NATIONAL QUALITY FORUM
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Attribution for Critical Illness and Injury

FINAL REPORT – DRAFT #2

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Executive Summary

Attribution is the method used to assign individuals and their quality and cost outcomes to providers or entities. Sound quality measurement attribution methodologies that can accurately reflect entity performance are essential to building value-based care models. Attribution models can also be used to incentivize desirable behavior and promote team-based models of care delivery. Most attribution models generally assign patients to a single entity based on rules related to the frequency of provider visits. Care for large-scale emergencies, however, is often based on regional response models, and patients may receive care or services from multiple entities (e.g., emergency medical services [EMS], hospitals, public health agencies, and local clinics). Accordingly, other types of models may be more appropriate for attributing high-acuity illness and injuries that result from large-scale emergency events.

With funding from the Centers for Medicare & Medicaid Services (CMS), the National Quality Forum (NQF) convened a multistakeholder Committee to put forth recommendations for developing quality measurement attribution approaches for high-acuity emergency care-sensitive conditions (ECSCs) and mass casualty incidents (MCIs). To support the Committee's work, NQF conducted an environmental scan of the existing literature, quality measures, and attribution models that are population based or that assign responsibility to multiple units. Although there was little evidence to support one superior attribution model, the findings indicate that geographic-based models may be appropriate based on the unpredictability of large-scale emergencies and need for a coordinated response.

This report outlines the elements of attribution approaches for large-scale emergencies: establishing the goal of attribution, defining the population/geographic regions, establishing the teams involved in the response, determining the timing of attribution, making data decisions, supporting the patient role in care selection, and avoiding negative unintended consequences. The purpose of measurement—whether for quality improvement, accountability, or assigning payment—should be defined before making attribution decisions. Attribution models should account for the roles of the multiple entities involved in response, including EMS agencies, local hospitals and clinics, specialized facilities, health departments, and government agencies. A regional approach to attribution for critical illness and injury is a promising model, given the nature of large-scale emergency events. Likewise, a hybrid prospective and retrospective approach that assigns responsibility based on predicted numbers of people and entities involved and clinical data identified may be preferable to promote coordination and communication. Ideally, data for attribution models should be the same data used to inform care to reduce data collection burden on providers and patients. Although self-attestation may not be an appropriate attribution approach for emergency events, patient input should help to inform the design of attribution models. Additionally, unintended consequences should be considered at the start of attribution model creation to mitigate potential negative effects for patients.

The report also discusses approaches and recommendations for developing quality measurement attribution models for high-acuity ECSCs and MCIs. Namely, key considerations include that attribution approaches for MCIs should:

- encourage coordination between all entities and appropriate resource allocation to promote collaborative provision of care;
- employ a shared accountability model in which patients are assigned to all entities providing care;

- define regions prospectively based on geography and/or patterns of healthcare use;
- use process and structure readiness measures to align incentives; and
- support greater data sharing and development of a central repository for MCI data.

The report includes six use cases representing the application of these attribution considerations to various high-acuity emergency scenarios. Furthermore, the report identifies the current state of quality measurement for MCIs and high-acuity ECSCs, prioritizes quality measures for potential use, and identifies concepts for new measures relevant to building a cohesive measurement system for MCIs and public health emergencies. Future measurement opportunities include developing attribution models that integrate the impact of entities outside of hospitals that are involved in emergency response. The measurement considerations put forward in this report can be used as a starting point to develop or select concrete quality measures for which multiple entities in a region should share accountability. This work is intended to inform the development of attribution approaches that encourage care coordination and strengthen accountability at the system level during large-scale emergency events to achieve the best possible outcomes.

Introduction

Attribution is a methodology used to assign individuals and their quality and cost outcomes to providers or entities. Attribution is increasingly important as the healthcare system moves from fee-for-service payments to alternative payment models and value-based care. Sound attribution methodology is essential to building accepted value-based models that accurately reflect provider/entity performance, particularly when a team or teams are involved in patient care. Traditionally, attribution can occur when patients are included in a particular program or when clinicians are held accountable for a particular outcome. Alternatively, a performance measure may be used to assess the performance of multiple providers.[1] For example, a readmissions measure may be attributed to both the hospital that discharged a patient and the outpatient primary care clinician responsible for managing that patient post-discharge. To date, most attribution models have focused on chronic diseases and generally assign patient outcomes to a single entity based on rules related to the frequency of provider visits, a combination of prospective and retrospective adjustment, or based on self-attestation, in which patients identify the provider they believe is primarily responsible for their care.

In the case of high-acuity illness and injuries that result from large-scale emergency events, different attribution models may be more appropriate. Effective care delivery during and after mass casualty incidents (MCIs) (e.g., mass shootings), public health emergencies (PHEs) (e.g., coronavirus 2019 [COVID-19]), and for high-acuity emergency care-sensitive conditions (ECSCs) (e.g., trauma and burns) involves teams or multiple teams who must collaborate over time and across specialties, institutions, and geography. These events are unpredictable and require a timely, coordinated response by various entities within a community or region. Attribution in these cases is particularly difficult for a variety of reasons: Among them, entities do not have advance knowledge of the patient population they will be responsible for treating, teams and entities have different abilities to have an impact on certain outcomes, a lack of alignment in standardized response protocols for emergencies exists, and entities involved in the emergency response can often be in business competition with one another.

Though complex, a model of shared attribution can help to promote what is necessary for effective response to MCIs, PHEs, and high-acuity ECSCs: more active collaboration among organizations that compete with or are not intrinsically aligned with one another, also termed *coopetition*.[2] This collaboration is vital to ensure that patients are cared for appropriately across settings. For example, emergency medical services (EMS) must respond appropriately at the scene and transport patients to hospitals with appropriate resources in a timely manner. Receiving hospitals must care for patients, and if necessary, transfer them to higher levels of care outside of their system. During the post-discharge stage, patients must be cared for longitudinally by community-based providers. Better communication, coordination across the entire continuum of care, and collaboration among entities may lead to better preparedness, response, and patient outcomes.

While prior NQF work funded by the Centers for Medicare & Medicaid Services (CMS) has focused on attribution and on measuring the quality of readiness for MCIs, PHEs, ECSCs, there is no specific guidance on attribution approaches for patients who receive care from multiple providers for unplanned high-acuity ECSCs. The Attribution: Principles and Approaches (2016) and Improving Attribution Models (2018) reports identified guiding principles and recommendations for designing and selecting an attribution model, explored key attribution challenges, and provided considerations for evaluating attribution models. More recently, the Population-Based Trauma Outcomes (2019) report emphasized evaluating trauma care within a population or geographic region rather than an individual facility or single part of the healthcare system, and the Healthcare System Readiness (2019) report identified guidance for developing readiness measures and identified key considerations for measuring and reporting the quality of healthcare system readiness.

Building on this previous work, this project aims to establish recommendations for developing geographical or population-based attribution models for unplanned high-acuity ECSCs, MCIs, and PHEs. This report details key elements of attribution models for MCIs and PHEs, considerations for developing measurement attribution models, and use cases illustrating how these considerations would apply to attribution models for various high-acuity emergency scenarios. Lastly, the report identifies relevant quality measures and concepts and offers preliminary recommendations for future measure and attribution model development to encourage care coordination and strengthen shared accountability at the system level, with the goal of achieving favorable population-level outcomes during large-scale emergency events.

Project Overview

In 2021, NQF, with funding from CMS, convened a multistakeholder Committee to make recommendations for developing geographical/population-based quality measurement attribution models applicable to MCIs, PHEs, and high-acuity ECSCs. The 25-member Committee represent experts in measurement attribution approaches; experts in high-acuity MCIs, PHEs, and ECSCs; patients, consumers, and caregivers; emergency clinicians; first responders; state public health department and Medicaid staff; and representatives of health plans, healthcare facilities, and specialty societies (see Appendix A for a full list of Committee members).

NQF convened the Committee for five web meetings to discuss patient-centered attribution approaches that encourage care coordination and accountability during MCIs, PHEs, and high-acuity ECSCs; review and provide feedback on the project's Environmental Scan Report; and develop attribution considerations and use cases that illustrate what to consider in developing an attribution approach for team-based approaches to high-acuity unplanned care. The use cases focus on trauma, a chemical event, a small-scale nuclear event, high-consequence infectious diseases, and burns (independent of trauma). NQF gathered additional feedback from key informant interviews (KIIs) to supplement the literature and Committee discussion, refine use case findings, and expand on key themes (see Appendix B for the KII methodology and interview guide and Appendix C for details on themes from the interviews). To produce the final report, NQF will engage the Committee in one additional web meeting in 2021 to discuss public comment and gather additional feedback on this draft report, specifically refining the attribution model key elements and future measurement recommendations.

Key Terms and Definitions

Definitions for several key terms in this report are included below. These definitions were developed based on literature review, prior NQF reports, and the Committee's input.

Attribution – The process of linking the treatments, processes, or outcomes of care to one or more providers. Attribution can have many purposes, one of which is performance measurement. For example, attribution may be used in performance measurement when two providers are to be jointly measured for patient outcomes or costs of care when they both have participated in providing care. [1]

Attribution model for performance measurement – A set of rules to define which entity or entities are accountable for a patient's healthcare processes, outcomes, and/or costs of care.[1]

Emergency Care-Sensitive Condition (ECSC) – Time-critical, high-acuity conditions such as trauma, stroke, acute myocardial infarction, sepsis, and burns are emergency care-sensitive conditions in which emergency departments (EDs) and hospitals are required to deliver specialized services. ECSCs include conditions evaluated in EDs where time-critical, high quality conditions are considered (e.g., chest pain, abdominal pain, and fever). ECSCs can occur during MCIs and PHEs but also occur in everyday medical care.[3]

Mass Casualty Incident (MCI) – An event in which emergency medical services resources, which may include prehospital, hospital and other community providers, are overwhelmed by the number and severity of casualties. Limitations often involve personnel and equipment. Examples include active shooter events, earthquakes, building collapses, bombings, and plane or train crashes. An MCI may involve ECSCs, but it also includes other types of patients, including minor injuries and worried well. It is also important to note that an MCI is defined based on local resources. Therefore, the same number of patients may be considered an MCI in a small hospital but not a large hospital that has sufficient staff and space.[4]

Public Health Emergency (PHE) – An event in which there is a need on an emergency basis for healthcare services for disaster response. Examples include infectious disease outbreaks or bioterrorism attacks. A PHE may involve an MCI if resources are acutely overwhelmed.[4]

Preparedness – Preparedness includes the plans, policies, protocols, analysis of risks, and curricula for incident response and recovery related to an MCI, PHE, or other hazards.[4]

Readiness – Readiness is a concept that is larger than preparedness. Readiness is the capability to successfully prepare for, mitigate against, rapidly identify, evaluate, and react to a wide spectrum of emergency conditions related to an MCI, a PHE, or other hazards. [4]

All-Hazards Approach – To deliver healthcare services during MCIs and PHEs, health systems must be ready for all types of events. This is an "all-hazards" approach.[4]

Attribution Approach Development Considerations

An attribution approach for MCIs and PHEs should promote high quality, team-based care and encourage the right care in the right place, by the right provider, and at the right time to achieve positive patient outcomes. The Committee sought to lay the foundation for how attribution for critical illness and injury should advance. Although there was no one attribution model the Committee recommended based on the evidence, they established several pivotal elements that future models should include. To support the development of attribution approaches for health outcomes from MCIs and PHEs, the Committee recommended that attribution approaches consider the following items:

- The attribution methodology goal
- Defined geographic region and population
- Attribution to multiple entities
- Attribution timing
- Data availability and capture
- The patient role in care selection
- Negative unintended consequences

Each of these elements is outlined below along with preliminary recommendations from the Committee and key informants. NQF will finalize these recommendations following public comment and Committee discussion.

