NATIONAL QUALITY FORUM

Attribution: Principles and Approaches

DRAFT REPORT

October 7, 2016

This report is funded by the Department of Health and Human Services under contract HHSM-500-2012-00009I Task Order HHSM-500-T0019.

Contents

Executive Summary

The United States has the highest per capita healthcare spending in the world yet this high spending does not translate into uniformly better health outcomes for Americans. Performance measurement aims to address issues of quality and cost to improve health outcomes. Increasingly performance measures are used for accountability purposes such as public reporting or value-based purchasing. Value-based purchasing is intended to link payment to improvements in healthcare quality, rather than simply paying for the volume of services rendered. National consensus-based performance measures are critical to support public reporting and value-based purchasing efforts because they provide the necessary information on quality and cost improvements. However, providing information about the quality of care to the public or reimbursing clinicians or providers for their performance on quality and cost outcomes requires understanding which patients and their subsequent outcomes a clinician or provider is accountable for. This can be challenging as healthcare continues to become increasingly team-based and patients often receive care from numerous clinicians and facilities.

Attribution is a process that aims to clarify these relationships and assign accountability for a patient's outcomes to a clinician, groups of clinicians, or a facility. The choice of an attribution model can affect which patients are included in the population addressed by a value-based purchasing program or included in the denominator of a performance measure. Differences in the populations included can result in meaningful differences in the cost and quality profiles for clinicians and facilities, affecting their reputation and reimbursement. However, attribution remains a relatively unstudied aspect of performance measurement.

In an effort to further explore these challenges, the National Quality Forum (NQF) convened a multistakeholder expert committee and commissioned an environmental scan of current attribution models to define guiding principles, develop the Attribution Model Selection Guide for measure developers and program implementers, and develop a set of recommendations for the field.

Guiding Principles

The Committee agreed on a set of guiding principles to address attribution challenges:

1. Attribution models should fairly and accurately assign accountability.
2. Attribution models are an essential part of measure development, implementation, and policy and program design.
3. Considered choices among available data are fundamental in the design of an attribution model.
4. Attribution models should be regularly reviewed and updated.
5. Attribution models should be transparent and consistently applied.
6. Attribution models should align with the stated goals and purpose of the program.

Recommendations

The Committee's recommendations build on the guiding principles and the Attribution Model Selection Guide. They are intended to apply broadly to those developing, selecting, and implementing attribution

models in the context of public- and private-sector accountability programs. The Committee's recommendations for selecting and implementing attribution models are:

1. Recommendation 1: Use the Attribution Model Selection Guide to evaluate the factors to consider in the choice of an attribution model
2. Recommendation 2: Attribution models should be tested.
3. Recommendation 3: Attribution models should be subject to multistakeholder review.
4. Recommendation 4: Attribution models should attribute results to entities who can influence care and outcomes.
5. Recommendation 5: Attribution models used in mandatory public reporting or payment programs should meet minimum criteria.

Introduction

Improving quality while making care more affordable is a goal of all healthcare stakeholders. The reasons for reforming the healthcare system are well known: costs are high, quality can be poor, and care is often inefficient and uncoordinated. In a 2009 statement to the House Ways and Means Committee, the chair of The Medicare Payment Advisory Commission (MEDPAC) noted that many of these problems are caused by the current fee-for-service payment system that rewards providing more care and creates a siloed approach to care delivery.[1]

Value-based purchasing, including alternative payment models, is widely seen as one potential solution to high healthcare spending. Value-based purchasing rewards clinicians or providers based on their performance on quality and cost measures. Critical to these programs is an accurate determination of the relationship between a patient and a clinician or provider to ensure that the correct entity or entities are held responsible for the patient's outcomes and costs. Determining which entity is responsible may be complicated given that most people receive care from numerous clinicians across several facilities. Attribution is a process that is intended to address this issue. Attribution is defined as the methodology used to assign patients, and their quality outcomes, to providers or clinicians.

Project Purpose, Scope, and Approach

The issues regarding attribution to accountable units such as clinicians and facilities have complicated the evaluation and implementation of performance measures. Measurement approaches need to recognize that multiple entities are involved in delivering care, and that these entities often have joint responsibility to improve quality. These issues have become increasingly important in an environment of public reporting and value-based purchasing as one entity may be held responsible for outcomes influenced by a number of clinicians and facilities.

The National Quality Forum (NQF), with funding from the Department of Health and Human Services (HHS) convened a multistakeholder Committee (Appendix A) to provide guidance to the field on selecting and implementing attribution models. The project involves:

1. a commissioned environmental scan of current approaches to attribution;

2. an analysis of the strengths and weakness of these approaches;
3. development of guiding principles for attribution; and
4. recommendations to guide the selection and implementation of attribution models.

NQF commissioned a team of researchers and clinicians to conduct an environmental scan of attribution models currently in use, and those that have been proposed but not implemented, and to write a paper to inform the Committee's deliberations on selecting and implementing attribution models in healthcare. The Committee identified attribution challenges and drafted a set of guiding principles to address the attribution challenges. Building on these guiding principles, the Committee identified key questions and considerations in developing or selecting an attribution model, and made recommendations to guide the selection and implementation of attribution models. The process of drafting consensus-based principles and recommendations is iterative (Appendix B) and incorporates Committee discussions from two in-person meetings, web meetings, and responses to public comments received on the draft principles and commissioned paper (Appendix C).

This report details the Committee's guiding principles, Attribution Model Selection Guide, and recommendations for attribution models. The Committee recognized that in some cases attribution can be applied in multiple ways within a single program. First, one attribution model is used to determine which patients are included in a program (e.g., Accountable Care Organization program) (Figure 1). Another attribution model is used to determine which patients are included for a performance measure that is used to determine the score that an accountable unit will receive for the program (e.g., diabetes quality measure) (Figure 2).

Figure 1. Program Level Attribution: This figure depicts patients being selected for inclusion in an accountability program through the application of an attribution model

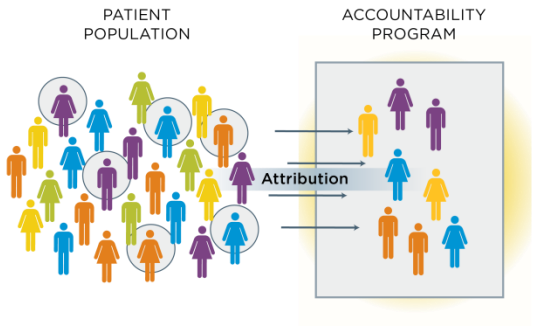
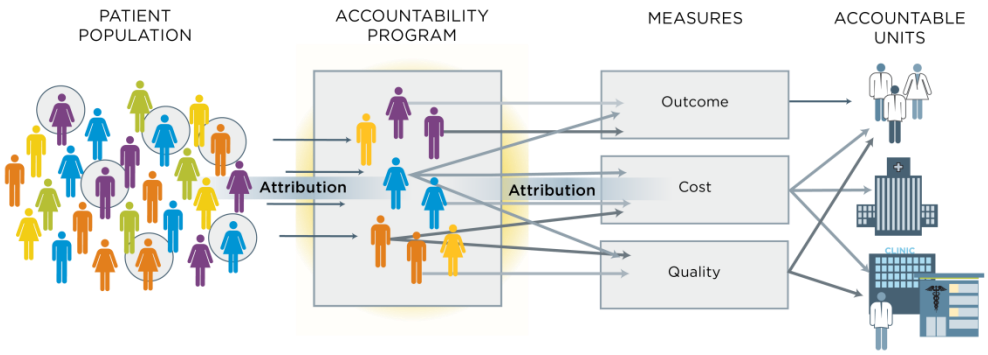


Figure 2. Measure Level Attribution: This figure depicts patients' costs, outcomes, and quality being attributed to various accountable units by applying an attribution model within each measure.



The Committee acknowledged that there is a desire among many for the committee to recommend a single attribution model or what attribution models should be used in specific contexts. Unfortunately, there is insufficient evidence to support such guidance and recommendations at this time. As such, the Committee adopted a broad focus on attribution across a range of applications (quality measures, cost and resource use measures, and accountability programs), identifying areas of tension, key considerations, and where tradeoffs are required.

Definitions and Terminology

The key terms used in this report are also included in the glossary (Appendix D).

- **Accountable unit:** the entity whose performance is being measured, which could be a hospital, health plan, clinician, etc. Performance measurement can be applied to any setting and level of analysis.
- **Attribution**: The method used to determine which accountable unit is responsible for a patient's care and costs.
- **Attribution model:** An attribution model is a set of rules to define the accountable unit for a patient's healthcare outcomes.
- **Outcome:** The result of providing healthcare, broadly defined to include prevention and health promotion. The term, outcome, will be used to include the following types of outcomes relevant to performance measurement: quality outcomes of healthcare (e.g., mortality), intermediate clinical outcome (e.g., BP < 140/90), patient-reported outcome (e.g., depression), and economic outcomes of cost and resource use.
- **Quality of care**: This report considers quality broadly, based on a modified version of the Institute of Medicine's aims for healthcare: safety, timeliness, effectiveness, equity, and patient-centeredness.

Current Policy Landscape

Improving care delivery and quality continues to be a key focus for all healthcare stakeholders. Increasingly, there has been a focus on teamwork and a desire for performance measurement and reimbursement strategies that reflect this focus. Recent legislation, such as the Improving Medicare Post-Acute Care Transformation (IMPACT) of 2014 and the Medicare Access and CHIP Reauthorization Act of 2015 (MACRA), has increased the emphasis on person-centeredness and care coordination across providers.

As demonstrated by legislation such as IMPACT and MACRA, public- and private-sector payers as well as purchasers continue to look to value-based purchasing as a strategy to drive improvements in quality and cost while making the system more coordinated and person-centered by re-aligning incentives. Value-based purchasing aims to reward accountable units for meeting certain performance standards for quality and efficiency rather than paying for the volume of services provided. That is, these models aim to pay for performance. However implementing pay-for-performance models requires a payer or purchaser to know which unit or units to hold responsible for the results of the quality and efficiency measures used to judge performance. This has become increasingly challenging as public and private payers move to assess quality on outcome measures rather than process or structural measures.

The desire to move the system away from fee-for-service payment to alternative payment models has highlighted the need to better understand how patient outcomes and costs can be accurately attributed to a unit in a system increasingly built on shared accountability. In particular, the Department of Health and Human Services (HHS) has set a goal of tying 30 percent of traditional, or fee-for-service, Medicare payments to quality or value through alternative payment models, such as Accountable Care Organizations (ACOs) or bundled payment arrangements by the end of 2016, and tying 50 percent of payments to these models by the end of 2018. HHS also set a goal of tying 85 percent of all traditional Medicare payments to quality or value by 2016 and 90 percent by 2018 through programs such as the Hospital Value Based Purchasing and the Hospital Readmissions Reduction Programs.

HHS has developed a framework for categorizing payment models. Category 1 is fee-for-service (FFS) with no link between payment and quality. Category 2 is fee-for-service with a link between payment and results on quality measures. Category 3includes alternative payment models built on the fee-for-service system. Finally, category 4 is population-based payment. Value-based purchasing includes payment models in categories two, three, and four. Accountability for quality and cost as well as the focus on population health management increases through the categories. Increased use of these payment models makes the issue of attribution increasingly important and challenging.

Table 1. HHS Payment Model Taxonomy

	Category 1 FFS; no link of payment to quality	Category 2 FFS; link of payment to quality	Category 3 APMs built on FFS architecture	Category 4 Population-based payment

Description	Payment based on volume of services; no link to quality or efficiency	Payment varies based on quality or efficiency	Some payment linked to population or episode management. Payment triggered by delivery of service but opportunities for shared savings or risk	Volume not linked to payment. Providers are responsible for care of a beneficiary over time.
Medicare Examples	Limited in Medicare Fee for Service	• Hospital Value-Based Purchasing • Physician-Value Based Modifier • Hospital Readmissions Reduction Program	• Accountable Care Organizations (ACOs) • Medical homes • Comprehensive Primary Care Initiative • Comprehensive End Stage Renal Disease (ESRD) Model • Bundled Payments for Care Improvement (BPCI) Initiative	Eligible Pioneer ACOs in years 3-5

Other efforts in the field have also attempted to review questions of attribution. In particular, the Health Care Payment Learning & Action Network (LAN) recently released a white paper exploring issues of attribution for population-based payment models (category 4). The LAN developed an attribution model that assigns populations to accountable units in a population-based payment model. This work attempted to incorporate and build on the work of the LAN by also addressing models found in categories 2 and 3.

Attribution challenges have also arisen across NQF's work. Attribution concerns have been raised by NQF measure evaluation Standing Committees reviewing measures for NQF endorsement as well as by the Measure Applications Partnership workgroups considering measures for implementation in federal public reporting and value-based purchasing programs.

NQF endorses performance measures suited for both performance improvement and "accountability applications" (e.g., pay for performance, public reporting), when those measures meet a standard set of criteria using its Consensus Development Process (CDP). Committees of experts examine the importance, scientific acceptability, feasibility, and usability of performance measures. When examining the scientific acceptability of a measure (i.e., its reliability and validity), Committees have questioned a

measure's attribution model. This has been particularly challenging in the evaluation of cost and resource use, readmissions, and population health measures. Specifically, questions have focused on the locus of control of accountable entities when there is significant variability in the degree of care delivery fragmentation. Committees have also challenged the appropriateness of the selected accountable unit for a performance measure based on the measurement time period for which that accountable unit is responsible for a patient's outcomes.

The Measure Applications Partnership (MAP) convened by NQF provides input to CMS on the selection of measures for specific federal public reporting and payment programs through its annual pre-rulemaking process. Attribution concerns that have come out of this work include the application of measures in programs that do not align with the level of analysis or attribution approach specified in the measure. Additionally, measures are being used in payment programs that attribute outcomes to units that may be outside their direct locus of control (e.g., readmission rates, 30-day episode costs, and population health). The relationships between a hospital, the Hospital Value-Based Purchasing (VBP) Program and the Medicare Spending Per Beneficiary (MSPB) measure can help illustrate these challenges.

Medicare bases a portion of hospital reimbursement on performance through the Hospital Value-Based Purchasing Program. Although the exact scoring algorithm is subject to change, measures are generally grouped into four domains: clinical care, patient and caregiver experience, efficiency and cost reduction, and safety. In fiscal year (FY) 2017 and beyond, the efficiency domain makes up 25 percent of a hospital's score. Currently, that domain only includes a measure of Medicare spending per beneficiary although additional measures have been recently finalized for future use. The MSPB episode spans the period 3 days prior to the index hospital admission through 30 days post-discharge. All events that occur during this period are included in the MSPB episode. This attribution method makes a hospital responsible for care (and costs incurred) in outpatient and post-acute settings and factors this into a hospital's reimbursement.

Key Findings from the Commissioned Paper

NQF commissioned an environmental scan and white paper to explore attribution models that are in use or have been proposed for use in the literature (Appendix E). The literature review found over 170 different attribution models that have been implemented or proposed. An important finding of this paper was the variability in approaches to attribution and the lack of rigorous evaluation of the methods used.

There are several key findings from the commissioned paper that informed the Committee's deliberations. First, the authors found that the quality measurement field has not yet determined best practices for attribution models, and many existing models are largely based on approaches previously used. Second, the authors note that there are trade-offs in the development of attribution models that should be explored and made transparent. For example, there is a natural tension between the goals of reliability and validity of attribution models. Performance measures are more reliable and more able to distinguish performance across units when the sample size is larger. However, an attribution model that

results in a larger sample for each unit may include patients that only received a small portion of their care from that accountable unit. The accuracy of the attribution model may be diminished in this case, thus emphasizing the need to balance attributing enough patients and attributing patients to the correct accountable unit. Finally the authors noted that there is no standard definition of an attribution model.

The Committee recognized a number of current challenges to attribution. First, the Committee concluded that greater standardization among attribution models is needed to allow comparisons between models and for best practices to emerge. There is little consistency across models, but there is evidence that changing the attribution rules can alter results[2]. Currently there is often a lack of transparency on how care is attributed and no way for an accountable unit to appeal the results of an attribution model that may wrongly assign responsibility. This perception of a lack of control about which patients are attributed to them and their ability to influence those patient's outcomes has caused frustration and a sense of unfairness among accountable units. To address these concerns the Committee focused on developing principles, recommendations, and the Attribution Model Selection Guide to allow for greater standardization, transparency, and stakeholder buy-in with the aim of allowing evaluation of attribution models in the future and laying the groundwork to develop a more robust evidence base around this relatively unstudied measurement issue.

Guiding Principles

As a first step to addressing these attribution challenges, the Committee agreed on a set of guiding principles to ground its recommendations. The principles acknowledge the complex, multidimensional challenges to implementing attribution models, as the models can change depending on their purpose and the data available. The Committee grounded its work in the goals of the National Quality Strategy: better care, healthy people/communities, and smarter spending. Attribution can play a critical role advancing these goals and driving improvement in the healthcare system.

Attribution can refer to both the attribution of patients to an accountable unit for accountability purposes such as a value-based purchasing program as well as the attribution of results of a performance measure such as health outcomes or resource use to an accountable unit.

The Committee highlighted the absence of a barometer for designing or selecting an attribution model at this time. Therefore, it is important to understand the goals of attribution for each specific case when assessing potential attribution models to apply in particular situations. Key criteria to consider when selecting an attribution model are actionability, accuracy, fairness, and transparency. These criteria are particularly important, as the application of an attribution approach for performance measures can significantly influence measure reliability, validity, and results. Moreover, attribution can significantly affect the size of the population for whom accountable units are assigned responsibility as well as potentially determine their performance under value-based payment programs.

Principle 1: Attribution models should fairly and accurately assign accountability.

The Committee recognized the need to identify a trusted patient/clinician relationship and enhance patient-centeredness and coordination of care in developing attribution models. However, it can be

challenging to determine the patient/clinician relationship for purposes of performance measurement, particularly for outcomes where multiple clinicians or facilities may share responsibility. Not all healthcare can be delivered in the context of an established patient/clinician relationship, and there is a need to attribute acute or emergent events.

Principle 2: Attribution models are an essential part of measure development, implementation, and policy and program design.

The Committee noted that in the past the way care or health outcomes are attributed has not received sufficient attention. The choice of attribution model should be among the primary concerns of both measure developers and program implementers since the attribution model can have a significant effect on performance on a performance measure score or payment program results. A performance measure can be used with more than one attribution model, and measure implementers should carefully consider the downstream effects of the selected attribution model. For example, attributing a measure to multiple accountable units rather than using exclusive attribution broadens accountability for patient care and could help improve care coordination, but could also make it more challenging to take action on the measure results, if it is harder to pinpoint a quality problem.

Principle 3: Considered choices among available data are fundamental in the design of an attribution model.

Data plays an essential role in the implementation of an attribution model. Available data sources and data quality should be considered when designing and selecting an attribution model. Attribution models should leverage available data that are the most reliable and valid for their intended use. For example, the Committee discussed the attraction of using prospective patient-defined relationships for the purposes of attribution, yet the higher quality data may be claims data.

Data do not need to be limited to administrative claims, and the Committee recognized the importance of data from electronic health records as well as both patient- and clinician-reported data for attribution purposes. It is important to take into account new data sources as they become available. For example, the commissioned paper notes that while the exact attribution model varies among Pioneer ACOs, each involves some element of prospective attribution based on patient- or clinician-reported data. Physicians are provided a list of patients in their ACOs, and in some cases, ACOs may submit beneficiary attestations regarding their desire to be attributed to a certain clinician.

Principle 4: Attribution models should be regularly reviewed and updated.

Attribution models should be regularly reviewed and updated as data availability and quality, health system goals, and the evidence-base for attribution models evolve. The Committee acknowledged that best practices, care delivery systems, and the data available are constantly evolving and that attribution models will need to change to improve and capitalize on this evolution. The Committee also noted that attribution models must be flexible in order to accommodate variations in the structure of health delivery systems.

The Committee recognized that attribution models will need to evolve over time to support changes in policy, payment design, and measurement goals. As such, attribution models have to be judged within the context of the p measure, payment program, patient population, and level of consequence of how the measure will be used. The Committee recognized the impact that temporal and environmental context can have on attribution models. The Committee noted that the time frame (e.g., the period of time during which services were delivered, the period of time the patient was an enrollee of a plan or an ACO, or the measurement period), the services included, the geographic context (e.g., rural or urban settings), the payment model, and the care delivery model can all significantly affect an attribution model and that a model should be revisited as these factors evolve.

