	0.8	15.1	65.3	83.6	22.1	22.4	20.8	54.6	20.7	96.8
56	6,474	15.5	15.5	45.5	15.0	0.8	13.2	16.5	9.3	2.4	34.7	58.9	33.9	30.3	30.5	29.2	33.9	35.3	92.9
57	18,584	3.3	3.6	16.1	3.3	0.1	4.2	4.0	7.3	0.0	19.5	99.6	69.8	18.2	18.7	18.0	32.0	17.0	98.9
58	109	100.0	100.0	100.0	98.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	41.0	41.0	32.8	41.0	47.5	100.0
59	26,318	8.5	4.6	12.8	8.0	0.0	5.9	5.8	8.1	2.3	28.9	78.9	85.4	39.8	39.9	73.0	39.6	40.6	98.6
60	196,427	7.6	8.0	22.5	10.2	0.1	2.1	2.3	0.3	0.2	16.6	84.6	17.5	18.9	19.4	26.9	22.1	18.1	53.5
61	122,522	10.3	9.8	39.7	12.8	0.1	6.2	6.4	7.1	2.9	21.7	82.5	26.3	25.2	26.2	34.9	27.7	23.0	65.5
Unidentified	3,572	13.0	7.8	59	34.4	12.8	15.9	15.9	13.7	17.8	59.4	17.6	67.5	43.9	43.9	44.4	45.7	47.9	96.2

APPENDIX 6. STAKEHOLDER FOCUS GROUP AND INTERVIEW GUIDE

Focus Group and Interview Facilitator: Open with broad "opening question" below. Check off each of the specific topics as they come up organically, or ask directed questions to address them if they do not.

Opening question: What would you say are the characteristics of a successful MCA? What are the facilitators and barriers to success for an MCA?

		Specific Topics	Successes/Facilitators	Challenges/Barriers	Other
Overarching Topics	Org. Structure / Leadership	Current org structure?			
		Current leadership?			
		Ideal org structure?			
		Ideal leadership?			
	Relationships	MCA-Hospital			
		MCA-EMS Agency			
		MCA-MCA			
		Meeting frequency			
		Competition / collaboration			
		Ideal relationships?			
	Evaluation / Quality Improvement	What does it look like now?			
		Internal vs. external			
		Results sharing / in process learning			
		How could it be useful to you?			
		How should this be done?			

APPENDIX 7. RAPID ANALYSIS TEMPLATE

Guidelines for use: bullet notes are best, success, barrier, neutral, **theme,** *quote*, add notes about the transcript as relevant (e.g. this transcript has a lot of rich discussion of this domain, worth reviewing if more interpretation is needed, etc.)

FG Composition / Interviewee Role:

Success
-

Barrier
-

MCA Structure and Leadership
Organizational Structure:
-

Leadership:
-

Funding:
-

Relationships:
MCA-Hospital Relationship:
-

MCA-EMS Agency Relationship:
-

MCA-MCA Relationship:
-

Meeting Frequency:
-

Competition/collaboration:
-

Evaluation/Quality Improvement
Existing Evaluations:
-

Results sharing/In-Process Learning:
-

Ideal Evaluation:
-

MIEMSIS:
-

Other:

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