Attribution Methodology Goal

The goal of quality measurement should be defined before making attribution decisions, and attribution decisions should align with this goal. For MCIs and PHEs, quality measurement may aim to incentivize proactive care coordination of the different entities involved in the response or assess outcomes of all patients in a geographic region at different points in time. Determining which attribution decisions are most appropriate may also depend on whether the intent of quality measurement is to drive quality improvement or to support accountability applications (i.e., public reporting or value-based payment).

Measurement Purpose

If measurement is to be used to encourage proactive coordination and communication between healthcare providers, public health entities, and EMS, then a model that attributes care responsibilities ahead of events based on the expected responsibilities of these entities is preferred. Given that there are no validated outcome measures for healthcare system readiness for emergency care, using readiness process or structure measures that are shown to be linked to improved patient outcomes is the approach most likely to be accepted by entities being measured. As MCIs are rare compared to other healthcare events, the denominators for outcome measures would likely be too small (based on the scale of the event), and measures would lack performance comparison groups. Therefore, for MCIs, it may be difficult to use outcome measures to align performance incentives in value-based models. However, the Committee acknowledged it would be useful to begin tracking patients' longitudinal outcomes without tying them to accountability.

Those designing attribution models should determine which population-level outcomes are desired based on gaps in care in the region (or nation) using data from previous, similar events as examples. Then, they should consider which processes or structural elements, closely linked based on evidence to the desired outcomes, should be carried out for all MCIs and PHEs. Those elements could then be assigned to the providers/entities that hold most of the responsibility for that component of care or shared equally across providers/entities. This type of measurement system would give entities a target and encourage readiness.

The Committee generally agreed that all entities involved in emergency care and response should be incentivized to work in a coordinated manner with other providers and partners. Attribution methods should support stronger collaboration and ensure that networks are in place during an emergency to communicate to staff within and across health systems, EMS, and the community. Attribution models should not penalize healthcare entities for operating in emergency conditions or for using their best judgment and innovation to provide care in difficult circumstances. Each event or emergency is different and has specific local factors that affect the ability of accountable units to deliver high quality, team-based care. Rather than use negative reinforcement through penalties, attribution models should enable public and private payers to work with organizations that are not meeting the standards. Only when entities are operating broadly outside the standard of care and are not meeting safety standards should a penalty be used; nevertheless, technical assistance should be provided as opposed to reducing payment. Ultimately, the focus should be on incentivizing preparedness to increase buy-in from accountable stakeholders rather than penalizing response.

Entities and Responsibilities

Entities including EMS agencies, municipal police and fire, local hospitals, specialized facilities, local clinics, health departments, and government agencies must work together during large-scale emergency events and should coordinate and collaborate in response planning. Attribution models should account for the roles of all entities involved. Table 1 outlines the entities involved in large scale emergency events, their responsibilities, and potential quality measures for each applicable entity. These examples are generally applicable across multiple scenarios but are not intended to apply to every mass casualty event or PHE.

An attribution approach should incentivize high quality, coordinated care for emergencies while being accepted by the entities that it measures. Attribution models and the quality measures should be fully transparent, vetted, and understood by the accountable units. The Committee recommended using process and structural measures for accountability purposes rather than outcome measures, such as a comparative mortality rate. However, tracking and analyzing differences in outcomes are important to identifying opportunities to improve care and address disparities.

Table 1. Entities Involved in Emergency Response, Goals, and Examples of Measures

Entity	Goals of Response	Examples of Process Measures	Examples of Outcome Measures
EMS Agencies	First response - timing, safety, access to patients, and deploying correct equipment at scene	Triage to appropriate centers (burn, trauma, hyperbaric oxygen [HBO]), timely transfer	Mortality (risk-adjusted), patient experience, and functional outcomes
Municipal Police & Fire	First response - timing, safety, access to patients, and deploying correct equipment at scene	Triage to appropriate centers (burn, trauma, HBO), and timely transfer	Mortality (risk-adjusted), patient experience, and functional outcomes
Hospitals	Initial resuscitation, scaling up to treat lower acuity, long-term management (lower acuity), and appropriate triage to specialized center, comprehensive surge management	Quality of resuscitation, process metrics of ED / hospital flow, quality of long-term management, and smooth transitions to local clinics, appropriate transfer to specialized facilities, and coordination with other entities	Mortality (risk-adjusted), patient experience, and functional outcomes

Entity	Goals of Response	Examples of Process Measures	Examples of Outcome Measures
Specialized Facilities	Initial resuscitation, scaling up to treat lower acuity, long-term management of critically ill, and less critically ill referrals	Quality of resuscitation, process metrics of ED / hospital flow, quality of long-term management, and smooth transitions to local clinics and acceptance of transfers	Mortality (risk-adjusted), patient experience, and functional outcomes
Local Clinics	Deliver longitudinal subacute / chronic care during emergencies and long-term	Quality of long-term management and transitions in care, facilitate communications across entities, and community response (testing and vaccine outreach)	Patient experience, outcomes proximal to clinic care
Government Response	Coordinated response and outside of response (preparedness, mitigation, and recovery)	Information sharing, quality of communication, quality metrics aimed at preparedness, mitigation, and recovery	Mortality (risk-adjusted), patient experience, and functional outcomes

Defining Geographic Region and Populations

A regional approach to attribution is a promising model for critical illness and injury, as these events are sudden, and treatment usually occurs near the geographic location of injury. Geography may be the fairest method for assigning populations to a shared group of healthcare entities, acknowledging that there is likely to be overlap within regions and imprecision as geographic patterns may not remain consistent in emergency situations. Differences in local and state laws, public health regulations, transport and transfer protocols, declarations of emergency, and government intervention may also influence boundaries or regional capabilities.

Population-Based Approaches

A main issue in creating a geographic attribution model is determining the appropriate granularity of geographic boundaries. ZIP codes, counties, or Metropolitan Statistical Areas (MSAs) could be used to determine boundaries. A “staking” method, one that draws out geographic areas and aggregates them based on the scale of the event, could also be employed. Using the same geographic-level unit is not appropriate for all areas of the country, in part because the population density and geographic distribution, services provided, and makeup of healthcare organizations differ from region to region. Volume and risk level of patients will also differ based on the type of MCI.

Based on the probability and type of an emergency event, a realistic radius could be developed that considered the most likely way that patients would be distributed during an MCI. This type of method would be based on geographic population density, patterns of how people would assemble during an event, and predicted patient distribution. As an example, in such a model, all hospitals in each region would be responsible for the entire patient volume, and a method of division would be determined based on resource capacity and capability. Relevant stakeholders should be involved in establishing the expected capacity and volume they could manage, which would help contribute to the buy-in required for this approach to be successful.

A complimentary approach would be to use data on existing patterns of healthcare utilization, such as the Dartmouth Atlas[5] project's hospital service areas (HSAs) or hospital referral regions (HRRs). The Assistant Secretary for Preparedness and Response's (ASPR) Hospital Preparedness Program (HPP)[6] involves 10 regions of Health Care Coalitions (HCCs) (i.e., groups of healthcare and response organizations, such as acute care hospitals, EMS providers, emergency management agencies, and public health agencies) that work in defined geographies to respond to emergencies. This data could also be leveraged in establishing regions for use in a geographic attribution model. Furthermore, for specific types of emergencies, existing data (e.g., a FEMA flood map) could be used to establish boundaries for cooperation, recognizing that entities may still work outside of established zones in disasters.

Additionally, trauma systems represent another population-based approach to care delivery that may be referenced when developing attribution models for MCIs and PHEs. In the U.S., some locations have state-wide, regional, or city-wide trauma systems that organize trauma care response within a region. For example, Texas has regional advisory councils for trauma and emergency care,[7] Maryland has the Maryland Institute for EMS Systems,[8] and Pennsylvania has the Pennsylvania Trauma Systems Foundation.[9] Considering these more organized areas or states in relation to attribution is important, as the system determines where patients go for the right care. Therefore, in certain locations, this has the potential to be a basis for attribution for reimbursement and quality of care.

Patient Inclusion Considerations

All persons at risk of exposure to an MCI could be considered prospectively depending on the type of event. For instance, a nuclear disaster could be modeled, but modeling a mass shooting may be more challenging because of all the location variables. Populations may also be defined as those exposed to or at risk for the event. If populations are assigned ahead of events, healthcare entities may have a greater understanding of the estimated volume of patients that may need care and the capacity of other entities in the region. Prospective understanding may provide a greater incentive for entities in a region to work together, as well as support vulnerable populations that may have limited access to the healthcare system. An alternative approach, more in line with existing models of attribution, would be to consider only the patients who interact with the healthcare system. However, a sizable portion of individuals in some areas may not interact with healthcare system, potentially leading to them being excluded from this model.

Data collection and analysis should be as granular as possible, as it is easier to aggregate data to higher levels, such as ZIP codes, counties, MSAs, or states, than it is to narrow data down to the patient or encounter level. Having a full population view of quality of care during an emergency or disaster (and potentially at the beginning and end) is important to accurately assess care delivered, as well as conduct a retrospective review to identify opportunities to improve future response. The ZIP codes of patients' residences, where care was provided, and where the event occurred should be captured and considered to best illustrate the full geographic scope of the incident.

Attribution to Multiple Entities

An important component of creating an attribution approach for MCIs and PHEs is determining how to recognize the multiple entities involved in responding to and providing care before, during, and after events. One would make decisions on what entities should be accountable for and whether a weighting approach should be used. These considerations are outlined below.

Team-Based Approaches

Team-based attribution approaches should recognize that multiple healthcare entities may be providing care for the same patient. While most attribution models in use today assign patients to one central unit, an approach for MCIs and PHEs should not assign patients in a 1:1 ratio to a single entity (e.g., hospital, EMS system, and physician). Instead, they should assign patients to multiple entities or regions in a model of shared accountability. Assignment may be based on region boundaries, where patients seek care, or the probability of where they might seek care.

All providers that are expected to deliver care in an MCI should be part of quality measurement, and ideally, part of an accountability structure as well. In such an approach, multiple providers in a region (e.g., hospitals) could be included even if a patient only received care from one of them. Entities should know that they are accountable as part of the team and what their responsibilities are ahead of time. Additionally, the length of the measurement period after the MCI, high-acuity ECSC, or PHE would be driven by the type of event and would have an impact on the number of providers involved. There may also be a timing component. For example, EMS might take part in an event earlier rather than later, and their measures should consider the timing of their influence.

Weighting Approaches

Different opinions on the entity level of influence and specific weighting methods are expected (e.g., whether all entities are held equally accountable or different weights are assigned). An approach in which all entities in a region receive the same score may be most appropriate because it fosters shared responsibility, coordination, and communication. Although every hospital or entity may not come in direct contact with people directly affected by the MCI or PHE, their actions (e.g., accepting non-MCI-related overflow patients to help the affected hospitals treat more victims) can contribute to improved health in the region.