Principle 5: Attribution models should be transparent and consistently applied.

Currently, assignment of patients or outcomes to accountable units can be difficult to discern; often the details of the attribution model used are not available to the accountable unit. This lack of transparency may undermine the validity of such models because of perceived inaccuracies and lack of fairness.

Transparency is essential to accurate and fair attribution in both measure and program applications. It is critical that the attribution for care and health outcomes be transparent to accountable units and patients. Details of the attribution model used and the data available must enable clinicians to know which patients' care or which portion of any particular patient's care they are responsible for. Timing is also critical, since it can allow accountable units to know and agree to their patient panel prospectively. This review of a patient panel can improve the fairness and accuracy of an attribution model and enable an adjudication process for potential errors in attribution.

Principle 6: Attribution models should align with the stated goals and purpose of the program.

The Committee acknowledged that performance measurement and value-based purchasing are mechanisms to drive change and improvement in the healthcare system by incentivizing behavior that leads to better health for patients and lower costs. However, policymakers and program implementers should be clear about the behavior they are trying to incentivize by attributing health outcomes to a certain unit. Measure implementers should be aware that the attribution model selected will drive consequences, both intended and unintended. The selection and application of an attribution model should be accompanied by an explanation of the goals and purpose of measurement, the rationale used to identify the specific attribution methodology, and the intended/unintended consequences considered during the selection process.

Attribution Model Selection Guide

The Committee recognized the current tension between the desire for clarity about an attribution model's fit for purpose and the state of the science related to attribution. There is a desire in the field for rules to clarify which attribution model should be used in a given circumstance, but there is not enough evidence to support the development of such rules at this time.

As noted above a significant finding of the commissioned paper was the current lack of a standard definition of the elements included in an attribution model. This lack of standardization across attribution models significantly limits the ability to evaluate the effectiveness of different approaches. An important first step to evaluating attribution models is to determine the necessary elements of an attribution model that should be specified. The Attribution Model Selection Guide is intended to help measure developers, measure evaluation committees, and program implementers to specify the necessary elements of an attribution model. It should enable stakeholders to have a structured dialogue about attribution models and the decisions made when developing, selecting, or evaluating an attribution model.

The Attribution Model Selection Guide represents the minimum elements that should be shared with the accountable entities (Table 2). The details of an attribution model, and the choices made in developing the model, should be transparent to patients, accountable entities, and other stakeholders. An attribution model must be well defined and precisely specified, with adequate testing so that it can be implemented consistently. The Attribution Model Selection Guide includes a series of key questions to answer in the development and selection of an attribution model. It is intended to improve standardization across attribution models and increase the ability to evaluate attribution models in the future.

Measure developers and program implementers should use the Attribution Model Selection Guide when implementing an attribution model in a measure or program. The Attribution Model Selection Guide walks the user through a series of questions that must be considered for an attribution model and articulates strengths and weaknesses of different approaches. Users should consider these factors and the trade-offs they represent as they select an attribution model.

Table 2. The Attribution Model Selection Guide

What is the context and goal of the accountability program?	• What are the desired outcomes and results of the program? • Is the program aspirational? • Is the program evidence-based? • What is the accountability mechanism of the program? • Which entities will participate and act under the accountability program?
How do the measures relate to the context in which they are being used?	• What are the patient inclusion/exclusion criteria? • Does the model attribute enough individuals to draw fair conclusions?
Who are the entities receiving attribution?	• Which units are eligible for the attribution model? • Can the accountable unit meaningfully influence the outcomes? • Do the entities have sufficient sample size to meaningfully

	aggregate measure results? • Are there multiples units to which the attribution model will be applied?
How is the attribution performed?	• What data are used? Do all parties have access to the data? • What are the services that drive assignment? Does the use of those services assign responsibility to the correct accountable unit? • What are the details of the algorithm used to assign responsibility? • Has the reliability of the model been tested using multiple methodologies? • What is the timing of the attribution computation?

What is the context and goal of the accountability program?

Attribution models must be evaluated in the specific program context in which they are intended and take into account the context and goal of the program, the accountability mechanism used (e.g., payment or public reporting), and the intended behavior change. An attribution model must be aligned with these three elements, since an attribution model that works in one program context may not work for another. Finally, the attribution model should advance the National Quality Strategy by improving care and outcomes for patients or making care more affordable.

What are the desired outcomes and results of the program?

The Committee's discussion highlighted the need to understand the goals of attribution when assessing potential attribution models. Attribution is a powerful tool to increase accountability for outcomes. Tying outcomes to an accountable unit's reimbursement through a payment program or reputation through public reporting can catalyze improvement. Accountability programs are designed to foster specific improvement goals. The Merit-Based Incentive Payment System (MIPS) reimburses clinicians based on quality, resource use, clinical practice improvement activities, and meaningful use of certified EHR technology. The Hospital-Acquired Condition Reduction Program requires payment reductions based on rates of specific hospital-acquired conditions. An attribution model must support the outcomes that a program is trying to improve and tie the correct outcomes to the correct units.

Is the program aspirational? Is the program evidence-based?

While some accountability programs (i.e. payment or public reporting programs) are designed to speed uptake of evidence based-care practices already in use, others are designed to incentivize fundamental shifts in how units understand and act on their responsibility for patient outcomes. The changes envisioned may reflect aspirations for health systems and care providers to better coordinate care. Such programs are not inherently good or bad, but in the context of an aspirational program, the attribution model is central and should be fully vetted. The intended behavior change expected should be fully

transparent and understood, the attribution strategy should align with the desired change in behavior, and the outcome measure's use should be fair to the accountable unit.

An example of an aspirational use of an attribution model is the attribution of a population outcome such as county smoking rates to particular providers, such as hospitals (as listed on the list of measures under consideration reviewed by MAP in 2015-2016 pre-rulemaking). Attributing county smoking rates to hospitals would assign hospitals a new responsibility and incentivize them to act to lower rates among the many people in their community who never seek hospital care. The attribution of this measure to a hospital program would clearly be aspirational, as it would attribute the outcomes of many people who were never seen at hospital. It might be acceptable to patients, program implementers, and the accountable unit if expectations were clearly defined and there were interventions that the accountable unit could take (e.g., hospitals advocating for higher cigarette taxes, funding quit lines, making nicotine replacement more accessible), and rewards or penalties were commensurate with the uncertain results. If aspirational programs achieve results, they generate evidence and gain acceptance over time (e.g., attribution of 30-day readmissions to hospitals; Maryland's population-based global hospital budget). As Ryan, et al.[3], note, however, it can be challenging to develop attribution models for this purpose while being responsive to concerns about achievability. Hence, it is important to consider explicitly the degree to which an attribution model is aspirational and guide its design and use accordingly.

What is the accountability mechanism of the program?

Attribution models used in payment, public reporting, or network design programs require a greater degree of accuracy than those used for quality improvement purposes. An attribution model used for these purposes can affect an accountable unit's reimbursement and reputation, creating a tension between the desire for improvement shared by all stakeholders and the need to ensure that a model is holding the right unit accountable.

Specifically, the Committee discussed a tension between a desire to try new approaches to attribution that may not have had rigorous testing and to be fair to clinicians and facilities in who is being held accountable for what. The tolerance of error or inaccuracy in the data, measurement, or attribution results may be higher for quality improvement applications and lower when attribution models are being used for accountability applications, such as payment public reporting, and whether provider participation in the accountability programs is voluntary or mandatory. When clinicians or facilities are subject to mandatory accountability programs, greater accuracy in the data supporting the attribution model and attribution results may be needed.

Which entities will participate and act under the accountability program?

Accountability programs may target different levels of the healthcare system. Some programs such as the Medicare Shared Savings Program assess quality at the ACO level. Others, such as the Hospital Readmissions Reduction Program, assess an individual hospital, while MIPS could assess an individual clinician or a group of clinicians. An attribution model should align with how the program assesses quality and the goals it is trying to achieve while recognizing the locus of control of each unit.

How do the measures relate to the context in which they are being used?

The Committee recognized that attribution happens at both the program and measure level. An accountability program will likely only reflect a subset of a unit's patients, and an attribution model is needed to determine which patients attributed to the accountable unit by the program will be included in the results of each quality or cost measure in the program. For example, the measures included in the Hospital Readmissions Reduction Program would only reflect Medicare beneficiaries with certain conditions. A hospital's measure results would not reflect patients without these conditions.

Likewise, each measure within a program has an attribution model within it that attributes the measure outcome for the included population to the accountable unit. It is critical to have alignment between the accountability mechanism, goal of the program, measures being used, and the ability of the accountable unit to influence the outcome.

What are the patient inclusion/exclusion criteria?

The Committee emphasized the need to ensure that the outcomes addressed by the measures in the program are driving towards the ultimate improvement goal. The Committee reiterated its focus on attribution for accountability purposes and recommended that measures being used for such purposes have an appropriate degree of scientific rigor. In particular, there should be accurate data to support the measure and the attribution of its results.

The Committee recognized the importance of ensuring fair comparisons between units and recommended that measures used for accountability purposes be appropriately risk-adjusted and have adequate exclusion criteria to ensure outlier management. Such outlier management is essential to remove randomness from the sample that could lead to incorrect inferences about a unit's performance, especially when the results of a measure are being used for accountability purposes.[4] For example, the Committee recognized that a unit may see a complicated case that requires a higher intensity level of care to ensure a positive outcome which could have a significant negative impact on how the unit performs on resource use measures.

The Committee looked to the work of the NQF Consensus Development Process (CDP) to ensure the scientific acceptability of performance measures.

Does the model attribute enough individuals to draw fair conclusions?

Accurate measurement depends on having a large enough sample size for results to be meaningful. An attribution model must include enough individuals to draw fair conclusions while appropriately excluding outlier and employing proper risk adjustment to accurately compare the performance of attributed entities. The Committee recognized that performance measures employ exclusion criteria and risk adjustment within the measure but emphasized that there must be alignment between the specifications of the measure and the program. An attribution model may require its own rules outside of the measures being used to ensure fair comparisons. The Committee noted that attributing enough individuals to draw fair conclusions is a particular concern for rural clinicians or providers or other entities facing issues with small numbers.

Which units will be affected by the attribution model?

Increasingly, healthcare is being provided in a team-based environment, making it important to attribute results to the right players. Attribution is a tool to create groups for comparison. An attribution model should identify who is expected to take action based on the goals and purpose of the program or measure balanced with the ability of the accountable unit to influence the measure.

Which units are eligible for the attribution model?

Attribution models can assign accountability to individual clinicians, groups of clinicians, facilities, or ACOs. The goal of the attribution model should define its breadth, as some circumstance may require attributing results to individual clinicians, while others favor greater aggregation. While the greater number of patients that can be assigned to larger entities can improve the reliability of a measure, this must be balanced with the actionability of results. Models that assign accountability to smaller units may allow for more ability to pinpoint where specific improvements are needed. The Committee emphasized that entities eligible to receive attribution must be able to meaningfully influence the outcomes of the patients they are being held accountable for.

Attribution models that assign patients to clinicians may also specify what types of clinicians patients are attributed to. The Committee recognized the particular challenges that attribution to certain types of clinicians may entail. Many attribution models depend on attribution to a primary care provider (PCP). However, primary care may be provided by clinicians other than those who are considered to be PCPs. For some chronic conditions, the care plan may be driven by a specialist or the patients may consider a specialist to be their PCP. Attribution to a specialist involves challenges including scope of practice and holding a specialist responsible for outcomes well beyond what he or she can meaningfully influence.

The Committee stressed that measures used in an accountability program must be tested at the level of analysis of that program. Measures, and measure concepts, may be taken from one program where they were attributed to one accountable unit or set of entities and used in different programs. When a measure is adapted for new program contexts or different accountable units, the attribution model must be tested at the level for which it is being proposed or used. The Committee noted that it is essential to consider whether the measure performs adequately in this new context before it is used to evaluate the performance of an accountable unit.

Can the accountable unit meaningfully influence the outcomes?

Accountable units receiving attribution should be able to meaningfully influence the outcomes they are being held accountable for. The Committee recommended that accountability applications (e.g., public reporting, payment, network design) may require more certainty that the accountable unit can influence the results compared to quality improvement programs. Attribution models can help drive progress towards aspirational goals such as improved care coordination, and the Committee noted the desire to use attribution to incentivize behavior change. For example, the Committee noted that holding hospitals accountable for 30-day readmission rates could incentivize them to improve care coordination and ensure that they are working with high-quality post-acute care partners. However, attribution models should identify accountable entities that are able to meaningfully affect measured outcomes directly or through collaboration with partners whom they can reliably influence.

Do the units have sufficient sample size to meaningfully aggregate measure results?

The Committee discussed the need to be transparent about the minimum sample size needed to support the attribution model and measure computation. There is increased reliability in performance measures when a large number of patients are attributed to accountable entities. While this increases the ability to distinguish performance across clinicians or facilities, it risks including patients that may have received the majority of their care from a different clinician or facility and compromises the validity of the attribution model. Increasing validity of the attribution model means that some patients or cases are left out.

In order to fairly compare the performance of attribution entities, an adequate sample size to achieve sufficient rigor in the measure computation is needed, with outliers excluded and/or risk adjustment performed. In some cases, however, it may not be possible to achieve an adequate sample size. For example, small group practices and small rural and urban hospitals with lower patient volumes, where there may be fewer clinicians with a larger scope of services will still require attribution and attribution models. These "non-perfect" cases where there is not a large enough sample size or accurate data represent the reality of our diverse healthcare system, and require consideration in developing and selecting an attribution model.

Are there multiple units to which this attribution model will be applied?

Attribution models may attribute patients to one accountable units or multiple accountable units. The authors of the commissioned paper found that the majority of current models only attributed to a single units but noted that attribution to a single unit may not recognize the role that other units play in that person's care. Attribution to multiple entities may help to foster shared accountability and recognizes the role multiple units may play in a person's care. Future models should consider ways to attribute to multiple units in ways that are proportional to their involvement, such as weighting schemes. The Committee expressed a desire that future models will better reflect an accountable unit's scope of practice and locus of control.

How is the attribution performed?

There are varying attribution methods currently performed, and there is a lack of objective evidence to recommend one approach over another. The questions in this section represent key considerations that should be taken into account when developing an attribution methodology. The Committee emphasized that the methodology must be developed to fit the context of its use. A methodology that works for a quality improvement program may not work for an accountability application. The attribution methodology should help drive the goal of measurement but must take into account the clinical circumstances, an accountable unit's ability to meaningfully affect the measured outcomes, and scientific rigor.

What data are used? Do all parties have access to the data?

The Committee reiterated the guiding principle that available data and data quality is fundamental to the design of an attribution model and recommended using the most accurate and timely data possible. An attribution model must demonstrate sufficiently accurate data sources to support the model in fairly attributing patients to accountable entities.

Ryan, et al[5] found that medical claims are the most commonly used data source for current attribution models. The Committee recognized the potential advantages of claims data such as accessibility and larger sample sizes. However, the Committee reiterated that data does not need to be limited to administrative claims and encouraged the continued development of alternative data sources that would support more accurate and timely attribution models. The Committee recognized the promise of data from electronic health records (EHRs) but noted some current limits of this data, such as data blocking, inability to access records from other organizations, and lack of interoperability.

The Committee acknowledged the current desire to move to patient attestation as a data source for attribution models. While patient attestation can advance a more person-centered system, there are concerns about this data, including data collection burden, accuracy, and availability. Engaging patients can improve data about what care was provided for them and help provide a more complete picture of the relationship. Clinician attestation would allow clinicians and providers an opportunity to confirm the relationship as well.

Finally, the Committee recognized a number of promising new data sources that could improve attribution such as the development of the CMS patient relationship codes and categories required by MACRA, increased use of the National Provider Identifier, and integration of registry data.

What are the qualifying events for attribution and do those qualifying events accurately assign care to the right accountable unit?

The scan of current approaches found a number of potential events that are used to trigger attribution. The scan found that visits and spending were the two most common approaches. The authors noted some key considerations around each approach. They noted that visits can differ depending on the purpose and the services provided, while spending could lead to increased attribution to specialists who may have limited involvement in the clinical decisions that lead to that spending.

What are the details of the algorithm used to assign responsibility?

An attribution model is based on a series of rules used to determine accountability. The Committee recognized that current attribution models use different algorithms to assign responsibility. The algorithm could be attestation based, assigning accountability to the unit identified by the patient. As noted above, the Committee commended the patient-centeredness of this approach but cautioned that this must be balanced with accuracy of the data provided as patients may see multiple clinicians, change health plans or primary care providers over the course of the measurement period, or may attribute to a clinician who may not have had control over the majority of their care. The Committee did note that patient and clinician attestation can help to verify the relationship and ensure that the attribution model reflects the care provided. Prospective approaches can also help a unit to understand which patients they are responsible for in advance and work with those patients proactively to manage their health—a significant potential positive for a population-based payment model.

The Committee recognized that claims-based approaches have the benefit of reflecting the care that was actually provided. Ryan et al.[6] found a number of claims-based approaches in the environmental scan. An algorithm based on plurality may assign accountability to the clinician with the greatest

number of a patient's evaluation and management (E&M) visits. One study found that this approach allowed for the greatest number of patients and their visits to be counted.[7] However, the Committee raised caution that this approach can have significant drawbacks and could lead to a clinician being attributed an entire episode when that clinician had only limited interaction with the patient. For example, if a person was hospitalized for congestive heart failure and suffered an adverse drug reaction during a hospital stay that presented as a severe rash and required a consultation and follow-up care from a dermatologist, that dermatologist may end up billing the greatest number of E&M visits. This approach would attribute all responsibility for the patient's costs and outcomes to the dermatologist. The Committee noted that the desire to attribute highest number of patients must be balanced with what is in a unit's control and the actual clinical circumstances.

Other retrospective claims-based approaches include a majority approach, which might attribute responsibility to the clinician who billed greater than 50 percent of E&M visits. This stricter approach may help prevent attributing patients to a clinician who has limited interaction with them but may result in a smaller sample and could affect reliability. Ryan, et al., also noted that this approach could exclude some patients with whom the clinician does have a relationship.

Other approaches may attribute responsibility to multiple units. These include a "one-touch" rule, attributing the patient to anyone who provided care, or a multiple approach, attributing the patient to all clinicians billing more than a certain percentage of E&M visits. These approaches could help to foster shared accountability but could also result in less specificity, making results less actionable.

Have multiple methodologies been considered for reliability?

The Committee stressed the need to use transparent, clearly articulated, reproducible methods of attribution. Currently, little information is available about the reliability testing of attribution models, and the choice of attribution model can have a significant impact on the measure or program score. The Committee recommended that multiple methodologies be tested and compared to see how the results would differ. One study of physician cost profiles found significant variation in which episodes could be attributed to a physician based on the attribution methodology selected (range 20percent to 69 percent).[8] The work also found that compared to a default rule, 17-61 percent of physicians would be assigned to a different cost category when a different methodology was used. Program implementers and measure developers should choose a reliable approach that aligns with the improvement goals they are trying to achieve.

What is the timing of the attribution computation?

The Committee stressed the importance of timing in an attribution model and noted that there are multiple relevant time periods that should be considered: one for performing the attribution and then the measurement period during which outcomes are tracked.

First, the Committee found the need to consider retrospective versus prospective attribution. Ryan, et al., found several advantages and disadvantages to each approach. The authors found that retrospective attribution allows for assignment based on how care was actually delivered but does not

allow clinicians to know which patents will be assigned to them until after care has been provided. The authors note that prospective attribution removes this uncertainty but raised concerns about the possibility of gaming or providing differential levels of care based on attribution status. Additionally, there are concerns that patients can seek care from units other than the ones they are attributed to, and this could lead to inaccurate representations of the care provided.

The environmental scan found that the majority of current models use retrospective attribution but noted increasing uptake of prospective attribution. For example, the Medicare Shared Savings Program was initially designed to use retrospective attribution, but changes have been made to implement different tracks, some of which used prospective attribution.[9] Next, the Committee noted the need to consider the measurement period during which outcomes are tracked. The Committee stressed the importance of considering the relationship between the measurement period and the period in which patients are attributed to an accountable unit and the need to align the performance periods for payment and quality measures.