Conversely, all entities being equally responsible may run the risk of lack of accountability among all hospitals involved, whereas if one hospital is being heavily weighted during an emergency, that hospital may feel more inclined to coordinate the processes. If a weighting approach were to be considered, hospitals could be weighted based on size, capabilities, or the voluntary amount of responsibility they are willing to take on (potentially tied to greater incentives). One option could be to allow each region to decide upon a weighting system with some safeguards in place to ensure fairness (e.g., setting minimum or maximum weights in advance). A map of all the potential providers, from first responders to EDs to hospitals to post-acute care, could be created to understand local healthcare systems. Data may be helpful in defining populations and resource use, but attribution may require consensus between healthcare resources at the local level to ensure stakeholder buy-in.

Attribution Timing

Central to an attribution model is the ability to identify which entity provided care at which time point. This will provide the information needed to understand the patient's journey through the system and provide a fuller picture of actions taken to inform payment. Timing decisions include whether retrospective or prospective approaches should be used, as well as the measurement period's start and stop points. In today's measurement system, quality measurement for emergency care generally begins when the patient enters the hospital. Retrospective attribution based on claims data and continuous enrollment is commonly used. Considerations for alternative or complementary approaches that align with the goal of recognizing multidisciplinary care for emergencies and incentivizing coordinated care are outlined below.

Prospective, Retrospective, and Hybrid Methods

To incentivize a multidisciplinary, coordinated response to emergencies, a prospective model or hybrid model with components of both prospective and retrospective methods is preferred. Assigning patients to regions prospectively would promote proactive coordination and communication ahead of events. However, it may be challenging to determine the population and regions ahead of time when payment structures are not population based. In addition, few hospitals and health systems have a clearly defined population that they know they are responsible for; a majority have a variety of payers, including Medicaid and Medicare, and commercial payers, which include payment systems such as preferred provider organizations (PPOs), health maintenance organizations (HMOs), and capitation. Prospective attribution assumes that one can accurately anticipate what care will look like during the emergency. Population-based models should also consider that predictions of where patients might go may not align with where they actually receive care.

Retrospective methods have the benefit of knowing, based on actual event-specific data, which providers interacted with patients and, methodologically, are likely easier to apply. For MCIs, these methods can be used to learn about the quality of response, understand the scale of an event, and determine where patients received care versus what was predicted, with the intent to build a better system for the future. Identifying and tracking a population retrospectively would require data from any entity, system, or individual who interacted with a person, as some people may be triaged on scene and others may be treated at hospitals or in ambulatory settings. Specific to hospital care, more detail in hospital coding data would be needed to indicate which patients were part of an event. For example, data would have to be specific enough to indicate that smoke inhalation was directly caused by a wildfire rather than an unrelated shortness of breath diagnosis. However, retrospective methods may not promote coordination and communication to the same extent as prospective methods. This is particularly the case if the attribution includes providers who did not actually see a specific patient.

The choice of prospective versus retrospective attribution may be contingent on the type of MCI and the trajectory of an injury or condition. This may warrant the utilization of a hybrid attribution approach, combining both prospective and retrospective approaches. A hybrid model would look at certain high-acuity ECSCs and MCIs, create subcategories for certain events, and use historical data to generalize the potential types of events in order to understand which structures and processes to have in place across these events and would factor in different variables, such as demographics. A hybrid approach would involve assignment rules based on the predicted number of people who would be involved, and which entities would provide care and their roles. This type of approach would actively promote coordination and communication through a prospective model, with the added benefit of a retrospective method's ability to evaluate the effectiveness of care response plans. A hybrid model may have different predictions based on historical data on different types of MCIs or high-acuity ECSCs.

Measurement Duration

MCIs have different durations and patterns of severity. Measurement start and stop time and which entities are accountable at different time periods may differ based on the event. Recognizing these differences, the Committee did not recommend one generalizable measurement duration that should be used in attribution approaches but discussed several factors that should be considered.

Attribution methodology may layer levels of accountability over time. For example, at the onset of an event with a clear start, first responders and EMS play a key role in the initial care provided. This is when quality measures that focused on immediate care that took place outside of the hospital setting would be useful and appropriate. Quality measurement could then shift to focus on more traditional medical care, such as ED, surgery, and post-acute care. However, the Committee recognized the complexity of measurement when patients are transferred from one setting to another during the course of emergency/urgent/semi-urgent care. The further attribution is from the initial event, there is less clarity about who may influence the patient's outcomes. Longer-term quality outcomes may be more influenced by primary care physicians and/or specialists. Furthermore, public health and social services contribute to response and patient outcomes at different points during emergencies, especially during longer-term events (e.g., pandemic).

Data Availability and Capture

This section outlines recommendations on the types of data that can be used for quality measurement attribution, whether data are able to be captured and shared across entities involved in providing care and future data sources. Data used for quality measurement should align with data that would be collected to advance readiness for large-scale events or with data that are collected as part of the normal provision of care. Quality measurement results should be used to improve readiness for MCIs and PHEs and support better response during large-scale events. A combination of technology, communication, and stakeholder engagement is necessary to achieve minimal data collection burden and buy-in on the accuracy of data sources for use in quality measurement attribution models and to provide results in a timely, actionable manner.

Connected Data Systems to Support Attribution

Attribution of quality measures today relies primarily on claims-based data. Although this data lacks the clinical richness of other data (e.g., electronic health record [EHR]) needed to calculate certain quality measures or for risk adjustment, it may provide much of the needed information for geographic attribution. For example, claims data can provide historical information on utilization, facilities the patients visited, and the location where care was received. These data can be used to develop an understanding of existing care networks that can help to inform decisions on defining geographic regions. Claims data can also help to support prospective attribution.[10,11] To use other data sources for quality measures, it is essential that there be standardized and uniform definitions. An initial step would be to create rules for having consistent data in place (e.g., in EHRs) and requiring it to be validated and accurate. Standardization efforts may be further supported by recognizing and modeling examples of successful regional data sharing.

A connected, or interoperable, data system that allows for sharing data related to emergency response is critical to inform decision making and support accurate attribution. The lack of connected data systems across the various entities involved in MCIs (e.g., hospitals, practices, public health, and first responders) becomes a major challenge for the assessment of quality in an actionable, understandable way. In addition, the potential use of quality metrics based on these MCI-associated data to drive value-based payment models creates even more complexity and increases concern about financial risk for the entities involved. However, if data start being collected and shared across entities, it will help create the opportunity for attribution models to mature. One option to obtain process and structural healthcare system readiness data for attribution would be for payers or accreditation bodies to require it to be collected.

Data systems or health information platforms that allow entities to follow a person's healthcare journey should be created. Linking healthcare delivery data from the first responder/community sector with the hospital sector is essential to providing the right care and achieving better outcomes. The Committee supported the development of a central data repository of shared MCI information. This could potentially be layered or integrated with an existing registry (e.g., the American College of Surgeons Trauma Quality Improvement Program [ACS TQIP®]). The Health Information Exchange (HIE) infrastructure could also be leveraged to support data sharing across entities. Strong incentives and funding are needed to create a central repository, develop an interoperable data system at the state or federal level, and facilitate data sharing while protecting patient privacy.

Data to Inform Real-Time Care

Quality measurement attribution models should not add data collection burden during an event or divert focus from the primary goals of saving lives and ensuring optimal quality of life for those affected by emergency events. Ideally, quality measurement data and how they are attributed would support better response during an event. A main barrier to an organized response to MCIs and PHEs is the disparate data available to support a real-time understanding of the event scope, regional needs, and neighboring entity capabilities. Standardization and sharing of MCI and PHE information is needed. Data infrastructure should allow entities to share their patient load, patients' illness/injuries, resource availability, and capacity to accept transfer patients. This critical information is needed to help manage MCIs and PHEs. For example, it is used by the prehospital sector to make decisions about where to bring patients and by facilities to determine when higher levels of care are needed. This type of model would also support better decisions on subspecialty needs during events (e.g., which patients receive trauma, burn, or emergency pediatrics care). The sharing of this information through dashboards could be incentivized through quality measurement. This data should be accessible by the measured entities that are part of the attribution model (e.g., hospitals, EMS, and state and local agencies).

In this type of data-sharing system, automatic, electronic data collection is preferred; however, some manual data collection based on clinical judgement is likely needed (e.g., severity of patients' conditions, who should be transferred). In addition to ambulance/EMS data, hospitals should account for patients who arrive through alternative transport (e.g., driven by family/friend, rideshare, and walk-in) for data on capacity and resource availability. During some MCIs and PHEs, these alternative transport methods may account for a large volume of hospital arrivals. It is also important to consider the potential for loss of essential electronic infrastructure during emergencies (e.g., hurricanes, bombings); quality measurement can assess whether regions have plans and alternative communication channels in place to account for this disruption.

Future Opportunities for Data Collection

Recognizing the limitations in the ability to understand certain aspects of MCIs and PHEs through existing data sources, the Committee and key informants encouraged innovative thinking about what data could be used for attribution purposes in the future. Data collected during activities to prepare for events may be useful for quality measurement. For example, facilities or systems may engage in exercises (e.g., staff call-ins, patient placement exercises) to demonstrate which resources can be mobilized. ASPR's toolkits and coalition examples of requirements could be used to assess core capabilities of entities that would be involved in a response, and that data could be collected and used for prospective attribution. Table 2 provides additional examples of data that could potentially be used in the future for quality measurement. Further exploration is needed regarding how this data would be collected and which entity would be best suited to collect it in order for it to be usable when developing attribution models.

Table 2. Potential Future Data Sources and Use Examples

Data Source	Potential Information Provided/Use Examples
Car insurance claims	Volume of people affected by a motor vehicle accident
Motor vehicle data	Volume of people affected by a motor vehicle accident; to signal ambulances in a multi-crash situation; to alert nearby facilities to prepare for increased patient volume
Rideshare information	Volume of patients heading to hospitals in a region
Cell phone and wearables data	Patient location and health application data
Data on nonmedical interventions	Utilization of services outside of the traditional medical system (e.g., did a patient who was referred to stress management classes attend?)
Integration of pharmacy data with EHR data	Patients' conditions, access to medications, adherence
Utility bill data	Need for public health or social service check-in or intervention
Community services or directory assistance requests (e.g., rent, food bank assistance)	Community needs during emergencies
Weather data	Natural disaster locations and areas of impact
Dispatch/communications data	Signal start of entity involvement in care

Together these sources could provide a broader view of population health needs without added data collection burden on providers or on patients for providing additional information or filling out surveys for quality measurement. However, in order to leverage data sources, it is essential to address whether the data can be used for a broader purpose than initially intended and whether consumers would agree to share this data. There are also significant privacy questions and legal considerations for how such data can and should be collected, aggregated, and used. Furthermore, some data are inherently more sensitive and require different regulations. In the future, quality measurement attribution approaches may be able to leverage such new, connected data sources to identify opportunities for improvement and drive better outcomes for patients.

Patient Role in Care Selection

The patient role should be accounted for when developing geographical/population-based quality measurement attribution models applicable to high-acuity ECSCs. Patients should be included in designing attribution models to ensure that the agreed-upon systems and processes are fair and person centered. Patients should have a decision making role in their own care, including where they receive care; however, their engagement is often dependent on factors such as their cognitive state and the urgency of their care needs. A patient's ability to select a healthcare entity is also dependent upon the number and capacity of hospitals in an area that can deliver in-person or virtual critical care services.