The Committee also recognized the importance of the measurement period and the defined time period which with an accountable unit is held responsible. The Committee noted some potential trade-offs for the measurement period. As Ryan, et al.[10], noted in the commissioned paper, a longer time period increases the ability to identify a relationship between a patient and an accountable unit. Longer time periods may also increase the likelihood that the patients attributed to a unit accurately reflect their patient pool.[11] However, the authors cautioned that using a longer time period may introduce the risk of including patients that only received low levels of care. The Committee and the authors also cautioned that patients may frequently change clinicians or providers, making longer time periods potentially inaccurate. One study found that only 67 percent of patients were attributed to the same accountable unit in the following year.[12] Attribution models must balance these concerns and ensure that the time period holds the correct units accountable.

Implementation and Evaluation of Attribution Models

As illustrated by the Attribution Model Selection Guide, designing an attribution model involves factors that must be carefully considered and balanced. The elements examined in the Attribution Model Selection Guide are an attempt to provide greater standardization of attribution models while laying out a series of considerations that measure developers and program implementers must make when designing an attribution model. As noted above, the current evidence does not support recommending one approach over another for a given circumstance. Rather, the selection tool is intended to help those developing attribution models think through what approach may be best for their circumstance rather than relying on the most convenient approach.

The Attribution Model Selection Guide aims to standardize the elements of an attribution model allowing for better comparisons between models and a stronger evidence base about which approach may be favorable in a certain situation. Developing this evidence base will allow for evaluation of attribution models in the future. With this in mind, the Committee made a series of recommendations to guide those seeking to implement attribution models. The recommendations are designed to aid

implementers in designing and selecting attribution models to ensure that the desire for improvement and accountability is balanced with accuracy and actionability.

Finally, the Committee emphasized the need to fully examine the potential consequences, both intended and unintended, of the attribution model. How outcomes are attributed can significantly impact both patients and accountable units. Patients need accurate information to make decisions about where to seek care. Accountable units need to have control over the outcomes attributed to them to ensure fairness in reporting and reimbursement.

Recommendations for Attribution Models

The Committee's recommendations build on the guiding principles and Attribution Model Selection Guide. They are intended to apply broadly to those developing, selecting, and implementing attribution models in the context of public- and private-sector accountability programs. In their deliberations on the recommendations, the Committee recognized the current state of the science, considered what is achievable now, and what is the ideal future state for attribution models. The Committee stressed the importance of aspirational and actionable recommendations in order to drive the field forward.

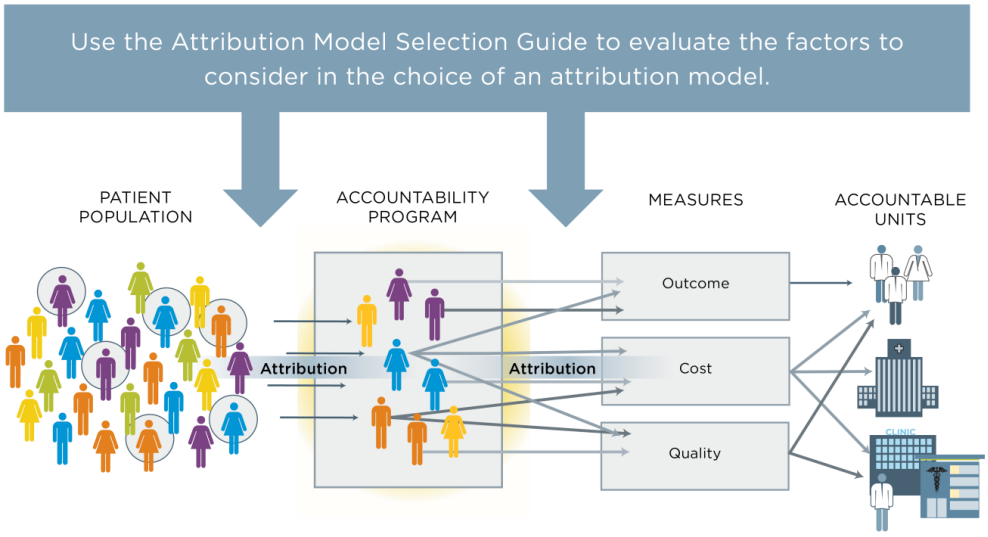
Recommendation 1: Use the Attribution Model Selection Guide to evaluate the factors to consider in the choice of an attribution model

Given there is currently no single gold standard attribution model, the choice of an attribution model should be dictated by the context in which it will be used and supported by evidence. The Committee recommends using the Attribution Model Selection Guide to consider and evaluate the trade-offs in choosing an attribution model (Figure 3). Providing a clear rationale for why a particular attribution model was selected can help foster trust among stakeholders. Measure developers and program implementers should be transparent about the potential trade-offs between the accountability mechanism, the gap for improvement, the sphere of influence of the accountable unit over the outcome, and the scientific properties of the measure considered for use.

In some cases the sphere of influence of the accountable entity may be aspirational. For instance, an attribution model may be chosen that attributes care to accountable entities with varying degrees of influence over the outcomes to incentivize those with a smaller degree of influence to partner those who have a larger degree of influence. As noted in the example above regarding smoking cessation rates, if a measure attributed the smoking cessation rate for a county to an individual hospital. Accountable entities, hospitals in this case, have varying degrees of influence over this outcome and need to partner with others in the community to meaningfully influence this outcome.

The selection and application of an attribution model should be accompanied by an explanation of the goals and purpose of measurement, the rationale used to identify the specific attribution methodology, and the intended and unintended consequences considered during this selection process. For example, physicians might avoid caring for high cost patients because of concerns that having these patients attributed to them could negatively impact their reimbursement or reputation.

Figure 3. Given that attribution can occur at the program level and the measure level, this figure depicts when the Attribution Selection Guide should be applied.



Recommendation 2: Attribution models should be tested.

The literature demonstrates that attribution of patients to particular units is sensitive to the attribution rules used. Therefore, attribution models must be subject to some degree of testing for goodness of fit, scientific rigor, and unintended consequences. Ideally this would include sensitivity analyses comparing alternative attribution models. Testing could include comparing across different attribution models what fraction of patients is attributed and consistency of assignment. The degree of testing may vary based on the stakes of the accountability program. Attribution models would be improved making the results of such testing public. Pilot testing may be acceptable under certain circumstances such as private reporting. This testing would generate data to determine whether the attribution model is achieving what was intended. If so, the attribution model could be used for higher stakes applications. When used in mandatory accountability programs, attribution models should be subject to testing that demonstrates adequate sample sizes, appropriate outlier exclusion and/or risk adjustment to fairly compare the performance of attributed entities, and sufficiently accurate data sources to support the model in fairly attributing patients/cases to entities.

One concerns from the Committee was that that quality measures developed for one setting (e.g., readmission rate for hospitals) frequently are translated to other settings (e.g., readmission rate for skilled nursing facilities). The Committee acknowledged that in some circumstances, attribution models may be inherited as part of programs, but that this should not negate that the model should tested for goodness of fit and unintended consequences considered.

Recommendation 3: Attribution models should be subject to multistakeholder review.

Attribution model selection and implementation decisions should involve multistakeholder engagement. Given the current lack of evidence on the gold standard for attribution models, perspectives on which approach is best could vary based on the interests of the stakeholders involved. The Committee emphasized the importance of multistakeholder review and engagement in decisions around the strengths and weaknesses, tradeoffs, and unintended consequences of different attribution models. No one sector or stakeholder group should make decisions about attribution models for all others and true stakeholder input requires adequate time for review and comment. Attribution model selection and implementation in public and private sectors, such as organizations implementing payment programs or health plans implementing incentive programs should use multistakeholder review to consider attribution models to use for their purposes.

An example of how this might be achieved is through local or regional collaboratives with multiple stakeholders, or the NQF multistakeholder committees. The Committee also noted that multistakeholder groups should be involved in the development of payment models and quality initiative programs.

In the NQF context, as part of the Consensus Development Process (CDP), Standing Committees could evaluate the attribution model of a performance measure. The approach and level of attribution of a particular measure may or may not be aligned with the goals of the program for which it is proposed, and its use in the program may affect the reliability and validity of a performance measure. The CDP could consider the change in behavior the attribution model is designed to incentivize, whether the change is aspirational or reflects current practice, and whether it is acceptable to program stakeholders. Incorporating consideration of a measure's attribution model into the CDP would ensure the scientific acceptability and facilitate stakeholder acceptance of a measure's attribution approach. Similarly, the Measure Applications Partnership (MAP) could ensure alignment between the attribution model of a measure and the program in which it will be used. MAP committees could examine the attribution model of a measure when making pre-rulemaking recommendations to ensure that the measures are attributed at the level it was tested and endorsed when used for accountability purposes.

Recommendation 4: Attribution models should attribute results to entities who can influence care and outcomes.

The committee was concerned some current attribution models in use assign care to entities that have little control or influence over patient outcomes. For instance, models that use plurality of visits can attribute costs and outcomes to clinicians or facilities that have seen a patient more frequently to address an acute issue resulting from care delivered by a different clinician or facility.

For an attribution model to be fair and meaningful, an accountable unit must be able to influence the outcomes for which it is being held accountable either directly or through collaboration with others. As care is increasingly delivered by teams and facilities become more integrated, attribution models should reflect what the accountable entities are able to influence rather than directly control. For example, a

clinician or facility could impact a patient outcome either directly or through collaboration with partners who they can reliably influence. For readmissions measures, for example, a hospital being held accountable for readmissions from a skilled nursing facility (SNF) may ensure that the facilities to which it is discharging patients are meeting the hospital's standards to reduce readmissions. Additionally, an acute care physician or nurse practitioner could follow-up with the patient while they are in the SNF to ensure appropriate care is being delivered.

The Committee recognized, however, that there is often a grey zone in which theory or limited evidence suggests clinicians or facilities can potentially improve patient care in collaboration with others but the ability of any given provider to achieve the desired outcome through collaboration is uncertain. In the example above, a hospital may have no choice over which SNF to choose (the choice may be dictated by a health plan or only one SNF has available beds) or the SNF refuses to work with the hospital. The Committee recognized the tension between the current state and attempting to drive change through an aspirational assignment of responsibility. Performance measures and payment models are tools to move the system forward and incentivize behaviors that will improve quality and lower costs. However, higher stakes applications that affect clinician or facility reputation or payment require the measured unit to have a higher degree of influence over the results.

Recommendation 5: Attribution models used in mandatory public reporting or payment programs should meet minimum criteria.

The results of an attribution model can significantly affect the reputation and payment of a clinician or facility; particularly in high stakes accountability applications such as public reporting or pay for performance programs. Given concerns from clinicians that they do not know why certain patients were attributed to them, it is important to have a system that is transparent. Clinicians should be able to examine why a patient's care was attributed to them and there should be open adjudication processes that allow for appeals and refinements to the attribution model.

In order to be applied to mandatory reporting or payment program attribution models should:

- Use transparent, clearly articulated methods that produce consistent and reproducible results;
- As noted under recommendation 4; accountable units should be able to meaningfully influence measured outcomes;
- Utilize adequate sample sizes, outlier exclusion, and/or risk adjustment to fairly compare the performance of attributed units;
- As noted in recommendation 2; undergo sufficient testing with scientific rigor at the level of accountability being measured;
- Demonstrate that the data sources are sufficiently robust to support the model in fairly attributing patients/cases to entities;
- Be implemented with an open and transparent adjudication process that allow for timely and meaningful appeals by measured entities.

Applying these criteria to attribution models used in mandatory payment or public reporting programs allows other attribution models to enter the field for experimentation and to incentivize entities to find new and innovative ways to partner to improve care and quality. The requirement of "adequate enough data to support the model" allows for imperfect data sources, but still requires data accuracy.

Conclusion

As the healthcare system continues its push towards value-based purchasing, particularly alternative payment models, it is essential that attribution models that assign accountability for a patient's care accurately reflect the relationship between that patient and the accountable unit. There are currently a wide range of approaches to build an attribution model and the evidence is not conclusive in recommending one approach over another. The Committee recognized that attribution can be a tool to help advance health care improvement and to assign responsibility for complex outcomes. Attribution is essential as the system moves towards population-based payment models that seek to assign units responsibility for population health management. Attribution can be a mechanism to advance care coordination and incentivize units to think beyond their usual ways of delivering care to create a more person-centered system.

However the Committee noted the limitations to current attribution models. Current models may be overly complex and the details of their algorithms are not available to the entities being held accountable. Furthermore current models can be inaccurate and assign outcomes to units outside the scope of their practice or that they are not able to meaningfully influence. At the extreme, some models may hold a unit responsible for a patient they have never seen.

There is currently limited evidence to support the selection of an attribution model. To improve attribution models further research is needed on ways to quantify relationships and understand the sphere of influence of an accountable unit. Additional research could help to provide a better understanding of the current issues and potential best practices, including a better understanding of current issues from the perspectives of patients and clinicians. In particular the Committee noted a need to better understand how cases that are more expensive or complex than are managed. Qualitative research involving both patients and clinicians could help illuminate some of the inaccuracies with current models and opportunities for improvement in the current models. A better understanding of why a patient was attributed to a clinician and how that actually aligned with who had influence over that patient's care could help improve attribution models.

Furthermore, better data sources and analytic techniques should be explored to support more accurate attribution in the future. Electronic Health Records (EHRs) patient relationship codes, and increased use of National Provider Identifiers (NPIs) are potential data sources that could to more appropriately assign accountability.

The Committee also recognized the importance of engaging the patients and clinicians reflected by an attribution model. Patient attestation allows the patient to decide which clinician should be accountable for his or her care. It can be an important way to ensure the model reflects a patient's relationship with

a clinician. Likewise allowing clinicians to better understand why a patient was attributed to him or her will encourage buy-in into attribution models.

The Attribution Model Selection Guide presented in this report aims to create greater standardization among attribution models. While the Committee recognized that one model will not fit all purposes, greater standardization of the elements of an attribution model will allow for more objective evaluation of how a model performs and which approach might best fit the goals the model is trying to achieve. The Committee recommends transparency on the decisions made in developing or selecting attribution models, and the potential trade-offs considered by measure developers, and program implementers. The Attribution Model Selection Guide offers a way to make clear and consistent decisions in selecting and implementing attribution models. Empirical research, and experience with evaluating these models in multistakeholder forums may help to illuminate opportunities for objective evaluation of attribution models in the future.

Better understanding the reasons for inaccuracies in current models, leveraging new data sources, and standardizing elements of attribution models to allow for evaluation and comparison will all help improve attribution. Attribution models that truly reflect a patient's relationships with their clinicians and healthcare providers are essential to ensuring value-based purchasing can drive the system to better quality at lower costs.

---

[1]Medicare Payment Advisory Commissions (MEDPAC) *Report to Congress: Medicare Payment Policy*. Washington, DC: MEDPAC; 2009. Available at http://www.medsolutions.com/clinical_quality/facts/MEdPAc%20Mar09_report%20testimony%20Self%20Referral.pdf. Last Accessed September 2016.

[2] Mehrotra A, Adams JL, Thomas W, et al. The Effect of Different Attribution Rules on Individual Physician Cost Profiles. *Ann Intern Med*. 2010;152:649-654.

[3] Ryan A, Linden A, Werner R, et al. Attribution Methods and Implications for Measuring Performance in Healthcare: Commissioned Paper. 2016.

[4] NQF (National Quality Forum). 2014. *Risk adjustment for socioeconomic status or other sociodemographic factors*. Washington, DC: National Quality Forum.

[5] Ryan A, Linden A, Werner R, et al. *Attribution Methods and Implications for Measuring Performance in Healthcare: Commissioned Paper.* 2016.

[6] Ibid

[7] RQI Data Collection and Reporting Workgroups. *Approaches to Attribution for Measure Physician Performance*; 2008. Available at http://www.chcs.org/media/Mai_Pham_Presentation.pdf

[8] Mehrotra A, Adams JL, Thomas W, et al. The Effect of Different Attribution Rules on Individual Physician Cost Profiles. *Ann Intern Med*. 2010;152:649-654.

[9] Baseman S, Boccuti C, Moon M, et al. Payment and Delivery System Reform in Medicare: A Primer On Medical Homes, Accountable Care Organizations, And Bundled Payments. KFF; 2016.

[10] Ryan A, Linden A, Werner R, et al. Attribution Methods and Implications for Measuring Performance in Healthcare: Commissioned Paper. 2016.

[11] AcademyHealth. 2012. Research Insights: What Works in Care Coordination? Activities to Reduce Spending in Medicare Fee-for-Service. Orlando, FL: AcademyHealth.

[12] Pham HH, Schrag D, O'Malley AS, et al. Care Patterns in Medicare and Their Implications for Pay for Performance. *N Engl J Med* 2007;356:1130-9.

Appendix A: Committee Roster and Biographies, and NQF Project Staff

Multistakeholder Committee Roster

Ateev Mehrotra, MD, MPH (Co-Chair)
Department of Health Care Policy
Harvard Medical School
Massachusetts

Carol Raphael (Co-Chair)
Senior Advisor
Manatt Health Solutions
New York

Michael Barr, MD, MBA, MACP
Executive Vice President of Quality Measurement & Research
National Committee for Quality Assurance
Washington, District of Columbia

Jenny Beam, MSc
Vice President of Operations
University of Louisville Physicians
Kentucky

Jill Berger, MAS
Former Vice President
Health & Welfare for Marriott International
Washington, District of Columbia

Anne Deutsch, PhD, RN, CRRN
Senior Research Public Health Analyst
RTI International
Illinois

Elizabeth Drye, MD, SM
Director of Quality Measurement Programs
Yale-New Haven Hospital, Center for Outcomes Research and Evaluation (CORE)
Connecticut

Troy Fiesinger, MD
Family Physician
Population Health Lead, Village Family Practice of Fort Bend
Texas

Charles Hawley, MA
Analytics Lead
Utah Department of Health
Utah

Ari Houser
Senior Methods Advisor
AARP Public Policy Institute
Washington, District of Columbia

Keith Kocher, MD, MPH, MPhil
Assistant Professor of Emergency Medicine
University of Michigan
Michigan

Robert M. Kropp, MD, MBA, CPHI
Interim Head of Care Delivery, Aetna Accountable Care Solutions
Saint Petersburg, Florida

Danielle Lloyd, MPH
Vice President of Policy & Advocacy, Deputy Director
Premier, Inc.
Washington, District of Columbia

Edison Machado, MD, MBA
Chief Quality Officer and Vice President of Strategic Planning
Island Peer Review Organization (IPRO)
New York

Ira Moscovice, PhD
Professor and Head
University of Minnesota, Division of Health Policy and Management, School of Public Health
Minnesota

Jennifer Nowak, RN, MSN
Center for Clinical Value
Blue Cross Blue Shield Association
Illinois

Jennifer Perloff, PhD
Scientist, Deputy Director Institute on Healthcare Systems

Heller School, Brandeis University
Massachusetts

Brandon Pope, PhD
Director of Analytics
Baylor Scott & White Quality Alliance
Texas

Laurel Radwin, PhD, RN
Research Health Scientist
Boston Veteran Administration Healthcare System
Massachusetts

Jack Resneck, MD
Professor, Department of Dermatology School of Medicine
Philip R. Lee Institute for Health Policy Studies, University of California, San Francisco
California

Michael Samuhel, PhD
Principal
Booz Allen Hamilton
Washington, District of Columbia

Robert Schmitt, FACHE, FHFMA, MBA, CPA
Chief Executive Officer
Gibson Area Hospital & Health Services
Illinois

Nathan Spell, MD
Associate Professor of Medicine, Medical Educator and Service Track and Vice Chair for Quality and Clinical Effectiveness
Emory University School of Medicine
Georgia

Srinivas Sridhara, PhD, MS
Chief, Cost and Quality Analysis
Maryland Health Care Commission
Maryland

Bharat Sutariya, MD, FACEP
Vice President & Chief Medical Officer Population Health
Cerner Corporation

Missouri

Federal Liaison

Lawrence Daniel Muldoon, MA
Social Science Research Analyst
Center for Medicare and Medicaid Innovation
Baltimore, Maryland

Biographies

Ateev Mehrotra, MD, MPH (Co-Chair)
Department of Health Care Policy, Harvard Medical School
Dr. Mehrotra's research focuses on interventions to decrease costs and improve quality of care. Much of his work has focused on innovations in delivery such as retail clinics and e-visits have on quality, costs, and access to health care. He is also interested in the role of consumerism and whether price transparency and public reporting of quality can impact patient decision making. Related work has focuses on quality measurement including how natural language processing can be used to analyze the data in electronic health records to measure the quality of care. Dr. Mehrotra received his B.S. from the Massachusetts Institute of Technology, his medical degree from the University of California, San Francisco and completed his residency in internal medicine and pediatrics at the Massachusetts General Hospital and Children's Hospital of Boston. His clinical work has been both as a primary care physician and as an adult and pediatric hospitalist. He also has received formal research training with a Masters of Public Health from the University of California, Berkeley and a Masters of Science in Epidemiology from the Harvard School of Public Health. In 2008, he received the Milton W. Hamolsky Award for Outstanding Scientific Presentation by a Junior Faculty Member by the Society of General Internal Medicine. In 2013, he received the Alice S. Hersh New Investigator Award from AcademyHealth for health services researchers early in their careers who show exceptional promise.

Carol Raphael (Co-Chair)
Senior Advisor, Manatt Health Solutions
Carol Raphael served as President and Chief Executive Officer of the Visiting Nurse Service of New York (VNSNY), the largest nonprofit home health agency in the United States from 1989 to 2011. Prior to joining VNSNY, Ms. Raphael held executive positions at Mt. Sinai Medical Center and in New York City government. In 2012, Ms. Raphael was an Advanced Leadership Fellow at Harvard University. In 2013, Ms. Raphael was appointed by President Obama to the Bipartisan Commission on Long Term Care. She is Co-Chair of the National Quality Forum MAP Post-Acute/Long Term Care Workgroup and a member of its Committee on All-Cause Readmissions. She is Co-Chair of the West Health Advisory Council on Emergency Department to Home-based Healthcare. She is Chair of the Long Term Quality Alliance, a Senior Advisor at Manatt Health Solutions and a Board Member of the New York eHealth Collaborative, a public-private partnership to advance the adoption of health information technology. She is the Chair of the AARP Board and serves on the boards of the Primary Care Development Corporation, the Medicare Rights Center, Pace University, Henry Schein, Inc. and ATE as well as numerous advisory boards. She is a member of the New York City Age-Friendly Commission and edited the book "Home Based Care for a New Century".

Michael Barr, MD, MBA, MACP

Executive Vice President of Quality Measurement & Research, National Committee for Quality Assurance

Michael S. Barr is a board-certified internist and Executive Vice President for the Quality Measurement & Research Group at NCQA. His portfolio at NCQA includes performance measurement development and testing, contract/grant management, research, and collaboration across NCQA on strategic initiatives, public policy, and program development. Prior to joining NCQA in May 2014, Dr. Barr was Senior Vice President, Division of Medical Practice for the American College of Physicians (ACP) where he was responsible for promoting patient-centered care through the development of programs, services, and quality improvement initiatives for internists and other healthcare professionals.

Jenny Beam, MSc

Vice President of Operations, University of Louisville Physicians

Jenny Beam, Vice President of Operations for University of Louisville Physicians, has delivered national presentations on productivity, benchmarking, labor management, and quality and process improvement at engineering and health care conferences. Jenny has also served on the National Quality Forum eMeasure Format Review Committee for Health Information Technology Panel. Jenny was responsible for analyzing and establishing the first generation patient attribution model for all quality and stars programs for a large national health plan and evaluated and scored providers and medical groups on evidence based quality metrics. She is currently pursuing her second Master's of Science in social work.

Jill Berger, MAS

Former Vice President of Health & Welfare for Marriott International

Jill is an Executive Consultant – Health Care for IBM Watson Health. She brings her expertise in health care management to developing innovative solutions for employers and health plans to transform health care. Jill was formally the Vice President of Health & Welfare for Marriott International, one of the nation's largest hospitality vendors. She was responsible for the strategy, design and management of Marriott's benefit plans--honing in on the need for quality improvement and greater engagement with employees about their health. Jill is a strategic health benefits professional with a passion to provide optimal population health management. Jill designed a global wellbeing program and implemented on-site clinics, health coach programs and other initiatives to greatly improve employee engagement. Jill served on the Maryland Health Quality and Cost Council and the Board of Directors for the Integrated Benefits Institute. Jill was also Co-Chair for the National Business Group of Health (NBGH) Institute on Health Care Costs and Solutions. Jill was on the Board of Directors for the Leapfrog Group, and was Chair from 2007-2009.

Anne Deutsch, PhD, RN, CRRN

Senior Research Public Health Analyst, RTI International

Anne Deutsch is a Senior Research Public Health Analyst with RTI International, a Research Scientist at the Rehabilitation Institute of Chicago's Center for Rehabilitation Outcomes Research, and a Research Associate Professor at Northwestern University's Feinberg School of Medicine. She is a certified rehabilitation registered nurse with a doctoral degree in epidemiology and community health. Her

research has focused on post-acute care patient outcomes, quality measurement, the impact of Medicare policies, post-acute payment reform, analysis of post-acute care payment episodes, the development of standardized assessment data elements, and the development of process and outcome quality measures.

Elizabeth Drye, MD, SM

Director of Quality Measurement Programs, Yale-New Haven Hospital, Center for Outcomes Research and Evaluation (CORE)

Dr. Drye is Director of Quality Measurement Programs at Yale's Center for Outcomes Research and Evaluation (CORE) and a leader in quality measurement. She is currently focused on developing ambulatory care outcome measures. Before becoming a physician, she worked in national health policy positions in Washington, DC, including Chief of Staff at the White House Domestic Policy Council and Legislative Assistant to U.S. Senator Joe Lieberman. Dr. Drye received her MD from Harvard Medical School and SM in health policy and management from the Harvard School of Public Health. She completed her residency in pediatrics at Yale-New Haven Hospital.

Troy Fiesinger, MD

Family Physician, Population Health Lead, Village Family Practice of Fort Bend

Dr. Fiesinger completed his family medicine residency at the East Carolina University Brody School of Medicine in 1999 and practiced family medicine including obstetrics with the Scott and White Clinic in Waco, Texas for seven years. While there, he served as the Regional Clinic Director for Quality and Safety. For the past nine years, Dr. Fiesinger has seen served as faculty at community based family medicine residency programs. During this time, he was the medical director of a federally qualified health center for two years. He also served on the board of directors of his health system's employed physician group. Dr. Fiesinger recently returned to private practice where he provides comprehensive care to patients of all ages as part of a 30 physician primary care group. He is also the lead physician for population health and care management of their commercial managed care, Medicare Advantage, and Accountable Care Organization patients.

Charles Hawley, MA

Analytics Lead, Utah Department of Health

Charles Hawley has been a research consultant and health data analyst with the Utah Department of Health for the last four years. He currently serves as Analytics Team Lead and Cycle III Grant Manager with the Office of Healthcare Statistics. The Office collects and analyzes Utah's health plan performance data, hospital discharge data, and All Payer Claims Database (APCD). Before joining the state, Charles earned a Master's degree in sociology from Kansas State University and an undergraduate degree in sociology and history from Weber State University. His graduate studies focused on quantitative research methods, social movements, and food systems.

Ari Houser

Senior Methods Advisor, AARP Public Policy Institute

Mr. Houser is a Senior Methods Advisor in the AARP Public Policy Institute, where his work includes demographics, disability, quality and patterns of use of long term services and supports, family caregiving, and methodological advising on many topics. Prior to joining the AARP Public Policy Institute, Mr. Houser worked at the RAND Corporation on a variety of topics including occupational health and safety management. He has a bachelor's degree from Swarthmore College and is a PhD candidate (ABD) in measurement, statistics, and evaluation at the University of Maryland.

Keith Kocher, MD, MPH, MPhil
Assistant Professor of Emergency Medicine, University of Michigan
Dr. Kocher is an emergency physician and health services researcher studying the delivery and performance of acute care, with particular interests in measurement development and its impact on payment and delivery system reform. He directs the Michigan Emergency Department Improvement Collaborative, a statewide project dedicated to measuring, evaluating, and enhancing the quality and outcomes of emergency department patients. He also has a career development award from AHRQ evaluating variation in hospitalization practice patterns from the emergency department, and actively shapes performance improvement efforts within his professional society, serving on research and policy-oriented committees at the national level.

Robert M. Kropp, MD, MBA, CPHI
Interim Head of Care Delivery, Aetna Accountable Care Solutions
Dr. Kropp holds board certification in pediatrics, neurology and clinical neurophysiology. He holds an MBA from the University of South Florida and a Certificate in Public Health Informatics from Johns Hopkins School of Public Health. During his tenure at Aetna he has held the titles of SE Senior Medical Director and SE Regional Medical Director. He is responsible for designing and delivering the collaborative clinical programs that Aetna and accountable care organizations use to improve quality, efficiency and the patient experience. He has held a variety of titles and functions in the managed care industry, including Chief Medical Officer for CIGNA Healthcare of Florida.

Danielle Lloyd, MPH
Vice President of Policy & Advocacy, Deputy Director, Premier, Inc.
Danielle Lloyd is the VP for policy development and analysis and deputy director of public affairs at Premier. Danielle leads Premier's policy analysis and development, which includes developing comments on federal legislative and regulatory proposals and research around the alignment of financial incentives to improve healthcare quality and reduce costs. She plays a leading role in Premier's ACO and Bundled Payment Collaboratives as well as Premier's non-profit research arm the Premier Research Institute. Danielle previously worked for the American Hospital Association, the California Hospital Association, the U.S. House of Representatives Committee on Ways and Means and the Health Care Financing Administration.

Edison Machado, MD, MBA
Chief Quality Office and Vice President of Strategic Planning

Dr. Machado is responsible for corporate strategic planning, business development and proposal services, and overseeing the corporate quality management system. In addition, he serves as the clinical lead for the CMS Innovation Center Episode Grouper for Medicare project. Finally, Dr. Machado acts as the medical director for IPRO's Health Informatics team. Dr. Machado worked as Senior Director in the Strategic Partnerships Department at National Quality Forum where he was responsible for managing projects related to uses of healthcare performance measurement information for payment incentives, public reporting, accreditation and certification, workforce education, and systems improvement. Dr. Machado has also worked as Medical Director and Programs Leader for the Health Care Incentives Improvement Institute, Inc. (HCI3) where he oversaw the Bridges to Excellence (BTE) Care Recognition Programs, and while assisting various stakeholders and partners (including the American College of Cardiology, American Board of Internal Medicine, the NYS Health Foundation, and NYC Dept of Health & Mental Hygiene) in managing and supporting healthcare quality performance measurement program implementations.

Ira Moscovice, PhD

Professor and Head, University of Minnesota, Division of Health Policy and Management, School of Public Health

Dr. Moscovice currently serves as the Mayo Professor and Head, Division of Health Policy and Management at the School of Public Health at the University of Minnesota. Dr. Moscovice is also the Director of the Rural Health Research Center, one of eight federally funded rural health research centers in the United States. The center at the University of Minnesota focuses on rural quality, including measure develop and analysis. Dr. Moscovice has served as a Member of NQF's Measures Application Partnership Steering Committee as well as Co-Chaired the NQF Rural Task Force.

Jennifer Nowak, RN, MSN

Center for Clinical Value, Blue Cross Blue Shield Association

Jennifer Nowak is a manager in the Center for Clinical Value at Blue Cross and Blue Shield Association, a national federation of 35 independent, locally operated Blue Cross and Blue Shield companies. She provides leadership developing and implementing programs to evaluate the value of care received by Blue Cross and Blue Shield members. Her primary focus has been on the Blue Distinction® program, a portfolio of designations awarded by Blue Cross and Blue Shield companies to providers for their delivery of value-based care. Jennifer received her nursing degrees from Rush University, and a bachelor's degree from University of Illinois, Champaign-Urbana.

Jennifer Perloff, PhD

Scientist, Deputy Director Institute on Healthcare Systems, Heller School, Brandeis University

Jennifer Perloff, Ph.D. is a Scientist and Deputy Director at the Institute for Healthcare Systems within the Schneider Institutes for Health Policy. Dr. Perloff has over fifteen years of experience in evaluation and health services research. Currently she is involved in a CMMI funded project to develop an episode grouper for Medicare (EGM). In addition to serving as project manager for this effort, Dr. Perloff is directly involved in analysis on attribution and provider profiling along with a range of other applied,

claims-based studies. Dr. Perloff also teaches research methods to Ph.D. students and sits on many dissertation committees.

Brandon Pope, PhD
Director of Analytics, Baylor Scott & White Quality Alliance
Brandon Pope is the Director of Analytics for the Baylor Scott & White Quality Alliance, an NCQA-recognized ACO with more than 4,000 physicians and 275,000 members. Brandon's primary responsibilities include delivering descriptive, predictive, and prescriptive analyses and insights in all areas of population health. Before joining Baylor Scott & White Health, Brandon worked as a research scientist for the Regenstrief Center for Healthcare Engineering and the School of Industrial Engineering at Purdue University. Brandon received his Ph.D. and M.Eng degrees in Industrial and Systems Engineering from Texas A&M University and his B.S. in Mathematics from Abilene Christian University.

Laurel Radwin, PhD, RN
Research Health Scientist, Boston Veteran Administration Healthcare System
Laurel Radwin is a registered nurse with measurement experience and related methodologic expertise from using a variety of quantitative and qualitative methods. Laurel is recognized internationally for measures of nurses' contributions to patient outcomes, and is currently the lead investigator on three VA-funded initiatives that examine measurement of clinicians' and patients' perspectives on quality health care.

Jack Resneck, MD
Professor, Department of Dermatology School of Medicine, Professor, Philip R. Lee Institute for Health Policy Studies, University of California, San Francisco
Dr. Jack Resneck is Professor and Vice-Chair of Dermatology at UCSF, and holds a joint appointment at UCSF's Institute for Health Policy Studies. His leadership roles at UCSF have included oversight of the medical center's Medicare physician quality reporting. Dr. Resneck is active in health services research. He currently serves as a Trustee of the American Medical Association, and has advocated for physician engagement in data collection, as well as the development of meaningful, validated quality metrics with accurate attribution and risk-adjustment. Dr. Resneck received his B.A. in public policy from Brown University and completed his medical training at UCSF.

Michael Samuhel, PhD
Principal, Booz Allen Hamilton
Dr. Samuhel is a Principal with Booz Allen Hamilton and a highly experienced executive with nearly 30 years of experience leading large units conducting research projects both domestically and internationally. His technical expertise includes surveys, statistics, epidemiology, and health IT. He currently leads large contracts with CMS to independently evaluate the effectiveness of the CMS Quality Improvement Organizations and develop innovative methods to properly attribute the return on investment from funds spent on these programs. Dr. Samuhel also leads the social sciences program for Booz Allen Hamilton and he is responsible for the management and direction of multiple, large, or complex projects conducted by a staff of 75 professionals. He is active in several professional societies

and serves on the Board of Directors of the North Carolina Health Information and Communications Alliance (NCHICA). He holds a PhD in Statistics from American University.

Robert Schmitt, FACHE, FHFMA, MBA, CPA
CEO, Gibson Area Hospital & Health Services
With over 25 years in healthcare leadership, Robert Schmitt is the CEO of Gibson Area Hospital and Health Services. Rob is a Fellow of both the American College of Healthcare Executives and the Healthcare Financial Management Association. Rob received his Master in Business Administration from Webster University on their Fayetteville, Arkansas campus in 2001. Rob received his B.S. in Accounting from Eastern Illinois University in 1988. Rob is also a Certified Public Accountant. Rob has worked in small rural PPS hospitals, large PPS hospitals, and Critical Access Hospitals. In addition, Rob has extensive experience in Physician clinics, operations and management of physician groups, and physician recruitment.

Nathan Spell, MD
Associate Professor of Medicine, Medical Educator and Service Track and Vice Chair for Quality and Clinical Effectiveness, Emory University School of Medicine
Nathan Spell, MD, FACP is a graduate of Harvard Medical School and trained in internal medicine at the Brigham and Women's Hospital. Dr. Spell began as an internist in the US Air Force Medical Corps and transitioned to Emory University in 1998 as an associate professor of medicine. In 2006, he became Chief Quality Officer of Emory University Hospital, leading a variety of quality improvement activities, development and delivery of training programs, and intentional efforts to enhance the culture of safety and service. In 2014, he became the Vice Chair for Quality and Clinical Effectiveness in the Department of Medicine.

Srinivas Sridhara, PhD, MS
Managing Director, Clinician Analytics, Research & Development, The Advisory Board Company
Srinivas Sridhara has fifteen years of experience in measure development, health services research, and health policy analysis. He is the Managing Director for Clinician Analytics at The Advisory Board Company (ABC), where he leads development of provider performance measures and tools to profile and incentivize high value care. Prior to ABC, Dr. Sridhara worked at the Maryland Health Care Commission, where he managed Maryland's All Payer Claims Database and reported on health care costs, quality, utilization, and access; lead price transparency initiatives, program evaluations, and workforce studies; and managed the IRB and data release program. Dr. Sridhara previously worked at Johns Hopkins Bloomberg School of Public Health (JHSPH) and Baltimore Mental Health Systems and completed his graduate work at JHSPH.

Bharat Sutariya, MD, FACEP
Vice President & Chief Medical Officer Population Health, Cerner Corporation
Bharat Sutariya is responsible for leading population health innovation strategy and solution design for Cerner. In this capacity, he collaborates with leaders across the company and industry to enhance Cerner's industry leading Population Health Platform and solutions. Dr. Sutariya is a thought leader

across the healthcare industry on population health management and shared accountability between consumers, providers and payers. He leads internal Cerner and client collaboration teams to develop solutions by integrating near real-time analytics, risk and impact predictions. Prior to joining Cerner in 2004, Dr. Sutariya was leading healthcare information technology and clinical transformation across this integrated delivery network at Detroit Medical Center.

Lawrence Daniel Muldoon, MA (Federal Liaison)
Social Science Research Analyst, Center for Medicare and Medicaid Innovation
L. Daniel Muldoon has worked at the Center for Medicare and Medicaid Innovation (CMMI) since January 2014, primarily leading financial and analytic work for the Bundled Payments for Care Improvement Initiative and Oncology Care Model. Prior to joining CMMI, Mr. Muldoon was a staff economist at the Maryland Department of Budget and Management.

NQF Project Staff

Helen Burstin, MD, MPH
Chief Scientific Officer

Elisa Munthali, MPH
Vice President

Erin O'Rourke
Senior Director

Ashlie Wilbon, MS, MPH, FNP-C
Senior Director

Kim Ibarra, MS
Project Manager

Donna Herring, MPH
Project Manager

Taroon Amin, PhD, MPH
Consultant

Appendix B: Project Approach and Methods

General Approach and Timeline

NQF and the Multistakeholder Committee used the approach and processes shown in Figure 4 and described below to complete this project.

Figure 4. Four Step Process for the Attribution Project

Step 1 Convene Multistakeholder Committee & Commission Authors

Step 2 Conduct an Environmental Scan of Attribution Models and Approaches

Step 3 Develop Guiding Principles and Recommendations

Step 4 Obtain Public Comment and Finalize Recommendations, Principles and Checklist

Convene Multistakeholder Committee & Author Selection

NQF convened a 26-member Committee with diverse representation and knowledge from a variety of stakeholders, including consumers, purchasers, providers, clinicians, plans, suppliers, and healthcare quality experts. The Committee also includes a federal liaison member from the Center for Medicare and Medicaid Innovation to inform the Committee of federal attribution models. NQF convened the Multistakeholder Committee via a series of web meetings, in-person meetings, and conference calls throughout the project. Please see Appendix A for the full Committee roster.

Conduct an Environmental Scan & Draft Commissioned Paper

This paper was commissioned by the National Quality Forum to identify and evaluate current attribution models in health care. This paper served as a foundation to inform the deliberations of a multistakeholder committee that will provide input and recommendations related to the use of attribution models in health care.