Most often, MCIs and PHEs require urgent clinical attention and a coordinated response; therefore, the top priority is to save patients' lives. Systems should also be organized proactively to ensure the best possible outcomes for patients if patient decision making is impaired due to the MCI. During no-notice emergencies, such as MCIs and high-acuity ECSCs, patients require urgent clinical attention and may not be able to select where they receive care. In these cases, self-attestation may not be appropriate. If patients can select which healthcare entities are responsible for their care, exclusions would be needed for age and cognition, such as minors and persons with Alzheimer's Disease. Another possibility is to have an additional process in place that would provide a quality check against an objective data source. Furthermore, after an MCI occurs, patients may display symptoms that were not diagnosed during their initial visits and may require a broad set of specialists to diagnose and treat patients, which can further complicate attributing patient outcomes.

Negative Unintended Consequences

Negative unintended consequences refer to the potential unplanned and unanticipated adverse effects that can arise from selecting or applying a given attribution model. These unintended consequences should be considered when developing attribution models to mitigate any potential negative effects and prevent patient harm. For instance, an attribution model that is implemented by payers may incentivize entities to devote resources and attention to certain care processes and patient populations while unintentionally disadvantaging other patient populations or important aspects of care, thereby increasing health disparities. Involving as many stakeholders in a community as possible to participate in the design of attribution models and discussing the potential unintended consequences of attribution models during model development and prior to their use could help prevent and/or mitigate adverse consequences.

One unintended consequence is the potential for entities to control the data provided to receive payment for services rendered. Attribution model implementers should ensure that the selected attribution model does not incentivize gaming the data so that one entity receives a greater share of the payment. The attribution model should not penalize the entities that are initially responsible for patient care by assigning them responsibility for all outcomes related to patients. Finally, caution should be paid to potential disincentives for coordination and communication that may not be immediately apparent.

Given the complexity and large number of entities involved in an emergency response, stakeholders may have initial hesitation regarding being held accountable for health outcomes of victims of these events. Moreover, in some cases, attribution applications for quality improvement and knowledge dissemination may be more appropriate than accountability because of the novelty of this area. Another consideration for quality measurement attribution is that all measures may not be feasible for all MCIs, underscoring the need to ensure that measures are not inappropriately placed within models. For instance, measures may be appropriate for assessing large-scale public health emergencies, such as the COVID-19 pandemic; however, similar measures may not be acceptable for smaller emergencies in which volume is an issue. These considerations underscore the need for fair, transparent, and evidence-based attribution approaches.

Finally, attribution model developers must consider how to best monitor for negative unintended consequences while avoiding the creation of a complicated or burdensome data system. Reducing burden is critical, especially for entities such as safety net organizations that are already stretched for resources. A complex system for monitoring for negative unintended consequences would reduce hospital productivity and increase the potential to prioritize data entry over patient care.

Use Cases

To illustrate the application of these considerations within attribution approaches, the Committee developed six use cases of high-acuity ECSCs, PHEs, and MCIs. The scenarios display complex care coordination needs within and between settings and examine approaches to determine shared accountability for health outcomes. Designing an attribution model from these use cases may encourage improved health outcomes through optimized communication and aligned incentives across stakeholders. Detailed descriptions of each use case can be found in Appendix D.

Case 1: Trauma (Motor Vehicle Accident) ECSC

Rationale: This use case represents a rapid response scenario with a limited number of patients with ECSCs. It introduces principles applicable to larger scale events (e.g., coordination, transportation, and timely response). Although this case has fewer victims, how entities work together to respond to smaller events may also reflect how they collaborate during larger-scale emergencies, such as MCIs.

Description: Use case 1 describes a 45-year-old father and his 12-year-old son who are both involved in a head-on collision while driving back from an overnight camping trip. Local EMS evaluated the child and found bilateral facial fractures and a compromised airway. A laryngeal mask airway was placed, and the patient was stabilized on scene and transferred by air medical transport to the closest level I trauma center, which is across the state line. Local EMS evaluated the father and found an open tibial fracture, torso abrasions, and left arm laceration. The patient was hemodynamically stable. He was transferred by ground to the local community hospital. The following day, the father developed peritonitis and was transferred to a level I trauma center across state lines for repair of intestinal injuries. His tibial fixation repair wound became infected, requiring debridement and a skin graft by a second orthopedic surgeon once at the trauma center. The patient ultimately recovered and was transferred to an inpatient rehabilitation facility in his community.

Identified entities: local government, local authorities having jurisdiction (i.e., police, fire, and EMS), critical care transport, local hospital with ED and physicians, specialty orthopedic surgeon, local radiologist, trauma center, multiple teams at trauma center, including orthopedics and plastic surgery, inpatient rehabilitation center, plastic surgeons, and the community primary care doctor treating diabetes

Potential measures or measure concepts:

Process measures: timing of handoff, timing of diagnosis, timing of appropriate testing, appropriate triage (e.g., determining under- or overtriaging, EMS direct transfer to level I trauma center appropriately), and time to transfer

Outcome measures: mortality (or survival, at 30 or 60 days), functional ability post-accident and post-care, and acuity of patients to evaluate potential attribution (e.g., severity, injury scores)

Considerations:

When determining entities for shared accountability as well as measures or measure concepts, the time course of the outcome is important. There may be different responses for each entity if the time course measured was based on the initial survival only or expanded to survival at 30 days or six-month mobility or functional ability. Additionally, the entities for included shared accountability would depend on measure specifications. For example, if six-month mobility is the measurement goal, the denominator could include all involved patients or only those who survive their initial hospital stay. This use case scenario involves crossing state lines, which introduces a unique geographic consideration for attribution as states and regions generally have separate health and transportation systems. Additionally, there was a missed diagnosis related to the abdominal perforation that was not detected early. The perforation may only be able to be attributed retrospectively due to the time of discovery.

Case 2: Trauma (Bombing) MCI

Rationale:

This use case is presented as a clinically complex example of an MCI following multiple patients throughout the aftermath of a bombing. The use case extends to First Aid-trained community members to reflect increased survival rates in areas with a higher level of CPR training.

Description:

Use case 2 describes four patients who were injured because of a pipe bomb detonation at a large event in North Central Illinois. The area is served by Fire Department EMS, and this city has one single level II trauma center (Hospital X). The nearest level I trauma center is 25 minutes by ground (Hospital Y). Specialty services are in-state 60 miles east or out-of-state 45 minutes north in Wisconsin.

Patient 1 is collected by a fire department ambulance crew and rushed to the local level II trauma center. He is bleeding in his abdomen and requires an emergent operation. He is transferred to Hospital Y trauma center later in day 1. He has one additional follow-up surgery at the level I trauma center before being transferred to the burn center in Wisconsin.

Patient 2 is a 14-year-old girl who is Patient 1's daughter. She has abrasions and some shrapnel embedded in her face, as well as some bleeding near her right ear. She is awoken when collected by a fire department ambulance and transported to the level I trauma center (Hospital Y). Due to her small stature and loss of consciousness, she is thought to be a younger child and is immediately brought to a resuscitation bay.

Patient 3 is an 18-year-old male who suffered a laceration to his left arm. A bystander with "Stop the Bleed" training placed a tourniquet on his left upper arm, and he was assisted by a friend to a car where he is taken to Hospital X. Upon arrival, the patient is taken back to a resuscitation bay but quickly moved to another room to accommodate Patient 2. Patient 3 remains stable initially, but serial assessments by nursing staff reveal hypotension. The patient develops shortness of breath and upon further evaluation, the patient is found to have a wound in his left axilla and a developing tension pneumothorax. He is resuscitated, a chest tube is placed on water seal, and his left arm laceration is explored. The tourniquet is released after 90 minutes.

Patient 4 is a 67-year-old male with a history of atrial fibrillation on Coumadin. He has blunt trauma to the right upper quadrant of his abdomen. He was hypotensive at the scene and transported by a mutual aid ambulance to Hospital X. On arrival to Hospital X, he was intubated and resuscitated with blood products (two units of blood and two units of fresh frozen plasma), and stabilized by emergency physicians; he then was airlifted to a level I trauma center across state lines.

Identified entities:

local authorities (i.e., fire, EMS, and police), civilian responders, local level II trauma center, an in-state level I trauma center, out-of-state specialty hospital, skilled nursing facility, an inter-facility transport system, inpatient rehabilitation facility, or skilled nursing facility depending on patient outcomes.

Potential measures or measure concepts:

Process: appropriate triage, timeliness of care (e.g., time to the ED, time to operating room)

Using structure and process measures would support the creation of a delivery system that is prepared to function together before an MCI occurs. These measures would need to consider what entities would be reasonably comfortable being held accountable for (i.e., whether the measures are within their influence or control).

Considerations:

Prospective attribution within this use case would help determine the appropriateness of transfer and admissions between each hospital depending on patient condition (e.g., appropriate triage). Additionally, a prospective attribution consideration could include community preparation and resources to train civilians in First Aid.

From a measurement lens, an MCI should be viewed differently than an individual trauma. A healthcare entity trying to provide services at the time of crisis will likely have a level of discomfort with ambiguity of intent in measurement (i.e., future negative implications the measures may have). From an attribution perspective, an MCI should be measured in a way that is not punitive.

In a geographic accountability model, those hospitals or systems that are not directly affected should prepare for overflow cases to let the closest hospital treat MCI victims. Currently, there is no accountability for an MCI that happens adjacent to a hospital's area or service region. In a prospective geographic model, accountability would be tied to a level of attribution to each healthcare entity within the region.

Case 3: High-Consequence Infectious Disease (HCID) Public Health Emergency

Rationale:

This use case follows a man exposed to an HCID (Ebola) during recent travel and the healthcare systems that did not recognize the disease. Government entities and specialized units within hospitals were intentionally included for illustration of additional levels of coordination in this use case.

Description:

Use case 3 involves a 45-year-old man (Patient 1) who went to his doctor in a small, rural town with a fever of initially 100.1°F (38.4°C). He was treated with possible sinusitis and returned home. The next day, the fever increased to 102.9°F (39.4°C), abdominal pain, and a headache. He went to the closest ED at a hospital (Hospital A: critical access hospital) in a neighboring town. Again, he was treated with possible sinusitis and discharged.

Seven days later, the man returned to the same ED by ambulance with persistent fever (101.4°F [38.6°C]), abdominal pain, and new onset diarrhea. During the exam, clinicians identified that the man had recently returned to the U.S. from Liberia seven days earlier after attending a conference with his company. Reports out of Liberia state that an Ebola outbreak was just identified. The patient was placed in a private room under standard droplet and contact precautions and was tested for Ebola. The test confirmed the patient had the Ebola virus. Results were sent off to the state health department. The Centers for Disease Control and Prevention (CDC) was notified that the patient attended a conference where he likely contracted the virus. The case continues to reflect contract tracing and containment efforts, various other individuals contracting the virus, and the transportation of patients to facilities based on availability and ability to treat patients with Ebola virus.

Identified entities:

Community physician, Hospital A emergency department (ED) at the critical access hospital visit 1, Hospital A ED at the critical access hospital visit 2, Hospital B, Hospital C, ambulance service, the state and local health departments, the CDC, and the biocontainment units within each hospital

Potential measures or measure concepts:

Structural measures: effective infection control and decontamination along the chain of transport

Process measures: the CDC's Identify, Isolate, and Inform framework,[12] an automated and updated screening of new patients who have travelled within those countries that have identified Ebola (or HDIC) cases, supplies of personal protective equipment (PPE) on hand at all times, as well as others to ensure that all protocols are being followed and to prevent the transfer of the disease

Outcome measures: tracking the avoidance of transmission within a healthcare facility to both patients and staff, avoidance of transmission for EMS, avoidance of transmission for any directly contacted entities

Considerations:

This use case emphasizes the lack of early identification of a potential virus by initially excluding recently traveled out-of-the-country questions in triage and physician office and EMS triage and assessment. Effective sanitization after EMS transport for patients experiencing specific symptoms and/or that are identified through initial triage would have prevented additional contamination. Additionally, adequate resources should be made available to treat patients with HCIDs within a given region, including community health centers and appropriate transportation out of the region to other facilities.

Due to the nature of this highly infectious disease, the healthcare facility that is designed to treat the patient may not be fully capable or able to treat the patient at any given moment. There are scenarios in which, depending on the location of the patient, the current given facility may need to become a treating facility, even if it is not fully equipped ahead of time; it may also need to bring the CDC to help support containment and treatment.

This use case highlights the connections between communities across geographic lines, which are often based on immigrant or cultural status, that may have important healthcare considerations. Considering the potential networks between one local immigrant community within the U.S. and its sister community in a different state or country becomes very important. Improving communication temporally and spatially can help prospectively identify risks or origins of infectious disease.

Case 4: Burns MCI

Rationale:

This use case follows a large apartment fire MCI that focuses on burns specifically, independent of trauma. This differentiation is important to acknowledge the specialized needs of burn victims.

Description:

Use case 4 describes a large-scale apartment fire, resulting in 20 critically ill patients, five pediatric victims, and five additional acutely ill patients. Additionally, there are 80 patients estimated to have mild to moderate burn injuries but are ambulatory. These patients are transported to hospitals after the critically ill patients have been taken or obtain private transport. Of the critically ill patients, half of them are transported to a level I trauma center (Hospital A), which does not provide specialty burn care but can stabilize patients. The five pediatric victims are transported to a pediatric level I trauma center, and the rest of the patients go to Hospitals B and C. Two first responders suffer severe burn injuries and are taken to Hospital D as the only nearby designated burn center, 15 miles outside of the city.

An emergency shelter is prepared in coordination between local and state officials for all apartment residents. Hospitals A, B, and C initiate transfer processes for the severe patients to Hospital D. Hospital D delays acceptance processes due to difficulty prioritizing patients and coordinating transport, given the high volume. Hospital D accepts and treats the patients requiring specialty burn care and requests assistance from other area hospitals and additional resources from state officials. Hospital D also attempts to coordinate with external clinics, surgeons, and wound care specialists for minor burns, allowing specialty burn services to continue focusing on high-acuity injuries.

Identified entities:

Municipal fire rescue and police; EMS agencies; Hospitals A, B, C, and D; local burn centers; pediatric specialty facilities; and state assistance

Potential measures or measure concepts:

Process measures: adequate fluid resuscitation for burn patients (e.g., too little fluids or too much blood transfused)

Outcome measures: burn-specific outcomes; three- to six-month patient-reported outcome measure related to pain or functional status, (e.g., PROMIS)

Structural measures: prehospital transfer protocols for burn patients and whether they are consistent and aligned across hospitals

Considerations:

Due to the patient volume for this MCI, the importance of first responders is paramount. Timing, safety, and physical access to patients are all affected because of the apartment structure. High patient volume and acuity created a difficult scenario related to triaging patients to receive critical care, trauma, and specialty burn care. Specific to the treatment of burns, Hospital D faced overflow due to their ability to provide specialized treatment, including the hyperbaric oxygen chambers and burn-specific prolonged needs delivered in dedicated facilities. Pediatric-specialized treatment was also an additional variable, introducing a separate entity and set of patients who needed urgent treatment.

Risk adjustment models for outcome measures in this scenario would be difficult to develop due to lack of suitable data prior to the MCI, which could limit the utility of a risk-adjusted survival measure. Additionally, measuring appropriate fluid resuscitation would help to incentivize data collection across different entities (e.g., between EMS and hospitals) and could help provide the building blocks for electronic measurement across the care continuum.

Case 5: Chemical Attack MCI

Rationale:

This use case represents a large-scale gaseous chemical attack in an urban setting. Victims of the chemical attack vary in severity of illness and symptoms, and the potential long-term impact of this event is unknown.

Description:

Several cannisters placed throughout the subway system release a vapor cloud in a large metropolitan setting. Dozens of passengers quickly develop a cholinergic toxidrome with vomiting, respiratory distress, and muscle paralysis. EMS is summoned and begins decontaminating, treating, and transporting several dozen cases. Thousands of less severely ill riders, manifesting either milder symptoms or psychogenic symptoms, egress from the subway without being treated or decontaminated. Some subway riders walk to local hospitals directly, with others seeking care later. Overall, 14 hospitals see over 5,000 patients from the attack.

Identified entities:

EMS, incident command, hospital ED and ICU, law enforcement, decontamination agencies, critical care or trauma centers, rehabilitation centers for possible long-term care, and possible military response

Potential measures or measure concepts:

Process: time to decontamination, proportion of patients who are decontaminated prior to arriving at a care site

Structure: Hospital preparedness for decontamination (quantity of decontamination rooms with isolated water systems), coordination planning and protocols in place, holding annual city- or state-wide preparedness drills, real-time EMS, and hospital capacities

Considerations:

Attribution may be difficult to determine in this scenario, given multiple patients with varying degrees of illness presenting to multiple hospitals. Additionally, there may be patients who were not at the initial site of the incident who become patients as they are contaminated by residual nerve agent from an original patient. These patients may present to other hospitals or healthcare providers because of the chemical attack, even though they were not involved in the initial incident.

Regional preparedness and response are unique to this large-scale attack. Coordination and readiness of the full continuum of care providers (e.g., ranging from the role of regional EMS, local and adjacent hospitals, decontamination agencies, critical care or trauma centers, and rehabilitation) would need to be considered. Law enforcement and the military may also be involved in this type of scenario. Furthermore, treatment of both physical and psychological long-term effects may extend the duration in which patient outcomes should be tracked and in which quality measurement would be appropriate.

Case 6: Nuclear Explosion MCI

Rationale:

This use case is a large-scale nuclear explosion resulting in acute and chronic illnesses. The region impacted spans several nearby healthcare entities with differing capacities to respond and involves a regional evacuation by the military. Additionally, the geographic proximity to the nuclear power plant present the opportunity for preparedness and readiness for the surrounding area in a potential MCI.

Description:

An earthquake causes an explosion at a nuclear power plant, releasing an unknown quantity of radioactive materials into the environment. The Federal Nuclear Regulatory Commission (NRC) recently found violations that were not addressed prior to the incident. The plant has 11 employees on site and is within 10 miles of 15,000 residents and within 25 miles of 40,000 residents.

After the initial explosion, three workers are killed, five are critically injured, and three sustain non-life-threatening injuries but are exposed to large doses of radiation. There are three hospitals within 60 miles of the plant with varying levels of radioactive preparedness. Four victims are transported to a nearby Hospital 1, which decontaminates the patients and EMS responders. Three victims are transported to a further level I trauma center where there is a delay in decontamination procedures. Two patients are transferred from Hospital 1 to Hospital 2, although Hospital 2 declines the patients due to concern for radioactive exposure. The patients are then transported to the level I trauma center.

State and federal officials, including the National Guard, evacuate all residents within 10 miles of the plant, including Hospital 1. Hospital 2 begins to have patients arrive with limited decontamination personnel and equipment, causing delays in admission and care. One employee is taken to Hospital 2 and is not decontaminated prior to entry, with a family member also developing symptoms.

There are long-term increases of the incidence of cancer and autoimmune illness within the area, with patients seeking care at both local and remote facilities.

Identified entities:

Federal agencies (i.e., FEMA, Department of Energy [DOE], Department of Defense [DOD], NRC, Environmental Protection Agency [EPA]), State officials, EMS, multiple hospitals, and the National Guard

Potential measures or measure concepts:

Process: time to decontamination, proportion of victims decontaminated prior to arrival at the site of care, clinical care follow-up for those exposed to radiation at the time of the MCI

Outcome: Follow-up clinical care provided to those exposed to radiation

Structure: preparedness, including drills and increased PPE supply; proactive coordinated network for transfer protocols

Considerations:

A nuclear power plant in a rural setting poses unique challenges in preparedness, coordination, and response to a radioactive accident. Due to the physical location of the plant, at least 15,000 residents were evacuated. This case emphasizes the known and unknown long-term effects from these types of events. In this case, the event resulted in an increase in healthcare needs and poor outcomes for residents in the surrounding area.

Additionally, the high volume of patients who needed to be transferred to nearby hospitals and long or delayed transportation times due to decontamination time and hospitals not accepting patients because of exposure concerns pose challenges for EMS. In addition, there is variation in how EMS is provided (e.g., affiliation) across regions. For example, EMS in rural settings may be provided by volunteer staff. The safety of the first responders and ambulance decontamination processes are additional factors to consider.

Quality Measures, Concepts, and Gaps

Developing attribution models for MCIs and PHEs will be influenced by the available quality measures that can assess readiness for these events and care provided during them. Therefore, the current state of measurement, assessment and prioritization of existing measures, and future measurement opportunities are important contexts for creating attribution models. The Committee focused on structural and process measures to serve as the basis for measurement attribution models and prioritized key areas such as transfer, triage, and capacity measures.

Current State of Healthcare System Readiness and High-Acuity ECSC Measurement

The concept of measuring the quality of healthcare system "readiness" is important to ensure that the ill and injured receive appropriate and time-sensitive care during MCIs and PHEs.[4] However, measurement efforts to date have focused on specific actions that entities can engage in to prepare for or respond to disasters (e.g., simulations or exercises). Alternatively, measures may focus on capabilities to meet the needs of a disaster (e.g., having sufficient PPE). There are few measures that apply across disasters that can assess whether a system is ready in advance or was ready in retrospect. Measures focus on steps that organizations can take to be prepared for an MCI or PHE, not how well they actually performed. There is also a paucity of measures for specific incidents or that identify structural or operational challenges in maintaining high quality operations before, during, and following MCIs and PHEs. Measures for high-acuity ECSCs are typically facility based and focused on a narrow set of medical conditions, such as stroke care. Many measures for high-acuity ECSCs assess hospital quality only and do not assess the quality of prehospital care. For prehospital EMS agencies, there is no direct quality measurement; rather, state EMS office representatives license and enforce regulations for EMS agencies, conduct investigations, and inspect EMS vehicles.

Several factors contribute to the lack of measurement for MCIs and PHEs. Compared to routine clinical care, MCIs and PHEs are infrequent, often unique events. Assessing clinical quality during an event may be a challenge due to the lack of a comparison group and ability to determine what quality of care or outcomes could have been achieved under a different set of circumstances. Trying to ascertain the outcomes of an event that were preventable, unpreventable, or mitigatable through enhanced readiness is also difficult. Furthermore, disparate capabilities are required for an all-hazards approach. For example, readiness for multiple traumatic injuries from a bus crash is different from readiness for a bioterrorist event, with the latter requiring more specialized staff and equipment, such as a decontamination tent. Understanding the current science and limitations of readiness and high-acuity ECSC measurement is important context for determining which measures should be prioritized and how they may be attributed across entities during large-scale emergencies.