The environmental scan was conducted to identify the attribution models that are currently in use, as well as those that have been proposed but not implemented. These include retrospective and prospective attribution, whole and partial attribution, attribution for acute and chronic episodes, and primary care based and specialty-agnostic models. We will then discuss the challenges related to attribution and consider the relative merits of alternative attribution models. In addition to assessing the technical issues related to attribution, we consider the implications for using alternative approaches in the context of various programs – such as Accountable Care Organization programs and value-based payment – and payment modalities (e.g. fee-for-services and capitation). We will conclude with an assessment of the fit between current attribution models and programmatic needs, and how models may be revised to better meet these needs.

Develop Committee Recommendations and Principles for Attribution Models

Following the commissioned paper, the attribution Multistakeholder Committee identified areas of needed improvement among existing attribution models and their implementation. At the Committee's June 2016 in-person meeting, the discussion focused on the need for principles for attribution models (for the early draft of the principles and checklist, see the first draft report). At the Committee's August in-person meeting, the Committee created the checklist and developed a list of recommendations for consideration of those who were developing and implementing attribution models.

Obtain Public Comment & Finalize Recommendations, Principles and Checklist

Throughout the project, the public, NQF members and the public submitted comments on the draft report and Committee discussion during web and in-person meetings. The Committee considered these comments in refining the principles, checklist and recommendations to advance attribution methodologies.

Appendix C: Overview of Comments Received on the Attribution Principles and Draft White Paper

Overview of Comments Received on the Draft Report

The National Quality Forum (NQF) was fortunate to receive 33 from six different stakeholder groups during the public comment period. The Committee discussed public comments at the September 9, 2016 web meeting, and will work to reflect these comments and questions in the final version of the checklist, principles, and recommendations.

Comments on the Draft Principles

General Comments

Overall, there was support for the concepts and ideas presented within the principles. Some were unclear about what this project would be specifically addressing and would appreciate clarification around the actual scope of the project. In particular commenters asked for clarity on whether the Committee is focused on attribution for payment programs or attribution for specific measures. A number of comments expressed concern for the locus of control for physicians, especially if the principles were to be used for attribution payment models. Inappropriate attribution models could result in the assignment of costs to physicians outside their locus of control. Commenters asked the Committee to expand its discussion about aligning attribution methodology with the goal of attribution. Commenters noted that attribution is most likely going to be defined differently depending on whether you are trying to figure out which physician was accountable for quality, which facility or physician contributed to particular elements of costs/spending and which ones contributed to savings, or to which ACO a patient should be attributed. Commenters raised a number of potential data concerns, such as the lack of proper data and the possible substitution of patient attestation as the best source of data. Commenters also stressed the importance of timeliness and the need to drive quality improvement

Language Changes & Specificity

Many comments suggested adding or removing words to clarify the points made, clearly convey the messages, and make the principles more specific. Some were concerned that the principles were too broad and should be more direct. The language in the principles was designed to be broad enough to encapsulate multiple scenarios, but simple enough to be understood. Commenters commended the simplicity but believed further clarification was needed.

General Comments on the Commissioned Paper

Comments on the commissioned paper mostly centered on the language used and the inconsistency of terms. There was also concern that the content was too high-level. The inconsistency of the term “provider” in the commissioned paper was raised by commenters. Medicare law defines hospitals and other facilities as “providers” and defines physicians as “suppliers,” which could lead to misunderstandings. The term “primary care provider” was not given a definition within the paper and commenters felt a definition was needed. The lack of granularity when discussing the strengths and weaknesses of the approaches to attribution was noted by a commenter. It was suggested adding

additional resources and supporting broad statements with specific evidence when discussing the models. Comments supported adding structure or proposed methods to address issues in attribution models noted throughout the paper. Comments suggested aligning the language used throughout NQF's Attribution project with Health Care Payment Learning & Action Network's (LAN) whitepaper on attribution entitled "Accelerating and Aligning Population-Based Payment Models: Patient Attribution White Paper" to ensure consistency of approaches.

Appendix D: Glossary

- **Accountable unit:** the entity whose performance is being measured, which could be a hospital, health plan, clinician, etc. Performance measurement can be applied to any setting and level of analysis.
- **Attribution**: The method used to determine which accountable unit is responsible for a patient's care and costs.[2]
- **Attribution model:** An attribution model is a set of rules to define the accountable unit for a patient's healthcare outcomes.
- **Assignment**: Used synonymously with "attribution"[1]
- **Aggregation**: The combination of units at a lower level (e.g. individual provider) to a higher level (e.g. provider organization). Attribution is a necessary condition for aggregation [1]
- **Allocation**: The division of a performance indicator across different health care providers. For instance, 60% of health care spending may be allocated to Provider A and 40% is allocated to Provider B.[1]
- **Health care resource use**: Measures of health care utilization. Distinguished from measures of spending through the use of standardized prices.[1]
- **Health care spending**: Measures total health care spending, including total resource use and unit price(s), by payer or consumer, for a health care service or group of health care services associated with a specified patient population, time period, and unit(s) of clinical accountability.[1]
- **Outcome:** The result of providing health care. The term, outcome, will be used to broadly include the following types of outcomes relevant to performance measurement: quality outcomes of health outcome (e.g., mortality), intermediate clinical outcome (e.g., BP < 140/90), patient-reported outcome (e.g., depression), and economic outcomes of cost and resource use.
- **Population-Based Payment Model:** A payment model in which a provider organization is given a population-based global budget or payment and accepts accountability for managing the total cost of care, quality, and outcomes for a defined patient population across the full continuum of care.[2]
- **Quality of care**: This report considers quality broadly, based on a modified version of Institute of Medicine's aims for health care: safety, timeliness, effectiveness, equity, and patient-centeredness.[1]
- **Total Cost of Care (TCOC)**: A broad indicator of spending for a given population (i.e., payments from payer to provider organizations). In the context of PBP models, in which provider accountability spans the full continuum of care, TCOC includes all spending associated with caring for a defined population, including provider and facility fees, inpatient and ambulatory care, pharmacy, behavioral health, laboratory, imaging, and other ancillary services.[2]

1 Ryan et al., 2016 Attribution Commissioned Paper Definitions

2 Health Care Payment Learning & Action Network. (2016). *Accelerating and Aligning Population-Based Payment Models: Patient Attribution.* HCPLAN; Available at https://hcp-lan.org/groups/pbp/pa-final-whitepaper/

Appendix E: Attribution Commissioned Paper

Attribution Methods and Implications for Measuring Performance in Healthcare

Andrew Ryan, Ariel Linden, Kristin Maurer, Rachel Werner, Brahmajee Nallamothu

COMMISSIONED PAPER

SEPTEMBER 24, 2016

Purpose of the commissioned paper

This paper was commissioned by the National Quality Forum to identify and evaluate current attribution models in health care. This paper served as a foundation to inform the deliberations of a multi-stakeholder committee that will provide input and recommendations related to the use of attribution models in health care.

Attribution models are pre-specified rules that determine the specific patients, types of health care services, and the duration of care for which providers and organizations are responsible. Attribution of patients to providers is necessary to link indicators of patient-level health care quality and spending to specific providers for the purpose of profiling and accountability.

We conducted an environmental scan to identify the attribution models that are currently in use, as well as those that have been proposed but not implemented. These include retrospective and prospective attribution, whole and partial attribution, attribution for acute and chronic episodes, and primary care based and specialty-agnostic models. We will then discuss the challenges related to attribution and consider the relative merits of alternative attribution models. In addition to assessing the technical issues related to attribution, we consider the implications for using alternative approaches in the context of various programs – such as Accountable Care Organization programs and value-based payment – and payment modalities (e.g. fee-for-services and capitation). We will conclude with an assessment of the fit between current attribution models and programmatic needs, and how models may be revised to better meet these needs.

Definitions

- **Attribution**: pre-specified rules that determine the specific patients, types of health care services, and duration of care for which providers and organizations are responsible
- **Assignment**: used synonymously with "attribution"
- **Aggregation**: the combination of units at a lower level (e.g. individual provider) to a higher level (e.g. provider organization). Attribution is a necessary condition for aggregation.
- **Allocation**: The division of a performance indicator across different health care providers. For instance, 60% of health care spending may be allocated to Provider A and 40% is allocated to Provider B.
- **Quality of care:** In this paper, we will consider quality broadly, based on a modified version of Institute of Medicine's aims for health care: safety, timeliness, effectiveness, equity, and patient-centeredness.
- **Health care resource use**: Measures of health care utilization. Distinguished from measures of spending through the use of standardized prices.
- **Health care spending**: Measures total health care spending, including total resource use and unit price(s), by payer or consumer, for a health care service or group of health care services associated with a specified patient population, time period, and unit(s) of clinical accountability.
- **Providers**: denotes clinicians and health care organizations without respect to degree or sector (e.g. registered nurses, licensed practical nurse, primary care physician, specialist physician,

hospitals, post-acute care facilities, etc.). Although different attribution rules may prioritize different types of clinicians, the individual clinicians who are eligible to have attributed patients are typically those who have a National Provider Identifier (NPI).

- **Primary care providers:** We define primary care providers using the guidance from CMS (2011): 1) A physician who has a primary specialty designation of family medicine, internal medicine, geriatric medicine, or pediatric medicine for whom primary care services accounted for the majority of services; or 2) A nurse practitioner, clinical nurse specialist, or physician assistant for whom primary care services accounted for the majority of services.

Section 1. Introduction

The current health policy environment has made attribution – the methods used to assign patients to providers for the purpose of accountability – critical. Patients often receive care from numerous providers. Providers have historically lacked accountability for managing patients across the continuum of care. The resulting system-failures from poorly coordinated care are perceived to be responsible for many of the spending and quality problems in the United States.

New system reforms are trying to change this. Accountability programs require a set of rules to define which patients or episodes will "count" for which providers. Some of the most notable are the Accountable Care Organization (ACO) programs that have been initiated by the Centers for Medicare and Medicaid Services. These programs make groups of provider organizations that voluntarily choose to be part of the ACO responsible for the total spending and quality performance of traditional Medicare beneficiaries.

ACO payment models require a method to attribute patients to a particular ACO for the purpose of accountability. A common model attributes patients exclusively to the ACO that provides the plurality of primary care services from primary care physicians. Another possible model would attribute patients to the ACO that provides the plurality of any services by any provider. The first approach will only attribute patients to an ACO that includes primary care primary care providers. With more primary care providers, more patients would be attributed. The second approach could attribute patients to ACOs without primary care providers. The profound implications of these two models highlight the importance of attribution methods.

Attribution models matter beyond the ACO programs. Other accountability programs, such as the Physician Value-Based Payment Modifier and the soon-to-be-implemented Merit Based Incentive Payment System (MIPS) require attribution for the purpose of profiling physicians and group practices. Attribution is also critical in determining the hospitals and providers clinicians that will be accountable for care in the new episode payment programs. Attribution is most relevant in circumstances in which accountability has not been clearly defined (e.g. ambulatory care in fee-for-service medicine).

Attribution can range from being relatively straightforward (e.g. for hospital inpatient episodes), to moderately challenging, (e.g. 30/60/90 post-discharge episodes), to highly challenging and controversial (e.g. chronic disease management). Crucially, the implications of alternative attribution methods have not been rigorously evaluated and the field has not coalesced around best practices for attribution.

Instead, logical approaches have been developed based on previous methods. For instance, the approaches to attribution in the Medicare ACO programs were similar to those in the Physician Group Practice Demonstration.

To identify best practices for attribution, we must catalogue current approaches, identify criteria to assess their merits, and evaluate extant approaches with respect to appropriate clinical and programmatic contexts.

Section 2. Contextual factors and terms of attribution

Attribution can occur for different types of patients treated under different clinical circumstances by different types of providers. The resulting attribution can be for individual providers, provider organizations, or groups of larger providers. Attribution can cover a narrow or broad set of services. The duration under which an attributed provider is accountable for a given patient can also vary. Our conceptual model (Figure 1) contends that appropriate attribution should be determined based on the type of patient, the clinical circumstances, and the provider(s) delivering care. These combinations of factors will lead to a patient being attributed to a certain provider (or providers), for a specific duration.

Different types of patients may merit different attribution strategies. While a default rule could attribute patients to primary care physicians, patients with specific chronic diseases (e.g. end-stage renal disease) should perhaps be attributed to certain specialists (e.g. end-stage renal disease) should perhaps be attributed to certain specialists (e.g. nephrologists). Alternatively, attribution rules could make older patients more likely to be attributed to geriatricians or other specialists. The level of attribution (e.g. individual provider, provider organization, ACO) may affect the reliability and validity of performance measurement, as well as the incentives for accountability. Attribution rules may also seek to accommodate treatment patterns for patients in rural and urban areas. For instance, if a patient in a rural area receives extensive care at a tertiary care facility that is a substantial distance from the patient's residence, should an attribution algorithm preferentially attribute the patient to a local physician or practice?

The clinical circumstances surrounding the attribution of patients to providers may also be relevant. For instance, for attribution of acute events (e.g. 90-day episode following hip or knee replacement), the standard practice is to attribute patients to a hospital based on an "index hospitalization." The index hospitalization is defined by the first hospitalization that initiates an episode: another hospitalization occurring within 30-days of the index hospitalization typically does not initiate a new episode. Thus, temporal precedence matters. However, for chronic care, attribution models, temporality has not typically mattered. Instead, patients are typically attributed to the physician providing the highest frequency or intensity of care for that chronic condition.

The providers whose care contributes to attribution is also relevant. On one hand, only primary care providers could contribute to attribution decisions. Alternatively, any provider could contribute to an attribution decision. In between, non-primary care providers could contribute to attribution only when a patient was not cared for by a primary care provider. The latter example provides a framework for

customized attribution rules. These rules could hold that, optimally, certain patients should be attributed to certain providers under certain circumstances. If these conditions are not met, then attribution could default to a generic algorithm (e.g. plurality of primary care services).

After attribution occurs, the terms of accountability care vary across a number of dimensions. These include the type of services for which a provider is accountable (e.g. only care related to diagnostically defined episode, all care occurring within episode); duration of episode (e.g. 30 days, 90 days, one year, multiple years).

One final issue relevant to attribution concerns the data elements that are required. Medical claims are the most commonly used data source for attribution. Electronic health record data are an alternative, but imperfect given the priority of including data from providers from different organizations in attribution and the lack of interoperability of many EHRs. Patient/provider/payer designation or attestation could also be used for attribution, but would likely be most relevant for prospective attribution approaches.

Section 3. Environmental scan of attribution approaches

We performed an environmental scan to identify the attribution methods that have been proposed or are currently in use for accountability applications in health care. Initially, we pursued a search strategy using a variety of key words and MESH headings such as (attribut*[Title/Abstract] OR assign*[Title/Abstract]) AND(("Insurance, Health, Reimbursement"[Majr]) OR ("Accountable Care Organizations"[Majr]) OR ("Cost Control"[Majr]). However, this strategy was too sensitive and not sufficiently specific: it identified large numbers of irrelevant articles while failing to generate results that spanned all situations in which attribution is applicable. For instance, the strategy query detailed above produced 658 hits; yet it would have been unlikely to pick up articles describing the attribution of episode of care to providers. Queries resulting in more comprehensive searches, however, yielded over 2000 results. To address this issue, we employed a “snowball” search strategy in which we identified 15 highly relevant sources that described attribution and/or present different attribution models for a variety of purposes including accountable care organizations, physician profiling, and pay-for-performance programs (Figure 2). We used Google Scholar to identify publications that have cited these papers and then reviewed the hits for sources that outline one or more attribution models. We also searched the bibliographies of the initial 15 sources to identify additional relevant publications (Figure 3). No exclusions were made in either component of the search process based on the date of publication, location of study, or type of resource. As a result, our search generated a variety of materials including original research articles, editorials, and reports. To supplement our main search strategy, we used PubMed and Embase to identify additional examples of attribution models. The exact search terms and the results are outlined in Figure 4. This search uncovered 8 additional attribution models.

Overall, our environmental scan identified 84 sources describing 171 unique attribution models that have been proposed or are currently being used in accountability programs (Table 4 and Table 5). Attribution models were categorized by the following characteristics: 1. Clinical circumstances; 2. Type

of provider attributed; 3. Payer/programmatic circumstances; 4. Timing of attribution (retrospective vs. prospective); 5. Exclusivity of attribution (single vs. multiple provider); 6. Period of time of which providers are accountable for attributed patients; 7. Minimum requirement to make an attribution (such as a plurality or a majority); and 8. Measure used in attribution process (such as spending or visits) (Table 1). Due to the absence of information in the descriptions of some attribution models, several assumptions were made during the process of identifying model characteristics. For instance, it was assumed that approaches using claims data were retrospective unless explicitly stated otherwise. Another common assumption made in the absence of information regarding exclusivity of attribution was that approaches with either a plurality or a majority rule would attribute patients to a single provider. For models tied to previously or currently implemented accountability programs, we cross-referenced outside sources in cases in which the descriptions found during the literature review were highly ambiguous. Even after taking these steps, some models were difficult to characterize because they involved multiple steps and/or varying approaches for different patients.

Table 1 shows the characteristics of attribution approaches that were identified in the environmental scan (n=171). Of these approaches, 82.5% have been proposed but not implemented in a formal program and 17.5% have been implemented. Attribution to "any physician" was the most common type or provider attributed (48.5%), followed by attribution to primary care providers (PCPs) (15.8%). Most approaches employed retrospective attribution (88.9%) rather than prospective attribution (6.4%). Attribution approaches tended to focus on all care (45.6%) or care for particular episodes (39.2%). Most of the attribution models were studied among Medicare (43.3%) or commercially insured patients (32.7%). Attribution approaches tended to require attribution to only one provider (77.8%) rather than to multiple providers (19.3%). Visits (42.7%) and spending (30.4%) were the most common measures used to attribute patients to providers. However, the use of other approaches was also common (24.6%) and included approaches such as attributing patients based on their provider enrollment status. There was considerable variation with respect to the minimum criteria required for attribution: a plurality was the most common criteria (29.8%). Specific thresholds were enforced in 28.1% of approaches. Several (19.3%) models used other approaches. For examples, for some attribution models that spanned all programmatic circumstances, criteria varied depending on whether beneficiaries were enrolled with a physician as part of their health plan. The period of time for which the provider was responsible for attributed patients varied considerably across the models and in many cases the time period was not specified in model descriptions (39.2%). When duration was specified, the most common approach was to attribute patients for one year (29.2%). Other approaches such as the attribution of patients for the duration of an episode were also common (24.6%).

Table 2 shows the same set of characteristics of attribution approaches that were identified in the environmental scan among the implemented models (n=30). Compared to the characteristics of both the implemented and proposed models shown in Table 1, a greater share of the implemented models: were for ACOs (43.3% of implemented versus 10.5% of all); used prospective attribution (23.3% of implemented versus 6.4% of all); applied to all health care services (66.7% of implemented versus 45.6% of all); and were payer agnostic (30.0% of implemented versus 17.0% of all). The characteristics of implemented and all attribution models were similar with respect to exclusivity of attribution, the

measures used for attribution, the minimum requirement for attribution, and the period of time over which attributed providers were responsible for attributed patients.

Table 3 shows the bivariate relationship between the type of attributed provider (ACO; any physician/physician group; and PCPs) and the characteristics of attribution approaches (n=149). It shows that attribution models that were applied to ACOs were more likely to use prospective attribution (38.9%), were some somewhat more likely to make attribution on the basis of the plurality of care (44.4%), and more likely to require accountability for one year (44.4%).

Section 4: Discussion

Challenges Related to Attribution

Many of the challenges surrounding attribution are related to the high dispersion of health care in the United States. Medicare patients see a median of two PCPs and five specialists that are associated with for four different provider organizations in one year (Pham et al. 2007). The attribution of a patient to a provider implies that the provider is responsible for the care and/or influences the health outcomes of that patient. Providers are not inherently equal in their roles in patient care even when they have similar levels of contact with patients. Because of this, it is often uncertain how to determine which patients should be attributed and which should be excluded. The issue of care dispersion creates additional challenges when selecting an appropriate method to attribute patients to providers.

Attribution approaches should be simultaneously reliable and valid. When large numbers of patients are attributed to providers, performance measures are more reliable, increasing the ability to distinguish performance across providers. However, because care is highly dispersive, choosing attribution approaches based on their ability to result in a large n for each provider risks including patients that only receive a small portion of care from a provider. This in turn can compromise the validity of the attribution process. Attribution methods must strike a balance of attributing enough patients and attributing patients for which providers are responsible. Concerns that it was invalid to attribute episode spending for heart failure to hospitals – when the disease is not primarily managed in the inpatient setting –was one of reasons why a heart failure spending measure (NQF #2436: Hospital-level, Risk-standardized Payment associated with a 30-day Episode-of-care for Heart Failure (HF)) initially failed to receive NQF endorsement (NQF 2015).

Attribution approaches should also be fair and equitable to both patients and providers. Attribution approaches that are closely aligned with how providers feel they are responsible for patients are more likely to be perceived as fair. In a system of highly coordinated care, attribution can more easily be designed to reflect the ways in which care is already being provided and therefore may be more favorable to providers. However, when patients receive care from multiple physicians and provider organizations, an attribution approach can instead be used as a tool to incentivize desirable system outcomes such as greater care coordination. In this case, some unfairness in the approach is expected simply because providers will not have full control over patient outcomes. What is initially unfair can be transformed into an approach that is fair once providers implement systematic changes in the delivery

of care. Yet, when attribution is used in this way, there is a tremendous challenge in devising an approach that pushes providers to make changes without being perceived as entirely out of reach. The different aspects of attribution models attempt to mitigate the challenges of linking patients to providers while being fair, reliable, and valid.

Strengths and Weaknesses of Different Attribution Approaches

Attribution approaches may involve linking patients to individual physicians or groups such as ACOs or hospitals. One of the advantages of assigning patients to larger units is that more patients can be attributed and thus estimates of provider performance can be more reliable (Fisher et al. 2006). Yet, because care can be dispersed across different groups of providers, this approach does not completely eliminate the challenge of accurately representing providers' patient populations.

Approaches that assign patients to physicians may further specify the type of physician that to which patients can be attributed. Although for some clinical circumstances the choice of physician can be based on the type of service provided, attribution is more complicated for accountability programs assessing the delivery of primary care. Primary care is not always delivered by physicians that are typically defined as PCPs such as internists, generalists, and family medicine practitioners. As a result, some approaches will attribute patients to specialists, but the merits of this strategy as well as whether patients should be attributed to individuals or groups largely depend on the purposes of an accountability program. While empirical evidence does not currently support the relative merits of attribution approaches, rigorous justification of the elements of attribution models would likely enhance attribution choices.

Retrospective attribution has the advantage of making assignments based on how care is actually delivered, but has the disadvantage that providers do not who counts as their patients until after they have already provided care. Prospective attribution approaches remove uncertainty on the part of the provider. On one hand, from the perspective of providers, this may be fairer, but it also introduces the possibility of gaming or providing differential levels of care to patients based on attribution status. In the models using prospective attribution, even if patients are informed of their physician assignments, they are not precluded from seeking care outside of their designation. As a result, prospective attribution may lead to inaccurate representations of the care that providers actually provide. Although the vast majority of attribution models uncovered in our environmental scan utilize retrospective attribution, the debate over the virtues of the two methods does not appear to be resolved. The Medicare Shared Saving Program was originally designed to involve retrospective attribution, but has since implemented different programs tracks, some of which incorporate prospective attribution (Baseman et al. 2016). The provision of lists of patients that will likely be attributed to providers at the beginning of the measurement period is one approach that attempts to mitigate the uncertainty involved in retrospective attribution.

Most attribution models identified through the environmental scan involve all clinical circumstances (including primary care) or episodes of care rather than the attribution of acute or chronic care. Using episodes of care in the attribution process is advantageous in that care within an episode may be more

highly concentrated among an individual physician or provider group (Damberg et al. 2009). In addition, there may be more clarity about the roles of different providers within an episode, making attribution more straightforward. Despite these benefits, episodes of care are limited in their applications and may not be appropriate for all circumstances such as primary care or chronic conditions in which episodes are hard to define. Attribution to primary care providers may be more appropriate for clinical circumstances that occur over long durations favor attribution to primary care providers, whereas specialist attribution may be preferred for episodes of shorter duration. Nonetheless, attribution to some specialists – such as oncologists and cardiologists – to manage disease over longer periods is clearly warranted.

Attribution models vary in their exclusivity: whether patients are attributed to one provider or multiple providers. Given the highly dispersive nature of care, the attribution of a patient to a single provider may not be equitable because it may fail to attribute patients to providers that have significant involvement in their care. Attribution to multiple providers acknowledges that many patients receive care from more than one provider and may more accurately reflect providers' actual patient pools. This approach can potentially foster greater levels of accountability for all patients rather than only patients with whom providers have established relationships. Nonetheless, the allowance of attribution to multiple providers was significantly less common among models uncovered in the environmental scan.

Incorporating requirements when making attributions attempts to ensure that patients are only attributed to providers that are responsible for their care. Higher thresholds such as majority or plurality rules are in some ways more favorable to providers because they restrict the attribution of patients with whom they have had limited contact. However, these rules may result in the attribution of fewer patients while excluding some that providers would consider as patients. As a result, requirements that are too strict may compromise the reliability of an approach. Overall, the appropriate requirement depends on what is being measured in an accountability program. For example, a PCP treating a diabetic patient should follow certain clinical guidelines regardless of how many times he/she has seen a patient; however, attributing outcomes to a PCP who has seen a patient once may be unfair. In general, incorporating a majority rule may be appropriate for programs in which outcomes are assessed, but a one-touch rule may be more appropriate for an accountability program relying more on care that can be managed over a shorter interval. In some circumstances, it may also be fair to make providers responsible for care that occurs outside of their direct influence.

In conjunction with minimum requirements, many attribution approaches incorporate a specific measure to define greater involvement in patient care. The environmental scan revealed that visits and spending are the two most common measures used in this way. Although both are proxies for assessing the level of responsibility and influence of a provider on a patient, neither is necessarily proportional in terms of their impact on patient care. Visits, for example, can have different values for patients depending on the purpose and the services provided. In addition, spending disproportionately favors the attribution of patients to specialists even though they may have had limited involvement in the clinical decisions that led to spending (Leapfrog 2004). In an attempt to mitigate this challenge, a few models uncovered in the scan incorporated the attribution of Medicare patients using relative value units

(RVUs) (Lake 2007; Weiner 1995). Although RVUs differentiate services according to their resource intensity, this approach may be less straightforward and would be unlikely to fully address the disadvantages of using visits or spending.

Finally, attribution approaches also vary in terms of the length that patients are assigned to providers. Because more care is provided as time goes on, longer time periods increase the ability to identify patterns of care and link patients to providers that have more involvement in their care. Longer patient-provider relationships may indicate greater levels of responsibility and setting attribution lengths in this way may also encourage this form of care. Increasing the time period can also increase the number of patients that are assigned to providers, and thus increase the likelihood that attributed patients reflect their patient pool (AcademyHealth). However, because patients may not consistently see the same providers over longer periods of time, periods that are too long also introduce the risk of attributing patients that have only received low levels of care. Pham et al found that only 67% of patients were attributed to the same provider in the subsequent year.

Lessons from Attribution in Education

Much like health care, efforts to increase the quality of education in the United States have relied on accountability programs such as merit pay incentives and school performance rating programs. Although linking students to teachers or schools may seem fairly straightforward given the inherent enrollment process involved in education, attribution in education suffers from many of the same challenges as health care. For one, many students have more than one teacher for a single subject in a given year. Students may switch schools both within and between years. In addition, because academic gains are made over time and the effect of an individual teacher may not be immediate, attributing scores to a teacher who taught a student for one month might be unreasonable. Yet, there is no clear amount of instruction time a student must receive with a teacher to make an attribution fair. Further complicating attribution, a student's performance is influenced both by his/her previous teachers and current teachers of other subjects. As a result, a fifth grader's math scores could not only be attributed to the student's fifth grade math teacher but also other teachers like his/her fourth grade math and fifth grade English teachers. Different accountability programs have used various approaches in an attempt to address these challenges.

Pennsylvania Value Added Assessment System

The Pennsylvania System of School Assessment is a program that rates teachers and schools according to their impact on students' academic progress. As part of this program, teachers verify preliminary student rosters to ensure that all students are accurately attributed to teachers. Each individual student is then weighted according to the percent of instructional responsibility. This value takes into consideration the percent of days a student is enrolled in a teacher's class and the percent of content within a course that the teacher is responsible for (PVAAS 2014).

Denver Public Schools' Exceeds Expectations Program

The Exceeds Expectations Program is a system that awards bonuses to teachers on the basis of student growth percentiles. Students are attributed to teachers if they are enrolled for at 85% of a course and in attendance at least 85% of the time. This approach was implemented in an effort to exclude students who have not had sufficient amounts of instructional time with teachers (CDE).

Tennessee Teacher Evaluation System

The Tennessee Teacher Evaluation System is an accountability program uses a value-added approach to assess the impact of teachers on students' achievements. Students who are enrolled with a teacher for 150 days per year have 100% of their performance attributed to that teacher. Students who are enrolled for 75-149 days have 50% of their performance attributed to that teacher. Students enrolled for less than 75 days are not attributed to a teacher (Steele et al. 2010).

The strategy of using thresholds in both the Denver and Tennessee approaches mirrors that in health care. However, none of the models uncovered in the environmental scan use the partial or weighted attribution of patients to providers. Although determining how to weight patients would be challenging in practice, this strategy does have potential applications in health care. Incorporating the idea that some patients continuously receive the majority of their care from a single physician and thus should be weighed more heavily than those who visit a provider once may help address some concerns surrounding current attribution approaches.

Section 5: Improving Attribution in Healthcare

The importance of attribution will only continue to grow: the Medicare Access and CHIP Reauthorization Act of 2015 (MACRA) legislation created unprecedented accountability for clinicians in Medicare. Under both the Merit-Based Incentive Payment System (MIPS) and Alternative Payment Model (APM) tracks, the terms under which patients are attributed to clinicians, provider organizations, and larger constellations of aligned provider groups will be central to the effort of providing effective and equitable incentives for quality and efficiency. Under these circumstances, numerous efforts have formed to understand the implications of attribution (Health Care Payment Learning Action Network 2016).

Our review suggests that there is a no single attribution approach that best meets the needs of all accountability programs. Factors such as the interests of the stakeholders, aims of the accountability program, and clinical circumstances influence the appropriateness of an attribution approach. The models identified through the environmental scan portray both the variety as well as the similarities in ways that approaches have been devised to address the uncertainty and instability in attribution. Although any attribution approach will inherently involve making tradeoffs, certain steps should be taken to improve current attribution models:

Data

Current attribution methods could benefit from better data surrounding the relationship between patients and providers. This will increase the ability of attribution methods to reflect the ways in which

care is delivered as well as the ability to select measures that are useful in the attribution process. Due to the limits in information, many models use proxies to make links between physicians and providers. For example, it is common among attribution approaches use tax identifiers to differentiate between physicians or providers. Yet, physicians frequently bill under multiple tax identifiers and/or bill under tax identifiers that are at a group level, precluding the attribution of patients to individual providers (Damberg et al. 2009). Understanding the flaws of current methods as well as looking for appropriate alternatives can help strengthen attribution approaches.

Standardization

Even though the consistency of attribution approaches across all accountability programs is impractical, certain elements could be standardized. For example, several attribution models are designed around evaluation and management visits; however, there is no consistent way in which evaluation and management services are used to determine attribution (Damberg et al. 2009). Ensuring some standardization may increase clarity among providers and may also increase the ability to evaluate the effect of differences in attribution approaches as they are applied.

Patient and Provider Engagement

Attribution approaches could be improved by increasing the engagement of patients and providers. This includes not only incorporating their perspectives in the selection of a method, but also informing them of the details involved in the chosen method. The perspective on which approach is the best varies based on the interests of the stakeholders involved (Mehrotra et al. 2010). By engaging with patients and providers, accountability programs may be better positioned to balance competing interests and increase the responsiveness to programs.

Together, our analysis suggests the need to develop clear principles defining the use of attribution models in health care. These principles can be used to provide guidance to both measure developers and program planners regarding key considerations and trade-offs when specifying attribution approaches for accountability programs.

References

AcademyHealth. https://www.academyhealth.org/files/publications/EfficiencyReport.pdf

Baseman S, Boccuti C, Moon M, Griffin S, Dutta T. Payment and Delivery System Reform in Medicare. Henry J. Kaiser Family Foundation. 2016. Retrieved from http://kff.org/medicare/ report/payment-and-delivery-system-reform-in-medicare-a-primer-on-medical-homes-accountable-care-organizations-and-bundled-payments.

Center for Medicare and Medicaid Services. 2011. CMS Manual System: Pub 100-04 Medicare Claims Processing. Available at: https://www.cms.gov/Regulations-and-Guidance/Guidance/Transmittals/downloads/R2161CP.pdf.

Damberg C, Sorbero M. Hussey P, Lovejoy S, Liu H, Mehrotra A. 2009. http://aspe.hhs.gov/health/reports/09/mcperform/report.pdf. Accessed May 13, 2016.

Fisher, E. S., D. O. Staiger, et al. (2006). “Creating Accountable Care Organizations: The Extended Hospital Medical Staff.” Health Affairs (Millwood) 26(1):w44–57.

Health Care Payment Learning Action Network. 2016. Accelerating and Aligning Population-Based Payment Models: Patient attribution. Available at: https://hcp-lan.org/workproducts/pa-whitepaper-final.pdf

Lake T, Colby M, Peterson S: Health Plans' Use of Physician Resource Use and Quality Measures. 2007, Washington, DC: MedPAC

Leapfrog Group, Bridges to Excellence. Measuring Provider Efficiency, Version 1.0. 2004

National Quality Forum. 2015. Endorsing Cost and Resource Measures: Phase 2. Available at: http://www.qualityforum.org/Projects/c-d/Cost_and_Resource_Project/Final_Report.aspx

Pham HH, Schrag D, O’Malley AS, Wu B, Bach PB. Care patterns in Medicare and their implications for pay for performance. N Engl J Med. 2007;356(11):1130-1139.

PVAAS. https://www.psea.org/uploadedFiles/Publications/Professional_Publications/Advisories/Advisory-PVAASAttribution-April2014.pdf

CDE. https://www.cde.state.co.us/educatoreffectiveness/usingstudentgrowthpercentilesforee

RAND http://www.rand.org/content/dam/rand/pubs/technical_reports/2010/RAND_TR917.pdf

Steele, J, Hamilton, L & Stecher, B (2010). Incorporating performance measures into teacher evaluation systems. RAND Corporation. Available at: http://www.rand.org/content/dam/rand/pubs/technical_reports/2010/RAND_TR917.pdf

Mehrotra A, Adams JL, Thomas JW, McGlynn EA. The effect of different attribution rules on individual physician cost profiles. Ann Intern Med. 2010;152(10):649–54.

Weiner JP, Parente ST, Garnick DW, Fowles J, Lawthers AG, Palmer RH. 1995. Variation in office-based quality: a claims-based profile provided to medicare patients with diabetes. JAMA. 273(19): 1503-8.

Figure 1. Conceptual Model of Attribution

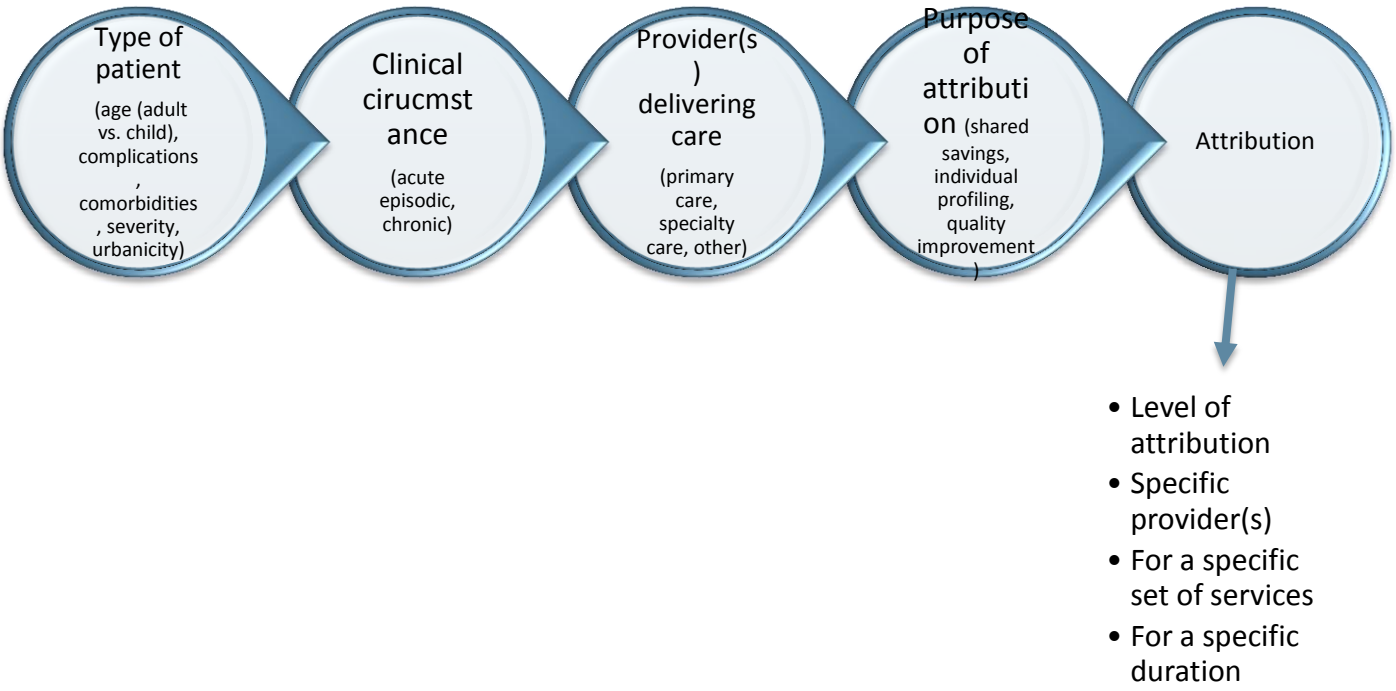


Figure 2. Schematic of Search Strategy 1: Search Reference Lists of relevant articles

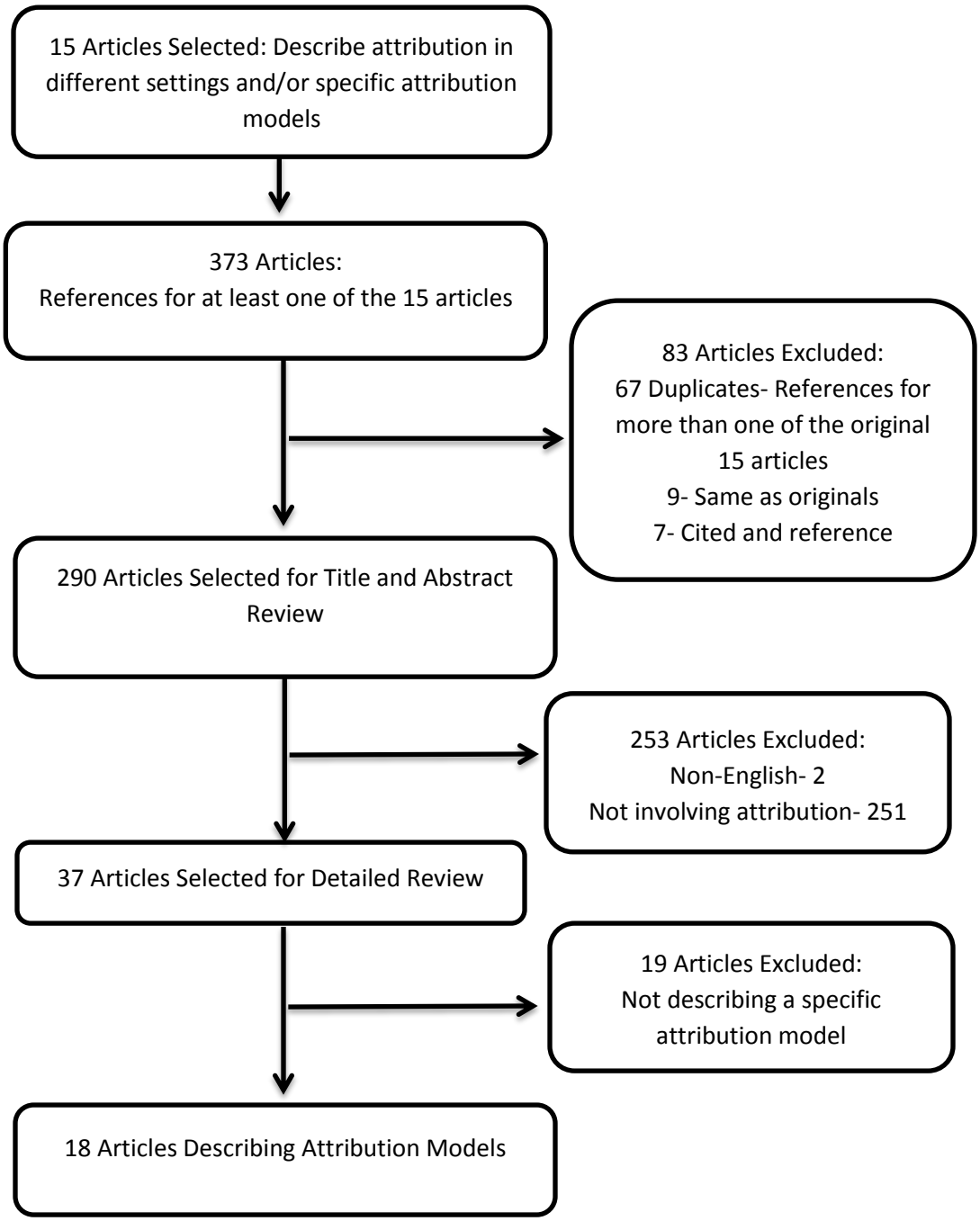


Figure 3. Schematic of Search Strategy 2: Search articles that cited relevant articles