Measures and Concepts to Prioritize

To objectively attribute responsibility for high-acuity ECSCs, PHEs, or MCIs, measures should reflect the healthcare continuum, including both traditional (e.g., hospitals, clinics) and nontraditional (e.g., EMS, community centers, and public health departments) healthcare entities. Currently, there are ECSC measures tied to traditional healthcare systems and settings, such as an ED or inpatient stay, but measures are limited when exploring care outside of hospitals. Measures for PHEs and MCIs are largely unexplored, with COVID-19 illustrating the lack of measures and an opportunity to develop measures to assess the health system’s ability to respond to such events. Table 3 displays the Committee’s recommended approach to quality measurement based on condition—MCI, epidemic, pandemic, or high-acuity ECSC. The Committee also discussed potential quality measures to use in geographic attribution models for emergency events and measurement concepts applicable to team-based emergency response.

Table 3. Approaches to Measurement Based on Condition

Condition	Readiness (Structure & Process)	Healthcare-Based (Structure, Process & Outcome)
Mass Casualty Incident	List of capacities and capabilities at the geographic level for MCI-specific readiness	Not measurable with healthcare-based measures as each event is unique, without comparison, or clarity on what represents good performance
Public Health Emergency (epidemic)	List of capacities and capabilities at the geographic level for PHE-specific readiness	Not measurable with healthcare-based measures as each event is unique, without comparison, or clarity on what represents good performance
Public Health Emergency (pandemic)	List of capacities and capabilities at the geographic level for PHE-specific readiness	Process measures for specific entities for specific conditions; outcome metrics at the geographic level with shared accountability through attribution
High-Acuity Emergency Care Sensitive Conditions	List of capacities and capabilities for high-acuity ECSCs at the geographic level for condition-specific readiness	Process measures for specific entities for specific conditions; outcome metrics at the geographic level with shared accountability through attribution

Quality Measures

Much of the traditional healthcare system is prioritizing outcome measures to best assess whether processes and protocols improve patient results. For nontraditional healthcare entities without established measures, structural and process measures may play a central role in attribution models for MCIs and PHEs to address response coordination and execution. Attribution model developers should consider prioritizing evidence-based structure and process measures that can drive improvement in health outcomes for patients and support a successful preparedness infrastructure.

Structural measures support the achievement of positive patient outcomes by assessing whether healthcare entities have resources and capacity in preparation for MCIs or PHEs. Operational structural measures could include the following:

- Healthcare providers' or systems' capacity
- Staffing ratios
- Available beds
- Staffed beds
- The number of board-certified or eligible physicians[13]

Process measures for emergencies can be used to assess timeliness and the appropriate use of protocols or other guidelines throughout treatment that improve care. Time-saving metrics that support quick action by entities to save lives during an MCI should be prioritized. Poor measure performance in these areas should trigger examination of infrastructure, as a strong foundation for response and care provision is essential to achieving positive population health outcomes. The Committee suggested the following process measures to capture appropriate care during an MCI or PHE:

- Time to triage
- Time to treatment
- Appropriate triage
- Timing of clinical resource mobilization
- Patient distribution
- Length of stay
- Days of rehabilitation
- Time to appropriate procedure
- Time to medication
- Time to an appropriate test

In some instances, months after an MCI or during longer-duration PHEs, patient-reported outcome-based performance measures (PRO-PMs) focused on the assessment of symptoms, functional ability, or patient experience which may be appropriate depending on the event. Attribution model developers should consider the additional resources and time to collect these measures during high-acuity emergencies and which time interval would be most appropriate.

Facility-Level Operational Activities and Measure Concepts

Facility-level operational activities, such as conducting drills and staff call-in exercises (i.e., where staff are mobilized to assess response capacity) and preparedness exercises could help gauge whether a facility is ready for large-scale emergency events. Measuring these activities could include compliance or exercise timing. Additionally, prospectively defined conditions for participation by multiple facilities based on expected capacity can ease coordination and ensure appropriate and equitable distribution of patient load. Examples of measuring these capacities include the percentage of ED beds that were made available within 15 minutes, 30 minutes, or one hour of an emergency. Other measurement concepts related to capacity include assessing whether 20 percent capacity is reached within four hours and determining the percentage of patients who would need to be transferred to another facility. Capacity issues were critical during the COVID-19 pandemic, which required creating and coordinating networks to distribute large volumes of patients across different facilities.

Additional facility-level preparedness metrics would assess whether facilities have created and maintained realistic MCI response plans and measure their engagement in readiness planning with external regional partners. Additional measures that should be prioritized include maintaining infection prevention and safety standards during times of crisis. As emergencies may affect running water or power at a healthcare facility, measures should assess whether there are contingency plans in place for facilities to continue providing care (e.g., backup generator capacity, battery charging protocols, stockpile potable, and sterile water).

Readiness and EMS Measure Sets

Although there are limited measurement programs that assess healthcare system readiness and EMS quality, the HPP and National EMS Quality Alliance (NEMSQA) measure sets include measures related to MCIs and PHEs. The measures used in these programs can serve as examples of measures to consider when creating a collaborative measurement system for large-scale emergency events.

The HPP promotes consistent national focus to improve outcomes during emergencies.[6] To measure performance, the HPP uses a variety of measures at the input, activity, output, or outcome levels.[14] These performance measures target preparedness and outcome measures to address the information needs of various stakeholders. These measures are the only measures on a federal level related to healthcare system preparedness and response. Performance measures within the HPP relate to the following items:

- Fiscal preparedness
- Response planning
- Identification of populations with unique needs
- Jurisdictional engagement
- Drills to test redundant forms of communication
- Surge planning to assess participation and time- and percent-based outcomes to coordinate load-sharing
- Coordination with other federal preparedness programs
- Measurement unique to remote or isolated communities[14]

Emergency care services, such as EMT and EMS, play a vital role in MCIs and PHEs. Measuring EMS processes and EMS coordination with the healthcare system should be explored to best understand the quality of emergency transport and the impact of EMS care on patient outcomes. In coordinating with an ED, measures such as timing of ambulance pick-up to hospital arrival, as well as wait times for ambulances in the ED ambulance bay can help providers understand efficiency. EMS resources that need to be mobilized during an emergency, patient triage and distribution, tourniquet application, and other timely healthcare interventions performed at the start of large-scale emergencies are examples of measures that could be prioritized.

The National EMS Quality Alliance (NEMSQA) has a set of 11 measures collected by EMS in the domains of clinical effectiveness, patient safety, and patient experience.[15] These measures focus on the following subjects:

- Assessing breathing, stroke, and pain
- Administering treatment for hypoglycemia, asthma, and epilepsy
- Documenting weight
- Effectiveness of pain management
- Transportation of patients to trauma center
- Lights and siren use during response and transport

NEMSQA also works closely with National Emergency Medical Services Information System (NEMSIS), a national database used to store states' EMS data.[16] Performance results are reported publicly through NEMSIS' dashboards, which aggregate and regionalize data for each performance measure.[17] There is an opportunity to coordinate performance on these measures with measures based on data from hospital EHRs and other systems to track and improve patient outcomes.

Future Measurement Recommendations

There are several opportunities to advance quality measurement approaches for MCIs and PHEs in the future. Current measurement programs related to acute illness and injury generally focus on facility or hospital performance. Nonetheless, quality measurement attribution should include the impact that entities outside of the those providing hospital care have on health outcomes (e.g., EMS, public health, health centers, and social services). The list of entities involved in a response—EMS, municipal police and fire, local hospitals, specialized facilities, local clinics, and government agencies—can be expanded and refined to develop concrete lists of capabilities on which regions must demonstrate competence or progress. In addition, while entities may have their own indicators or quality measures (e.g., EMS metrics), greater integration of this data with medical quality measure data would provide a more comprehensive picture of healthcare quality for emergencies. The Committee also recommends that CMS and private payers evaluate possible payment models for MCIs and PHEs that could align with the quality measurement attribution approaches in this report.

NQF's previously published work on population-based trauma outcomes and emergency care transitions emphasizes the importance of population-based measures and approaches during emergencies.[18] However, there are limited population-level measures applicable to emergency care, and available measures largely focus on inpatient care. Population-based measures represent a potential gap in assessing regional processes within nontraditional emergency care at higher levels of analysis. Developing additional measures at the population level of analysis would support a broader view of outcomes across communities.

When creating an attribution methodology that includes penalties or incentives, it is also necessary to consider whether risk adjustment is warranted to account for variation in the resources and capabilities of responding entities and differences in patient populations across regions. Future work may aim to prioritize the potential quality measures identified in this report, create new measure concepts for MCIs and PHEs, and consider how individual measure characteristics (e.g., denominator, inclusion/exclusion criteria, attribution, and risk adjustment) interact with program attribution decisions to determine overall performance results. Measurement approaches that account for team-based approaches to population health, especially for unplanned, large-scale emergency events, are crucial to understanding and improving health outcomes.

Conclusion

Quality measurement attribution approaches for large-scale emergencies should encourage entities to work together to provide quality care for as many people as possible, while also achieving the best outcomes for individual patients. The Committee emphasized that attribution approaches should help standardize the way emergencies are responded to and evaluated. Attribution models for MCIs and PHEs should incentivize entities to collaborate and innovate in pursuit of a more person-centered system rather than encourage siloed care delivery. This report outlines the considerations at key attribution decision points: determining the goal, geographic region, population, entities, timing, and data. The Committee also put forth key attribution considerations for recognizing the varying influence of different entities based on the type of emergency in a shared accountability approach, integrating the patient perspective, considering unintended consequences, and building incentives that are accepted by those being measured.

As a next step, the key considerations and recommendations should be used to develop and test quality measurement attribution models for PHEs and MCIs. While MCIs and PHEs share similarities (e.g., potential surge of patients, unpredictability, and rapid coordination across multiple entities), they are also unique (e.g., duration, severity of injury, volume of casualties, and government involvement in response). Future work may explore technical quality measurement attribution steps for subcategories of MCIs and PHEs or attribution models for groupings of similar events (e.g., infection outbreaks, natural disasters). Sound quality measurement attribution is essential to expanding value-based care and achieving equitable care for all.

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Appendix B. Key Informant Interview Methodology

Between March 15 and April 21, 2021, NQF conducted nine key informant interviews (KIIs) with patients; experts on developing measurement attribution models; experts in MCIs, PHEs, and high-acuity ECSCs; front-line clinicians; transport medicine/emergency response providers; health insurance providers; and staff from federal, state, and local agencies that design, implement, or evaluate emergency preparedness programs. Of the nine interviews, two joint interviews were conducted with multiple informants from an organization.

Interviews were audio recorded and transcribed verbatim. All interviewees provided their consent to be recorded and were acknowledged for their contributions within this report. NQF developed and used an in-depth interview guide to steer the discussions (see below).

In advance of each interview, NQF identified the goal of the interview based on the individual's knowledge area and expertise. The following questions were used across interviews to ensure essential information was elicited from each key informant in an objective manner, allowing staff to compare responses across interviewees. The interview guide was used in a semi-structured manner, given that not every question was appropriate for every key informant.