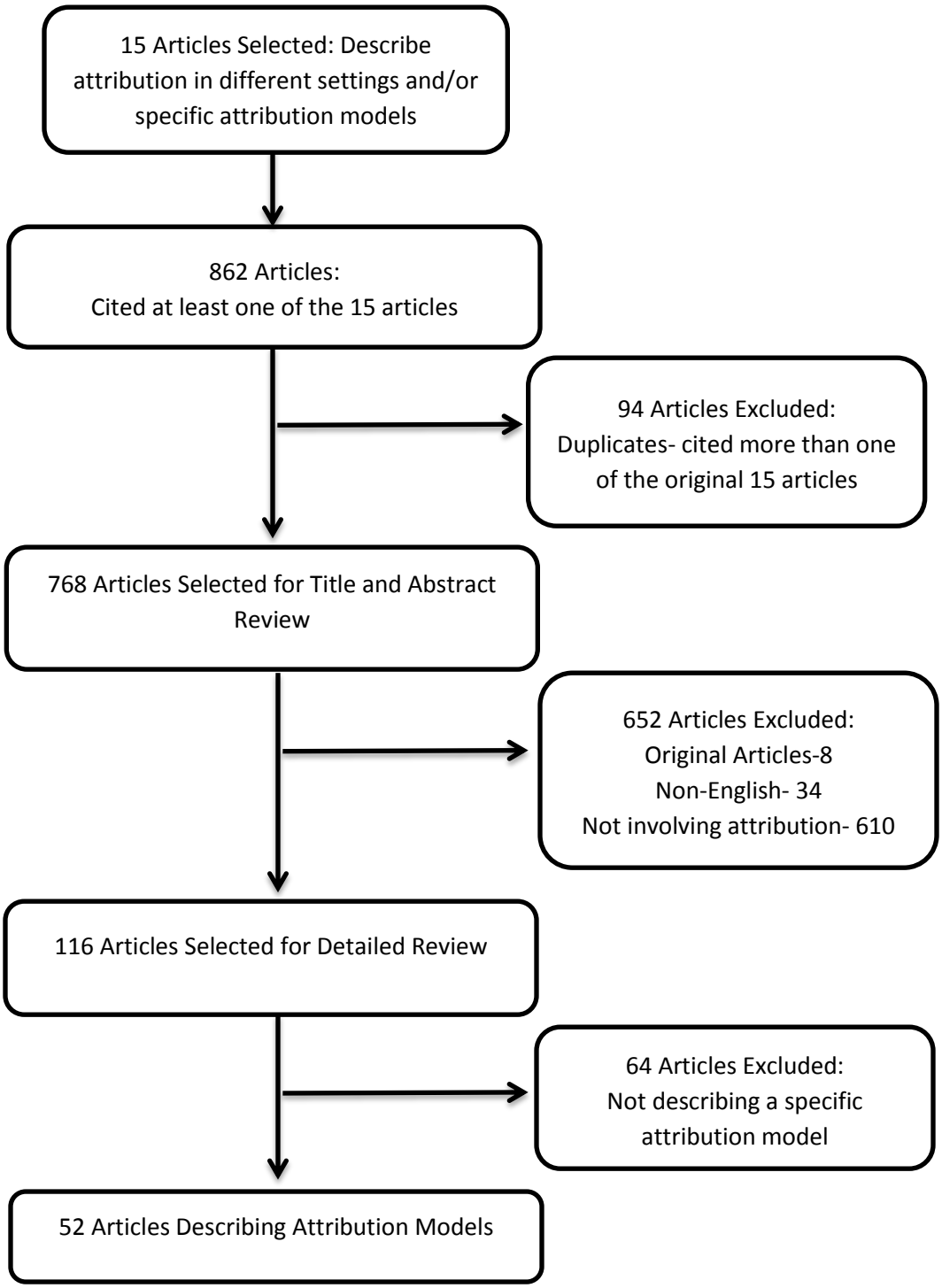


Figure 4: Schematic of supplemental search strategy: Search PubMed and Embase.

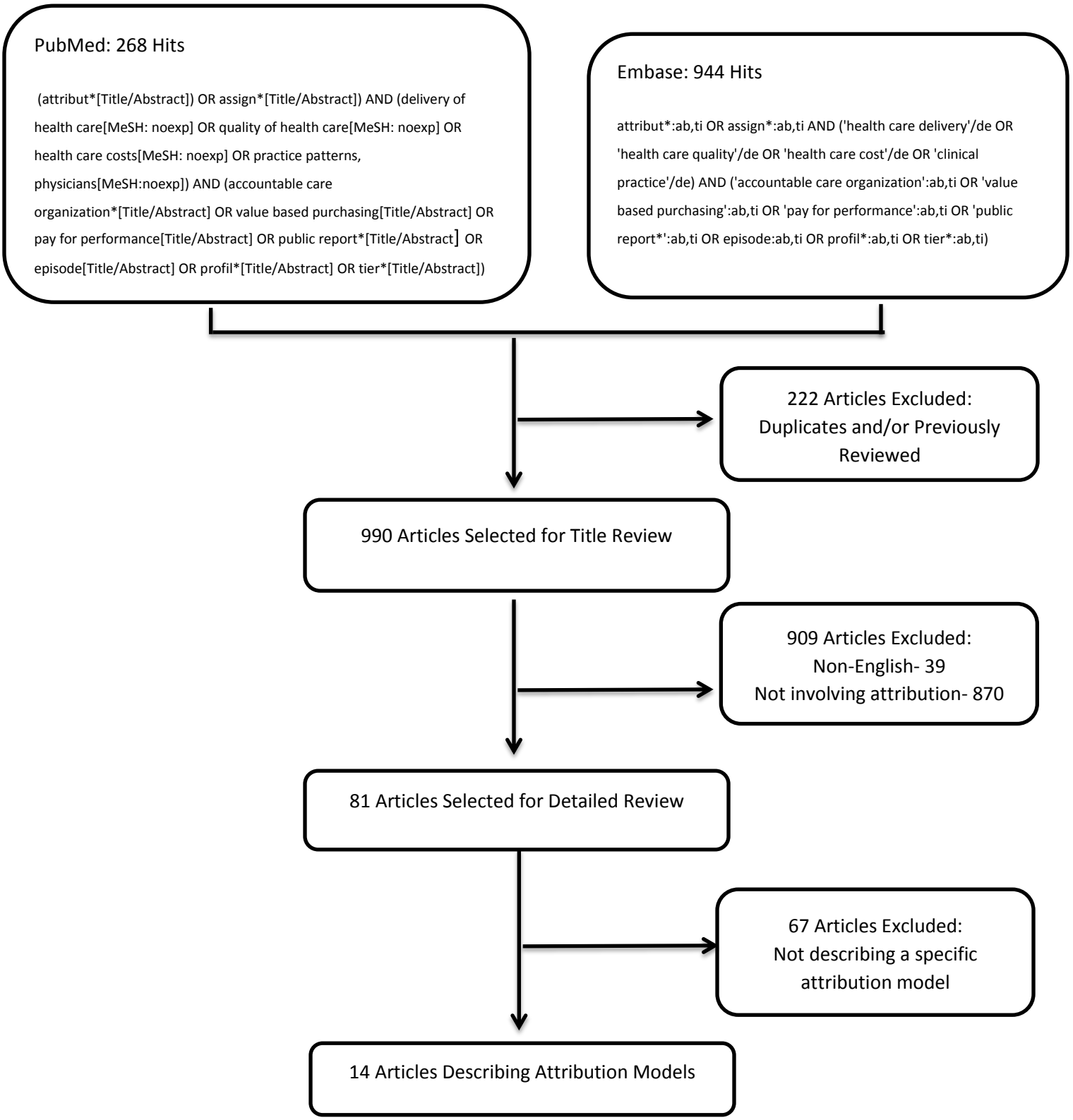


Table 1. Characteristics of approaches to attribution described in environmental scan (n=171)

Characteristic	Elements	N	Percentage
Program stage	Implemented	30	17.5%
	Proposed	141	82.5%
Type of provider attributed	ACO	18	10.5%
	Any physician	83	48.5%
	Hospital (Facility, clinic)	13	7.6%
	Other	5	2.9%
	PCP	27	15.8%
	PCP preferred	6	3.5%
	Physician group	15	8.8%
	Specialist	3	1.8%
	Unknown	1	0.6%
Timing of attribution	Other	8	4.7%
	Prospective	11	6.4%
	Retrospective	152	88.9%
Clinical Circumstances	All care	78	45.6%
	Chronic	20	11.7%
	Episodic	67	39.2%
	Other	6	3.5%
Payer/programmatic	Payer agnostic	29	17.0%
circumstances	Commercial payer	56	32.7%
	Demonstration	1	0.6%
	Medicaid	2	1.2%
	Medicare	74	43.3%
	Other	9	5.3%
Exclusivity of attribution	Patient is attributed to multiple providers	33	19.3%
	Patient is attributed to only one provider	133	77.8%
	Unknown	5	2.9%

Characteristic	Elements	N	Percentage
Measure used to make	Spending	52	30.4%
attribution	Enrollment	2	1.2%
	Other	42	24.6%
	Unknown	2	1.2%
	Visit	73	42.7%
Minimum requirement to	Majority of care	24	14.0%
make attribution	"One Touch"	13	7.6%
	Other	33	19.3%
	Plurality of care	51	29.8%
	Plurality of care with Threshold (ex. 30%, 2 visits)	20	11.7%
	Threshold	28	16.4%
	Unknown	2	1.2%
Period of time for which	More than 1 year	50	29.2%
provider is responsible for	One year	42	24.6%
attributed patients	Other	67	39.2%
	Unknown	12	7.0%

Table 2. Characteristics of approaches to attribution described in environmental scan from implemented models (n=30)

Characteristic	Elements	N	Percentage
Program stage	Implemented	30	100.0%
	Proposed	0	0.0%
Type of provider attributed	ACO	13	43.3%
	Any physician	8	26.7%
	Hospital (Facility, clinic)	1	3.3%
	Other	2	6.7%
	PCP	1	3.3%
	PCP preferred	3	10.0%
	Physician group	2	6.7%
	Specialist	0	0.0%
	Unknown	0	0.0%
Timing of attribution	Other	4	13.3%
	Prospective	7	23.3%
	Retrospective	19	63.3%
Clinical circumstances	All care	20	66.7%
	Chronic	0	0.0%
	Episodic	8	26.7%
	Other	2	6.7%
Payer/programmatic	Payer agnostic	9	30.0%
circumstances	Commercial payer	13	43.3%
	Demonstration	1	3.3%
	Medicaid	2	6.7%
	Medicare	3	10.0%
	Other	2	6.7%
Exclusivity of attribution	Patient is attributed to multiple providers	4	13.3%
	Patient is attributed to only one provider	24	80.0%
	Unknown	2	6.7%

Characteristic	Elements	N	Percentage
Measure used to make	Spending	8	26.7%
attribution	Enrollment	2	6.7%
	Other*	9	30.0%
	Unknown	0	0.0%
	Visit	11	36.7%
Minimum requirement to	Majority of care	3	10.0%
make attribution	"One Touch"	2	6.7%
	Other**	9	30.0%
	Plurality of care	10	33.3%
	Plurality of care with Threshold (ex. 30%, 2 visits)	3	10.0%
	Threshold	2	6.7%
	Unknown	1	3.3%
Period of time for which	More than 1 year	2	6.7%
provider is responsible for	One year	9	30.0%
attributed patients	Other***	11	36.7%
	Unknown	8	26.7%

Notes: * Some examples of "other" measures include: Attribution was made based on unspecified "services"; For some attribution models that spanned all programmatic circumstances, the measure used varied depending on whether beneficiaries were enrolled with a physician as part of their health plan; The model prioritized using either spending or visits to make an attribution, but used the other to resolve ties between two or more providers.

** Some examples of "other" minimum requirements include: Patients were enrolled with or designated a provider; For some attribution models that spanned all programmatic circumstances, the requirement used varied depending on whether beneficiaries were enrolled with a physician as part of their health plan

***The majority in the "other" category involved the attribution of episodes, in which case the duration of the attribution was dependent on the duration of the episode. A small number of models attributed patients for less than one year

Table 3. Bivariate relationship between attributed providers and characteristics of approaches to attribution for select attributed providers (n=149)

		Attributed provider					
		ACO		Any physician/ group		PCP/ PCP preferred	
Characteristic	Elements	N	Percentage	N	Percentage	N	Percentage
Program stage	Implemented	13	72.2%	10	10.2%	4	12.1%
	Proposed	5	27.8%	88	89.8%	29	87.9%
Timing of attribution	Other	2	11.1%	2	2.0%	3	9.1%
	Prospective	7	38.9%	2	2.0%	1	3.0%
	Retrospective	9	50.0%	94	95.9%	29	87.9%
Clinical	All care	13	72.2%	34	34.7%	24	72.7%
Circumstances	Chronic	0	0.0%	10	10.2%	4	12.1%
	Episodic	3	16.7%	53	54.1%	4	12.1%
	Other	2	11.1%	1	1.0%	1	3.0%
Payer/programmatic	Payer agnostic	0	0.0%	17	17.3%	10	30.3%
circumstances	Commercial payer	8	44.4%	37	37.8%	9	27.3%
	Demonstration	0	0.0%	1	1.0%	0	0.0%
	Medicaid	2	11.1%	0	0.0%	0	0.0%
	Medicare	7	38.9%	41	41.8%	12	36.4%
	Other	1	5.6%	2	2.0%	2	6.1%
Exclusivity of attribution	Patient is attributed to multiple providers	0	0.0%	23	23.5%	7	21.2%
	Patient is attributed to only one provider	16	88.9%	74	75.5%	26	78.8%
	Unknown	2	11.1%	1	1.0%	0	0.0%

Measure used to make	Spending	3	16.7%	41	41.8%	2	6.1%
Attribution	Enrollment	1	5.6%	0	0.0%	0	0.0%
	Other	9	50.0%	14	14.3%	10	30.3%
	Unknown	0	0.0%	1	1.0%	0	0.0%
	Visit	5	27.8%	42	42.9%	21	63.6%
Minimum	Majority of care	1	5.6%	17	17.3%	5	15.2%
requirement to	"One Touch"	1	5.6%	8	8.2%	4	12.1%
make attribution	Other	6	33.3%	8	8.2%	10	30.3%
	Plurality of care	8	44.4%	28	28.6%	10	30.3%
	Plurality of care with Threshold (ex. 30%, 2 visits)	0	0.0%	16	16.3%	1	3.0%
	Threshold	0	0.0%	21	21.4%	3	9.1%
	Unknown	2	11.1%	0	0.0%	0	0.0%
Period of time for	More than 1 year	1	5.6%	25	25.5%	18	54.5%
which provider is	One year	8	44.4%	24	24.5%	8	24.2%
responsible for	Other	6	33.3%	47	48.0%	4	12.1%
attributed patients	Unknown	3	16.7%	2	2.0%	3	9.1%

Note: Table does not include data from attributed hospitals, specialists, other providers, or unknown providers

Table 4. Summary of attribution approaches from implemented models identified in the literature search

Accountability Program	Description	Attribution Method	Related References
Accountable Care Organizations			
Alternative Quality Contract	A global payment contract for beneficiaries enrolled in Blue Cross Blue Shield of Massachusetts	Beneficiaries are prospectively attributed to a PCP by designating their PCP at the beginning of each year.	Song Z. Payment Reform in Massachusetts: Health Care Spending and Quality in Accountable Care Organizations Four Years into Global Payment. 2014. Doctoral Dissertation, Harvard University Medical School.
Children's Hospital and Clinics (CHC) of Minnesota	Medicaid ACO in the Twin Cities exclusively serving pediatric patients	Patients are retrospectively attributed to CHC based on: 1. whether they are in a healthcare home; or 2. where they received the plurality of their primary care.	1. Christensen EW, Payne NR. Effect of Attribution Length on the Use and Cost of Health Care for a Pediatric Medicaid Accountable Care Organization. JAMA Pediatr. 2016;170(2):148. doi:10.1001/jamapediatrics.2015.3446.; 2. Gleeson S, Brilli R. Does the Medical Home Really Matter? J Pediatr. 2016; 170: 14-16.
HealthCare Partners	Pilot ACO program for Anthem beneficiaries in California	Episodes are attributed to an ACO based on the plurality of allowed charges to either a primary care physician or a specialist.	Larson BK, Van Citters AD, Kreindler SA, et al. Insights from transformations under way at four Brookings-Dartmouth accountable care organization pilot sites. Health Aff (Millwood). 2012;31(11):2395-2406. doi:10.1377/hlthaff.2011.1219.; See also: Gbemundo JN, Larson BK, Van Critters AD, et al. HealthCare Partners: Building on a Foundation of Global Risk Management to Achieve Accountable Care. The Commonwealth Fund. 2012. Retrieved from

Accountability Program	Description	Attribution Method	Related References
		Attributions are also made prospectively based on historical care patterns-specifically, the plurality of outpatient evaluation and management visits.	http://www.commonwealthfund.org/~/media/Files/Publications/Case%20Study/2012/Jan/1572_Gbemudu_HealthCare_Partners_case%20study_01_17_2012.pdf.
Medica	A regional health plan based in Minnesota that operates a shared savings contract	Patients are retrospectively attributed to a care system if they received 50% of primary care services from that system. Primary care is defined by place of service (office visits, or for those in the Medicaid product, emergency department visits) and the provider's specialty (internal medicine, general practice, family medicine, or OB/GYN).	Carlin C. Patient loyalty in a mature IDS market: is population health management worth it? Health Serv Res. 2014; 49(3): 1011-33.
Medicaid ACOs in Arkansas, Ohio, and Tennessee	Medicaid ACO programs	Episodes of perinatal care are retrospectively attributed to the health care provider who delivers a neonate. That provider is responsible for all perinatal care that occurred up to 40 weeks before delivery and	Jarlenski M, Borrero S, La Charité T, Zite NB. Episode-based payment for perinatal care in medicaid. Obstet. Gynecol. 2016; 127(6):1080–84.

Accountability Program	Description	Attribution Method	Related References
		care for 60 days postpartum.	