Discussion Topic	Discussion Questions
Introductory Questions	• What are your experiences with attribution/emergency care/health system or public health emergency preparedness? (pick one based on interviewee)
Goal of the Attribution Methodology	• What attribution approaches do you know of that are currently being utilized in the health system? • What are the desired outcomes and goals of the health system in a mass casualty event? • Which entities do we want to provide help to in a mass casualty event? o What action do we want those accountable units to take? To be accountable for what? • What accountability mechanisms do we want to deploy? (i.e., how can we engage public health departments, what levers can CMS deploy—rules of participation, value-based purchasing, or QRP programs?)
Health System Readiness	• What structural-, communication-, and information-sharing networks do we want to have in place? What should be developed? • What are some of the federal response protocols that support readiness?
Defining the Population/ Geographic Regions	• How should populations be defined for high-acuity emergency care sensitive conditions (ECSCs) that result from mass casualty incidents (MCIs)? • What criteria should be used to determine whether an individual should be assigned to a particular population? Inclusion/exclusion criteria • What level of granularity in geography should be utilized?

Discussion Topic	Discussion Questions
	• What information do you think can be used to determine whether there are enough cases to draw conclusions about clinician/hospital/EMT performance? • Should all residents in a region or only those who interact with the medical system be considered?
Timing of Attribution	• In terms of the timing of measurement attribution for mass casualty events or individual emergencies, what are the pros and cons of a prospective attribution option? (If needed: Prospective might be ideal, but there is no data.) • In terms of the timing of measurement attribution for mass casualty events or individual emergencies, what are the pros and cons of a retrospective attribution option?
Data Challenges	• How can we ensure an attribution approach is data driven? • To what extent do existing data provide the information needed to support fair and accurate attribution for high-acuity ECSCs? • How should capturing non-healthcare claims-based data points (such as auto insurance claims in a multi-crash environment) be approached in these scenarios, and where would the responsibility for collecting this information fall within the care process? • How do we consider accountable units that do not have a health insurance claim? (e.g., public health departments, fire departments, and car insurance claims)
Patient Role in Decision Making During Emergencies	• Should measurement models for emergency care include the potential for patients to select the healthcare entities that are responsible for their care? • If so, under what circumstances?
Team-Based Attribution	• Building team-based attribution models can be approached using a person-centered perspective (i.e., where did a person receive care, by whom, and for what purpose?) The goal of a team-based attribution is to acknowledge the multiple entities that deliver care for a patient and each (in a coordinated fashion) can have an impact on patient outcomes. What information or data should be used to determine who/which entity can influence the outcomes of interest? • What are the qualifying events for attribution, and do those qualifying events accurately assign care to the right accountable units? • If multiple providers have influence over an outcome, under what circumstances should multiple attribution approaches be considered?

Discussion Topic	Discussion Questions
	• If so, what weighting approach should be used? In other words, what information would be needed to help determine whether all the providers should be held equally accountable for an outcome or if some of them should be held more accountable? • What input should the accountable units have?
Aspirational Approaches	• Are you aware of any actionable attribution approaches that could incentivize high quality, coordinated care for emergencies that would be acceptable to those being measured? [IF NOT:] In your opinion, what would such approaches look like? What needs to be put in place for these approaches to succeed in encouraging care coordination?
Unintended Consequences	• In your opinion, what might be the potential unintended consequences of attribution decisions for quality measurement of emergency care?
Wrap Up Questions	• Those are all the questions that I have for you today. Is there anything else that is important about attribution for MCIs and ECSCs that we have not discussed today? • Before we end the discussion, is there anything that you wanted to add that you did not get a chance to bring up earlier?

Appendix C. Key Informant Interview Themes

Theme	Key Points
Goal of the Attribution Methodology	• Save as many lives as possible • Support longitudinal measurement of quality care outcomes for patients over providers, settings, and time • Ensure proactive coordination and communication across multiple healthcare entities and non-healthcare entities • Incentivize readiness rather than penalize healthcare entities operating in emergency situations • Implement technology without creating a burden for data collection and reporting measures

Health System Readiness	• Encourage proactive coordination and communication
	• Ensure appropriate stock of personal protective equipment (PPE), resources, and equipment to respond to various types of MCIs since you cannot treat all mass casualty situations the same
	• Consider regional coordination of healthcare entities (regional task forces that can organize local response), also known as "healthcare coalitions" funded through the HPP by ASPR
	    o Regional coordination should support building community resilience with special attention on equity
	    o Consider what is the funding for these regional coordination efforts, what is the authority that they can exercise, what real-time data they have access to, and the clinical leadership needs
	• Support telehealth infrastructure
	    o Telemedicine options for calling specialists to help assist community facilities (e.g., those not directly providing in-person care, those from other states)
	    o Should be technology independent (i.e., usable by any provider in any emergency department)
	• Interoperability to share patient information in an MCI
	• Consider structure and safety measures rather than outcome measures
	• Consider the Joint Commission/CMS regulatory requirements for MCI readiness
	• Requirements for MCI readiness should not just be for trauma centers
	• Rural readiness is even more challenging given the limited staff and resource availability

Defining the Population/ Geographic Regions	• Varies by region and dependent on MCI • Overall, it should be as granular as possible, as it is easier to aggregate up • Consider all patients or populations that are at risk of exposure to an MCI (dependent upon the type of MCI and time of attribution/endpoint) • Draw a realistic radius based on the probability of an event, considering the most likely way that patients will be distributed • Should be prospectively defined to ensure coordination

Timing of Attribution	• Prospective is preferable, but it is also challenging given the payment system • Choice of attribution approach may be contingent on the type of MCI and trajectory of an injury/condition • Consider a hybrid model (of prospective and retrospective approaches) to encourage proactive coordination and communication but also retrospective to evaluate the effectiveness of care response plans
Data Challenges	• One of the major challenges is that entities cannot or are not willing to share data in real time • Interoperability challenges make it difficult to understand the patient's journey • Need for mass notification systems that reach all the impacted entities in real time, standardize what gets communicated and how, and include receiving capability (not just open beds) of hospitals • Most incident data systems are not clinical • Need to account for both patients who are transported by EMS and spontaneous patient load • Data infrastructure does not exist for most of the country, and there should be an incentive to create a better data sharing system because of the cost and need for resources
Patient Role in Decision Making During Emergencies	• MCIs require urgent clinical attention and saving lives is the top priority • Patients should always have a role in decision making, but also consider the urgency of the care needed and decision making ability of the patient at the time • Protocols that provide guidance on conditions under which seeking patient input is appropriate should be developed and used to inform attribution approaches • Systems should be organized proactively to ensure the best possible outcomes for patients if patient decision making is impaired due to the MCI
Team-Based Attribution	• All providers who are expected to deliver care in an MCI should be part of measurement • Consider capability-based planning (while we cannot plan for every event, we can determine the capabilities that we would expect from each member of the team)

Aspirational Approaches	• Ability to recognize who provided care to understand the patient's journey throughout the system and to provide the full picture and reimburse for providers' efforts • Reinforce telehealth through strengthening access to technology and increasing capabilities • Penalize vs incentivize: the goal should not be to penalize poor performance but rather to work with the organizations that are not meeting the standards • Only when the entities are operating broadly outside the standard of care and are not meeting safety standards should a penalty be considered • Quality measurement should encourage healthcare entities to plan for MCIs and PHEs, and results should provide quality information to help them respond more effectively • Coalitions may need standards for the clinical expertise and emergency management expertise needed for real-time decision making and may need to be given the authority to lead and act during emergencies • Prioritize time-sensitive metrics—actions that should be taken quickly to save lives in an MCI • Combination of technology, communication, and stakeholder engagement is needed in developing attribution approaches • Aim to minimize data collection burden, elicit buy-in on data sources and their accuracy, and agree on the entities that should be involved
Unintended Consequences	• Do not penalize, and be cautious of disincentives for coordination and communication for outcomes that may not be immediately apparent • Be careful about making a system that is complicated and burdensome, especially on the more constrained organizations, such as the safety net organizations, and during emergencies • Some hesitation for accountability for these events and in which CMS programs the measures would be used

Appendix D. Detailed Use Case Descriptions

Case 1: Trauma (MVA) ECSC

Driving back from an overnight camping trip, a 45-year-old father and his 12-year-old son are involved in head-on collision. The driver in other car is pronounced dead on scene. Local EMS evaluated the child and found bilateral facial fractures and a compromised airway. A laryngeal mask airway (LMA) was placed, and the patient was stabilized on scene and transferred by air medical transport to the closest level I trauma center, which is across the state line. Local EMS evaluated the father and found an open tibial fracture, torso abrasions, and left arm laceration. The patient was hemodynamically stable. He was transferred by ground to the local community hospital.

Patient 1 is a 12-year-old child diagnosed with traumatic brain injury and requires Oral maxillofacial surgery. He recovers and is transferred back to the local community hospital for rehabilitation services and a follow-up with Plastic and Cosmetic Surgery.

Patient 2 is a 45-year-old male with a previous history of Diabetes Mellitus (on Metformin). He is evaluated at the community hospital where the ED physician performed a Focused Assessment with Sonography in Trauma (FAST), which was negative, and repaired his lacerations. A community orthopedic surgeon performed the repair of his tibia shortly after ED arrival.

The following day, the father developed peritonitis. A computerized tomography CT scan revealed mesenteric stranding and intestinal perforation. Patient 2 is transferred to a level I trauma center across state lines for repair of intestinal injuries. His tibial fixation repair wound became infected, requiring debridement and a skin graft by a second orthopedic surgeon once arrived at the trauma center. The patient ultimately recovered and was transferred to an inpatient rehab facility in his community.

Case 2: Trauma (Bombing) MCI

A pipe bomb is detonated in a trash can at a university homecoming event in North Central Illinois. The festival is attended by several thousand people, and many are wounded. The area is served by Fire Department (FD) EMS, and this city has one level II trauma center (X Hospital). The nearest level I trauma center is 25 minutes by ground (Y Hospital). Specialty services are in-state 60 miles east (Illinois) or out-of-state 45 minutes north (Wisconsin). Local police and FD are completing patient triage and setting up a casualty collection point (CCP). FD ambulances, as well as mutual aid ambulances, are en route to the staging area.

Police officers and on-site EMS are rapidly treating the severely injured; however, other assets are instructed to stage until the police determine there are no other immediate explosive threats. Once allowed into the area, Fire/EMS assets are directed to collect the victims near each explosion's epicenter and take them to the CCP.

Patient 1 is a 47-year-old man in from out of state. He was standing near a trash can that exploded. He has a traumatic amputation to his left lower leg and penetrating injuries to his buttocks and left flank. He also has full thickness burns to his posterior left thigh. In the immediate aftermath, a police officer places a tourniquet on his left lower thigh, then moves on to the other victims.

Patient 1 is collected by a FD ambulance crew and rushed to the local level II trauma center. He is bleeding in his abdomen and requires an emergent operation. He is transferred to Hospital Y Trauma center later on day 1. He has one additional follow-up surgery at the level I trauma center before being transferred to the Burn center in Wisconsin. Patient 1 sustains full thickness burns to his left thigh, buttock, and left flank, requiring grafting and wound care. His abdominal and rectal wounds required surgical repair, and he is discharged with a colostomy.

Upon discharge, he is sent to a rehab facility near his home, where he remains for two weeks before being discharged to his home. He receives burn wound care at a local facility and is seen at a tertiary care center closer to his home for further abdominal surgeries. He returns to Hospital Y for his orthopedic surgery follow-up and prosthetic.

Patient 2 is a 14-year-old girl who is Patient 1's daughter. She was standing near Patient 1 and was knocked down. She is confused and has abrasions and some shrapnel embedded in her face, as well as some bleeding near her right ear. She is awake when collected by a FD ambulance and transported to the level I trauma center (Hospital Y). Due to her small stature and level of consciousness (LOC), she is thought to be a younger child and is immediately brought to a resuscitation bay.

Her CT scan is negative, and her facial wounds appear to be superficial. She has a ruptured eardrum and is admitted to the pediatric floor for observation. She is discharged on day 2 with a follow-up appointment with Neurology at the level 1 center and instructed to follow up with the local ENT.

Patient 3 is an 18-year-old male who suffered a laceration to his left arm. A bystander with “Stop the Bleed” training placed a tourniquet on his left upper arm, and he was assisted by a friend to a car where he is taken to Hospital X. Upon arrival, the patient is taken back to a resuscitation bay but is quickly moved to another room to accommodate Patient 2. Patient 3 remains stable initially, but serial assessments by nursing staff reveal hypotension. The patient develops shortness of breath and upon further evaluation, the patient is found to have a wound in his left axilla and a developing tension pneumothorax. He is resuscitated, a chest tube is placed to water seal, and his left arm laceration is explored. The tourniquet is released after 90 minutes.

Patient 3 is transferred to Hospital Y by private EMS. During transport, his water seal is closed to air and his tension pneumothorax worsens. The private ambulance crew fails to recognize this, and the patient experiences cardiac arrest while the ambulance is two minutes from the hospital. He is resuscitated but has severe deficits due to anoxic brain injury. He spends several days on the ventilator and requires a feeding tube and tracheostomy placement. He is discharged to a skilled-nursing facility (SNF).

Patient 4 is a 67-year-old male with a history of Atrial fibrillation on Coumadin. He has blunt trauma to the right upper quadrant of his abdomen. He was hypotensive at the scene and transported by mutual aid ambulance to Hospital X. On arrival to Hospital X, he was intubated, resuscitated with blood products (two units of blood and two units of FFP), and stabilized by emergency physicians; he was then airlifted to a level I trauma center across state lines.

Anticoagulation was held due to trauma, and he required a exploratory celiotomy and repair of the liver. Anticoagulation could not begin until the risk of bleeding was resolved after trauma. Patient 4 sustained a cerebral stroke from atrial embolus with permanent hemi-paresis. He recovered to be able to transition to a skilled nursing facility for long-term recovery. He was instructed to follow up with a trauma surgeon at the level I trauma center, a local neurologist, and the/his original primary care physician (PCP) for anticoagulation.

Case 3: High-Consequence Infectious Diseases PHE

On March 25, 2021, a 45-year-old man (Patient 1) went to his doctor in a small, rural town with a fever of initially 100.1°F (38.4°C). He was treated with possible sinusitis and returned home.

The next day, the fever increased to 102.9°F (39.4°C), abdominal pain, and a headache. He went to the closest ED at a hospital (Hospital A: critical access hospital) in a neighboring town. Again, he was treated with possible sinusitis and discharged.

On March 28 of the same year, the man returned to the same ED by ambulance with a persistent fever (101.4°F [38.6°C]), abdominal pain, and new onset diarrhea. During the exam, it was identified that the man had recently returned to the U.S. from Liberia seven days earlier after attending a conference with his company. Reports out of Liberia state that an Ebola outbreak was just identified. He was placed in a private room under standard droplet and contact precautions and was tested for Ebola. The test confirmed the patient had the Ebola Virus. Results were sent off to the state health department, and the CDC was notified that the patient attended a conference where he likely contracted the virus.

CDC teams were called in to establish contact tracing. The patient was transferred via ambulance to a hospital (Hospital B) the states designated as an Ebola Treatment Facility, located in the nearest, major metropolitan city (City A) that had the area for only 10 beds within the biocontainment unit for isolating and treating patients with high consequence infectious diseases.

The CDC identified other people who attended the same conference with Patient 1's company. The company is in City A where the other attendees had returned after the conference. After further investigation, the conference attendees were contacted, and some were found to be experiencing febrile symptoms but had not checked into an ED or visited a PCP.

The attendees were immediately transported to Hospital B and admitted to the biocontainment unit. Each patient was tested and found to be positive with the Ebola virus.

Through contact tracing, other people in Patient's 1 hometown as well as in the neighboring town where Hospital A is located and in City A were found to be experiencing the same symptoms. With only 10 beds, the biocontainment unit was quickly filled. Additional isolation rooms were hastily constructed and filled. Patients were transported to biocontainment centers around the country.

On April 8, 2021 Patient 1 died. On that same day, a 19-year-old male patient (Patient 2) was brought to the ED at Hospital C in an ambulance with a temperature of 103.5°F (39.7°C) and abdominal pain. Due to the biocontainment unit and isolation rooms at Hospital B being filled, the patient was admitted and placed in isolation in Hospital C. The next day, the patient was transferred to a medical center in a neighboring state that has a biocontainment unit.

Contact tracing did not find a direct connection between Patient 2 and patients who were previously diagnosed. Further investigation found that Patient 2 was transported to the ED for a sports injury five days earlier in an ambulance. The ambulance was found to have transported a patient with a positive Ebola diagnosis who was vomiting blood on the same day Patient 2 was transported five days earlier.

The ambulance had not been thoroughly cleaned in between transports, resulting in Patient 2 contracting the virus.

Patient 2 was treated at Hospital C where he recovered after 21 days and was discharged with continued follow-up with a PCP in City A.

Over a two-month period, 48 patients were positively diagnosed with Ebola Virus with a 38 percent mortality rate. Three hundred contacts were quarantined and monitored for 21 days.

Case 4: Burns MCI

At 3 AM on a winter night, a space heater malfunction leads to a fire in a moderately sized urban apartment building containing 500 residents. Despite early activation of fire alarms and immediate evacuation at the beginning, approximately 30 apartments are rapidly engulfed in flames. The structural integrity of the building remains intact for a few minutes until local Fire Rescue can access the burning apartment units, but several residents who were trapped in those areas are seriously ill.

Fire Rescue and paramedics attempt to triage victims as they are rescued and initiate transport for the most acutely ill. Twenty victims are found alive but with critical illness. Half of them are transported to a level I trauma center (Hospital A) located five miles away. This facility does not provide burn specialty care but can accept burn patients for initial stabilization and management. Five pediatric victims are transported to a Pediatric level I trauma center, also five miles away. The remaining five patients are distributed to two nearby hospitals (Hospitals B and C) without a trauma or burn center designation. A designated burn center hospital (Hospital D) is located approximately 15 miles away in a neighboring city.

An additional 80 patients are estimated to have mild to moderate burn injuries but are ambulatory; several patients await EMS transport pending transport of critically ill patients, while other patients obtain private transport to various area hospitals. Two additional first responders with Fire Rescue suffered severe burn injuries and were immediately transported to Hospital D.

An emergency shelter is prepared in coordination between local and state officials for all residents of the apartment building, including the unaffected as well as ambulatory patients with minor/moderate injuries but who do not require hospitalization.

Several critically ill patients are intubated upon arrival to the hospital and exhibit signs of severe inhalational injury. A single three-unit hyperbaric oxygen chamber is located at the burn center hospital (Hospital D). Hospitals A, B, and C initiate transfer processes; however, acceptance is delayed due to difficulty prioritizing patients and coordinating transport, given high EMS volume from the scene.

Over the following days, the survivors among the critically ill patients are transferred to Hospital D where they receive prolonged hospitalization for severe facial, hand, and body burns. The hospital care team request assistance from area hospitals and state officials for personnel, equipment, and funding.

In addition, many nearby hospitals refer patients requiring ambulatory burn clinic services to Hospital D. Given the high volume, Hospital D attempts to coordinate with other community clinics, plastic surgeons, and wound care specialists who can provide ongoing care for minor burns, allowing the specialist burn services to focus on high-acuity injuries.

Case 5: Chemical Attack MCI

At rush hour on a weekday morning in a large metropolitan area, several cannisters placed throughout the subway system release a vapor cloud. Dozens of passengers quickly develop a cholinergic toxidrome with vomiting, respiratory distress, and muscle paralysis. EMS is summoned and begins decontaminating, treating, and transporting several dozen cases. Thousands of less severely ill riders, manifesting either milder symptoms or psychogenic symptoms, egress from the subway without being treated or decontaminated. Some riders walk to local hospitals, and others head home and then later go to the hospital. Overall, 14 hospitals see over 5,000 patients as a result of the attack.

Case 6: Nuclear Explosion MCI

An earthquake causes an early morning explosion at a nuclear power plant that releases an unknown quantity of radioactive materials into the environment. At the time of the incident, there are 11 employees on site. The facility is located 10 miles from a city of 10,000 residents with an additional estimated 5,000 inhabitants within a 10-mile radius. A larger city of approximately 40,000 residents is 25 miles away. Two months prior, the Federal Nuclear Regulatory Commission (NRC) had found violations at the power plant, including in the emergency core cooling, although these were not addressed prior to the incident.

In the initial explosion, three workers at the power plant are killed, five are critically injured (Patients A-E), and three sustain non-life-threatening injuries but are exposed to large doses of radiation (Patients F-H). Patients A-E sustain primarily blunt trauma injuries due to the blast from the explosion, as well as burn injuries. Patients F, G, and H exhibit signs of nausea, vomiting, and headache but are stable in the hour following the incident.

Hospital 1 is a small community hospital located 10.5 miles from the nuclear power plant. Due to planning and given their proximity to the plant, Hospital 1 has a large supply of PPE and has previously held preparedness drills oriented to radioactive disasters. Hospital 2 is a level III trauma center located 25 miles from the site. Hospital 2 has a standard supply of PPE and has not held preparedness drills. Hospital 3 is a level I trauma center located 60 miles from the site.

Four workers (Patients A, B, F, and G) are transported by ambulance (by EMS Agency i) to Hospital 1. Hospital 1 decontaminates the arriving patients and EMS responders. Three workers (Patients C, D, and E) are transported to Hospital 3 where there is a delay in preparing decontamination procedures. Patient H refuses to be transported by ambulance, saying that she wants to save the ambulances for her more seriously injured colleagues.

After initial stabilization, Hospital 1 initiates the transfer process for Patients A and B to Hospital 2, given limited capacity to manage severely injured trauma patients at that facility. Hospital 2 declines to accept the transfer due to concern for radioactive exposure, and the patients are transferred to Hospital 3 via EMS Agency ii.

Within six hours of the explosion, the NRC, FEMA, and state officials, in coordination with the National Guard, decide to evacuate all residents within 10 miles of the power plant. Hospital 1 prepares to evacuate. They initiate transfer for 30 currently hospitalized patients to Hospitals 2 and 3, including patients F and G, but they encounter limited EMS capacity for this volume of patients, given the need to decontaminate personnel and equipment with each transport away from the area. Over this time, several new patients begin to arrive at Hospital 2 and other area hospitals with vague symptoms.

Patient H worsens at home and is driven to Hospital 2 by her husband. The patient continues to wear her power plant uniform. She is triaged through the standard mechanism at that hospital and is not decontaminated prior to entry into the ED. Her husband develops symptoms of nausea and vomiting after arrival.

Over the coming years and long after the lengthy process of environmental decontamination and resettlement of the area, the incidence of cancer and autoimmune illness begins to rise in the area. Patients seek specialized care at both local and remote facilities, including Hospital 3.