Accountability Program	Description	Attribution Method	Related References
Medicare Shared Savings Program	Medicare ACO Program	A beneficiary is attributed to an ACO if the beneficiary receives the plurality of his or her primary care services from primary care practitioners (primary care physicians, nurse practitioners, clinical nurse specialists, physician assistants, or ACO professionals providing services at a FQHC/RHC) within the ACO.	1. Baseman S, Boccuti C, Moon M, Griffin S, Dutta T. Payment and Delivery System Reform in Medicare. Henry J. Kaiser Family Foundation. 2016. Retrieved from http://kff.org/medicare/report/payment-and-delivery-system-reform-in-medicare-a-primer-on-medical-homes-accountable-care-organizations-and-bundled-payments/; 2. Hayen A. Incorporating shared savings programs into primary care: from theory to practice. BMC Heal Serv. 2015; 15:580.; See also: 1. Centers for Medicare and Medicaid Services. Medicare Shared Savings Program: Shared savings and losses and assignment methodology applicable beginning performance year 2016. CMS. 2015. Retrieved from https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/sharedsavingsprogram/Downloads/Shared-Savings-Losses-Assignment-Spec-V4.pdf 4; 2. MacKinney AC, Mueller KJ, Zhu X, Vaughn T. Medicare accountable care organizations: program eligibility, beneficiary assignment, and quality measures. Rural Policy Brief. 2014; 1–6.; This attribution model is applied and analzed in the following articles: 1. McWilliams JM, Chernew ME, Zaslavsky AM, Landon BE. 2013. Post-acute care and acos - who will be accountable? Health Serv. Res. 48(4):1526–38; 2. McWilliams JM, Chernew ME, Zaslavsky AM, Hamed P, Landon BE. 2013. Delivery system integration and health care spending and quality for medicare beneficiaries. JAMA Intern. Med. 173(15):1447; 3. Mukherji SK. 2014. The potential impact of accountable care organizations with respect to cost and quality with special attention to imaging. J. Am. Coll. Radiol. 2014; 11(4):391–96.

Accountability Program	Description	Attribution Method	Related References
Monarch HealthCare	Pilot ACO program for Anthem beneficiaries in California	Episodes are attributed to an ACO based on the plurality of allowed charges to either a primary care physician or a specialist. Attributions are also made prospectively based on historical care patterns- specifically, the plurality of outpatient evaluation and management visits.	Larson BK, Van Citters AD, Kreindler SA, et al. Insights from transformations under way at four Brookings-Dartmouth accountable care organization pilot sites. Health Aff (Millwood). 2012;31(11):2395-2406. doi:10.1377/hlthaff.2011.1219.
Norton HealthCare	Pilot ACO program for Humana beneficiaries in Kentucky	Patients are prospectively attributed to an ACO based on historical care patterns. Specifically, an attribution is made based on the plurality of outpatient evaluation and management visits.	Larson BK, Van Citters AD, Kreindler SA, et al. Insights from transformations under way at four Brookings-Dartmouth accountable care organization pilot sites. Health Aff (Millwood). 2012;31(11):2395-2406. doi:10.1377/hlthaff.2011.1219.

Accountability Program	Description	Attribution Method	Related References
Pioneer ACO	Medicare ACO program	The exact attribution method varies among Pioneer ACOs, however, each involves prospective attribution. Physicians are provided a list of patients in their ACOs. In some cases, ACOs may submit attestations from beneficiaries regarding their desire to be attributed to a provider. Beneficiary confirmations will be reflected in ACO alignment in the subsequent performance year.	1. Baseman S, Boccuti C, Moon M, Griffin S, Dutta T. Payment and Delivery System Reform in Medicare. Henry J. Kaiser Family Foundation. 2016. Retrieved from http://kff.org/medicare/report/payment-and-delivery-system-reform-in-medicare-a-primer-on-medical-homes-accountable-care-organizations-and-bundled-payments/; 2. Dowd B, Kane R, Parashuram S. Alternative approaches to measuring physician resource use final report. CMS. 2012. Retreived from https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/Reports/Downloads/Alt_Approaches_Measuring_Phys_Res_Use_Report.pdf.; 3. Hsu J, Price M, Spirt J, Vogeli C. Patient Population Loss At A Large Pioneer Accountable Care Organization And Implications For Refining The Program. Health Aff. 2016; 35(3)-422-30. 4. MacKinney AC, Mueller KJ, Zhu X, Vaughn T. Medicare accountable care organizations: program eligibility, beneficiary assignment, and quality measures. Rural Policy Brief. 2014; 1–6; 5. McWilliams JM, Chernew ME, Landon BE, Schwartz AL. 2015. Performance differences in year 1 of pioneer accountable care organizations. N. Engl. J. Med. 2015; 372(20):1927–36; 6. Schwartz AL, Chernew ME, Landon BE, McWilliams JM. Changes in low-value services in year 1 of the medicare pioneer accountable care organization program. JAMA Intern. Med. 2015; 175(11):1815

Accountability Program	Description	Attribution Method	Related References
Tucson Medical Center	Pilot ACO program for United HealthCare beneficiaries in Arizona	Patients are prospectively attributed based on historical care patterns—specifically, the plurality of outpatient evaluation and management visits. Patients are also assigned based on the recency of outpatient primary care visits or pharmacy claims.	Larson BK, Van Citters AD, Kreindler SA, et al. Insights from transformations under way at four Brookings-Dartmouth accountable care organization pilot sites. Health Aff (Millwood). 2012;31(11):2395-2406. doi:10.1377/hlthaff.2011.1219.
Vermont ACO Pilot	An ACO developed through the collaboration of three health care providers and three commercial insurers in Vermont	Patients are prospectively attributed to an ACO based on their choice of PCP. In cases in which patients are not required to choose a PCP as part of their health insurance, patients are retrospectively attributed based on claims data over a two year period.	Hester J, Lewis J, McKethan A, Fund C. The Vermont Accountable Care Organization Pilot: A Community Health System to Control Total Medical Costs and Improve Population Health.; 2010. Retrieved from http://www.leg.state.vt.us/CommissionOnHealthCareReform/Hester_Vermont_aco_pilot CMWF_final.pdf.

Accountability Program	Description	Attribution Method	Related References
Public Reporting Programs			
California Cooperative Healthcare Reporting Initiative	An initiative to collect and report standardized, reliable health plan and provider performance data in California	CCHRI has tested different methods of assigning patient events to physicians. One approach assigns denominator eligible patients to every physician of a relevant specialty for that measure who had at least one EM visit with the patient during the measurement period (i.e., one-touch rule). By the end of the project, the decision was made to align the numerator and attribution periods so that a physician must have seen the member for an EM visit during the time period in which they were to have received the numerator service.	Delmarva Foundation for Medical Care. Enhancing Physician Quality Performance Measurement and Reporting Through Data Aggregation: The Better Quality Information (BQI) to Improve Care for Medicare Beneficiaries Project. Delmarva Foundation for Medical Care. 2008. Retrieved from http://www.wchq.org/measures/documents/BQI_Final_Report_10_2008.pdf.

Accountability Program	Description	Attribution Method	Related References
California Physician Performance Incentive	A multi-stakeholder initiative to measure and report physician performance in California	A patient is retrospectively attributed to the single PCP with whom the patient had the most ambulatory/outpatient visits during the measurement year and the previous 1 year period. If the number of visits was equal for two or more PCPs, the patient is attributed to the physician that provided care during the most recent visit. For indicators that are relevant to specialists, patients are assigned to any specialist physician whom they saw during the attribution period. Patients can be attributed to more than one specialist for a given indicator. Patients without any visits or without a relevant specialist for a measure are not attributed. Patients are also attributed to "practice sites" (physicians of the same specialty who share the same practice address).	Cromwell J, Trisolini M G, Pope GC, Mitchell, JB, Greenwald LM. Pay for Performance in Health Care: Methods and Approaches. RTI Press Publication. 2011. Retrieved from www.rti.org/rtipress.

Accountability Program	Description	Attribution Method	Related References
Center for Health Information and Research	A regional database in Arizona that documents quality measurements	Patients are attributed to physicians using the following steps: 1. Physical exam or assessment performed by physician with allowed specialty (limited to selected specialties) and who is the PCP assigned via enrollment process. 2. Most recent physical exam or assessment performed by physician other than assigned PCP (limited to allowed specialties) 3. Physician who is in allowed specialty (other than the assigned PCP) and who performed largest number of EM type visits	Delmarva Foundation for Medical Care. Enhancing Physician Quality Performance Measurement and Reporting Through Data Aggregation: The Better Quality Information (BQI) to Improve Care for Medicare Beneficiaries Project. Delmarva Foundation for Medical Care. 2008. Retrieved from http://www.wchq.org/measures/documents/BQI_Final_Report_10_2008.pdf.

Accountability Program	Description	Attribution Method	Related References
Indiana Health Information Exchange	A collaboration of hospitals, providers, researchers, public health organizations, and economic development groups in Indiana to improve health care quality and safety through information technology	In order to attribute the patient to a provider, IHIE created an algorithm that creates a rank ordered list of physician associations with the patient. IHIE then uses data about the providers including their specialty to identify the PCP. The current version of the algorithm relies on actual encounters that occurred (not appointments), laboratory results and prescriptions. Patients fall into one of several categories: A. Patients who have not had interactions with any providers B. Patients who have had interactions with only one provider that meets criteria to be a PCP C. Patients who have had interactions with multiple providers that meet criteria to be PCPs.	Delmarva Foundation for Medical Care. Enhancing Physician Quality Performance Measurement and Reporting Through Data Aggregation: The Better Quality Information (BQI) to Improve Care for Medicare Beneficiaries Project. Delmarva Foundation for Medical Care. 2008. Retrieved from http://www.wchq.org/measures/documents/BQI_Final_Report_10_2008.pdf.

Accountability Program	Description	Attribution Method	Related References
Massachusetts Health Quality Partners	A quality measurement and public reporting program in Massachusetts	Patients in managed care insurance were attributed to the PCP whom the health plan assigned to the patients. For patients in PPO and Medicare FFS products to the PCP who had the highest volume of EM office visits with that patient in the 18 months before the end date of the measurement period. For PPO/FFS patients with no visits to a PCP in the specified measurement period, MHQP attributed care to a visited specialist relevant to the quality indicator (e.g., a cardiologist for cardiac measures).	1. Cromwell J, Trisolini M G, Pope GC, Mitchell, JB, Greenwald LM. Pay for Performance in Health Care: Methods and Approaches. RTI Press Publication. 2011. Retrieved from www.rti.org/rtipress.; 2. Delmarva Foundation for Medical Care. Enhancing Physician Quality Performance Measurement and Reporting Through Data Aggregation: The Better Quality Information (BQI) to Improve Care for Medicare Beneficiaries Project. Delmarva Foundation for Medical Care. 2008. Retrieved from http://www.wchq.org/measures/documents/BQI_Final_Report_10_2008.pdf.

Accountability Program	Description	Attribution Method	Related References
Minnesota Community Measurement	A statewide public quality reporting initiative	Each member in the eligible population for each measure is attributed to one Medical Group for the measurement year based on claims/encounter data for selected services (EM codes and Preventive codes) received in that measurement year. For non-diabetes measures, patients are attributed to group with the highest number of EM claims/encounters if those claims/encounters are associated with the following specialties: general practice, family practice, internal medicine, pediatrics, geriatric medicine, obstetrics and gynecology, cardiology, physician assistant, nurse practitioner. If there is a tie between a primary care and specialist provider, the group with primary care visit is preferred. If there is a tie between 2 PCPs, a patient is attributed to the one with the most recent date of	Delmarva Foundation for Medical Care. Enhancing Physician Quality Performance Measurement and Reporting Through Data Aggregation: The Better Quality Information (BQI) to Improve Care for Medicare Beneficiaries Project. Delmarva Foundation for Medical Care. 2008. Retrieved from http://www.wchq.org/measures/documents/BQI_Final_Report_10_2008.pdf.

Accountability Program	Description	Attribution Method	Related References
		service. Primary Care is defined as general practice, family practice, internal medicine, pediatrics, geriatric medicine, physician assistant, and nurse practitioner. For those members that have claims/encounters that are not associated with one of the specialties listed above, they are assigned to Medical Group 0 (zero). For diabetes measures, members that are not attributed to a medical group using the above steps, they are attributed based on the highest number of EM or diabetes claims/encounters (i.e., maximum frequency rule) during the measurement year regardless of specialty.	

Accountability Program	Description	Attribution Method	Related References
Wisconsin Collaborative for Healthcare Quality	A quality reporting initiative covering over 40 physician groups, hospitals, and health plans in Wisconsin	Members of this initiative self-determine responsibility for their patients based on three questions: For disease-specific measures: 1) Is this a patient with the disease or condition? – Patients require a defined number of office visits for their condition to qualify for the measure. 2) Is this patient whose care is managed within the physician group? Patients are required to be managed by the physician group in order to be eligible for the measure. 3) Is this a patient currently managed in our system – Patients must be currently managed by the physician group in order to be included in the measure. For other measures: 1) Is this a patient we manage? - Patients are required to be managed by the physician group in order to be eligible for the measure. 2) Is this a patient that is current in our system? Patients must be	1. Delmarva Foundation for Medical Care. Enhancing Physician Quality Performance Measurement and Reporting Through Data Aggregation: The Better Quality Information (BQI) to Improve Care for Medicare Beneficiaries Project. Delmarva Foundation for Medical Care. 2008. Retrieved from http://www.wchq.org/measures/documents/BQI_Final_Report_10_2008.pdf.; 2. Greer A. Embracing Accountability: Physician Leadership, Public Reporting, and Teamwork in the Wisconsin Collaborative for Healthcare Quality. The Commonwealth Fund. 2008. Retrieved from http://www.commonwealthfund.org/~/media/files/publications/fundreport/2008/jun/embracing accountability physician leadership public reporting and teamwork in the wisconsin coll/greer_embracingaccountabilitywisconsincollab_1142 pdf.pdf.

Accountability Program	Description	Attribution Method	Related References
		currently managed by the physician group in order to be included in the measure. 3) Is this a patient that is eligible for the measure? – Patients who meet the defined measure eligibility criteria	
Value-based Purchasing/ Pay-for-Performance			

Accountability Program	Description	Attribution Method	Related References
Medicare Physician Group Practice Demonstration Project	A 5-year P4P initiative that incentivized physician group to coordinate the care they provided to Medicare beneficiaries	Beneficiaries were retrospectively assigned to the practice group that provided the plurality of office or other outpatient evaluation and management services during the performance year.	1. Centers for Medicare & Medicaid Services. PGP fact sheet. CMS. 2009. Retrieved from http://www. cms.gov/Medicare/Demonstration-Projects/ DemoProjectsEvalRpts/downloads//PGP_ Fact_Sheet.pdf ; 2. Kautter J, Pope GC, Trisolini M, Grund S. Medicare Physician Group Practice Demonstration design: Quality and efficiency pay-for- performance. Health Care Financing Review. 2007; 29(1): 15−29.; 3. Pope GC, Trisolini M, Kautter J, Ada- manche W. Physician Group Practice (PGP) demonstration design report. CMS. 2002.; 4. Cromwell J, Trisolini M G, Pope GC, Mitchell, JB, Greenwald LM. Pay for Performance in Health Care: Methods and Approaches. RTI Press Publication. 2011. Retrieved from www.rti.org/rtipress.; 4. McKethan A. Improving Quality and Value in the US: Health Care System. Bipartisan Policy Center. 2009. Retreived from: http://bipartisanpolicy.org/wp-content/uploads/sites/default/files/BPC8-09-PCHC%20Qual%20rpt-8-20-09.pdf; 5. Schneider E, Hussey PS, Schnyer C. Payment Reform. RAND Health. 2011. Retrieved from http://s3.amazonaws.com/rdcms-himss/files/production/public/HIMSSorg/Content/files/RANDReport MeasurementImplicationsPerforamnce-BasedPaymentReformModels.pdf.; 5. Kautter J, Pope G, Leung M, Trisolini M, Adamache W, Smith K. Financial and quality impacts of the medicare physician group practice demonstration. Medicare Medicaid Res. Rev. 2014; 4(3):E1–22.

Accountability Program	Description	Attribution Method	Related References
Physician Value-Based Payment Modifier	This program began in 2015 and offers differential payments to physicians and physician groups on the basis of the quality and value of care provided to attributed beneficiaries during a performance period	Beneficiaries are retrospectively attributed to the group that provides the plurality of primary care services. Primary care services include office-based, home health, or nursing home evaluation and management codes as well as other codes defined by CMS. Certain large single specialty groups – such as those limited to emergency medicine, diagnostic radiology, pathology, and anesthesiology – may not be attributed any beneficiaries under this attribution methodology	Centers for Medicare & Medicaid Services. Summary of 2015 Physician Value-based Payment Modifier Policies. CMS. 2013. Retrieved from http://www.cms.gov/ Medicare/Medicare-Fee-for-Service-Payment/ PhysicianFeedbackProgram/Downloads/ CY2015ValueModifierPolicies.pdf
Physician Profiling and Network Tiering			
Aetna	This approach relates to Aetna's method for attributing patients for purposes such as network tiering,	Episodes are assigned to physician with majority of claims dollars included in the episode, or to surgeon if a surgery occurs.	Lake T, Colby M, Peterson S. Health Plans' Use of Physician Resource Use and Quality Measures. Mathematica Policy Research. 2007. Retrieved from https://www.mathematica-mpr.com/our-publications-and-findings/publications/health-plans-use-of-physician-resource-use-and-quality-measures.

Accountability Program	Description	Attribution Method	Related References
	providing physicians with feedback report, and public reporting	Episodes are assigned to each physician with more than 20% of claims dollars included in the episode.	
Blue Cross/Blue Shield	This approach relates to Blue Cross/Blue Shield's method for attributing patients for purposes such as network tiering, providing physicians with feedback report, and public reporting	Episode assigned to physician who bills the greatest total Relative Value Units (RVUs) for a given episode, as long as the physician has a minimum number of RVUs. When no physician is identified by RVUs, episode is attributed to the physician billing the greatest number of outpatient evaluation or management services for the episode, as long as the physician has a minimum number of outpatient EM services. When no physician is identified by either of the above, episode is attributed to the physician with the highest allowable cost included in the episode.	Lake T, Colby M, Peterson S. Health Plans' Use of Physician Resource Use and Quality Measures. Mathematica Policy Research. 2007. Retrieved from https://www.mathematica-mpr.com/our-publications-and-findings/publications/health-plans-use-of-physician-resource-use-and-quality-measures.

Accountability Program	Description	Attribution Method	Related References
Clinical Performance Improvement (CPI) Initiative	An initiative In Massachusetts that involves the construction a consolidated, multi-plan claims database to develop cost-efficiency and quality of care profiles for physicians that can be used by health plans to partition their physician networks into preferred and non-preferred tiers.	Episode responsibility is attributed to the physician accounting for the highest portion of professional cost in the episode, so long as the physician's portion equals at least 25%. Ideally, episode responsibility should reflect all costs – professional, inpatient, outpatient, and pharmacy	Green RA, Beckman HB, Patridge GH, Thomas JW. Review of the Massachusetts Group Insurance Commission Physician Profiling and Network Tiering Plan: a report to the Massachusetts Medical Society. Massachusetts Medical Society. 2006. Retrieved from http://www.massmed.org/AM/Template.cfm?Section=Pay_for_Performance&TEMPLATE=/CM/ContentDisplay.cfm&CONTENTID=16760; See also: Alteras T, Silow-Carroll S. Value-driven health care purchasing: a case study of the Massachusetts group insurance commission. The Commonwealth Fund. 2007. Retrieved from http://www.commonwealthfund.org/usr_doc/1053_Alteras_value-driven_Massachusetts_case_study.pdf.
Harvard Pilgrim Health Care	This approach relates to Harvard Pilgrim Health Care's method for attributing patients for purposes such as network tiering, providing physicians with feedback report, and public reporting	Episodes are assigned to physician with the highest amount of claims dollars, as long as physician is responsible for at least 25% of the episode fees charged. If no physician has at least 25% of the claims dollars for the episode, the episode remains unassigned.	Lake T, Colby M, Peterson S. Health Plans' Use of Physician Resource Use and Quality Measures. Mathematica Policy Research. 2007. Retrieved from https://www.mathematica-mpr.com/our-publications-and-findings/publications/health-plans-use-of-physician-resource-use-and-quality-measures.

Accountability Program	Description	Attribution Method	Related References
United HealthCare	This approach relates to United Health Care's method for attributing patients for purposes such as network tiering, providing physicians with feedback report, and public reporting	For non-proceduralists, episodes are assigned to the physician with the majority of claims dollars included in the episode .For proceduralists, episodes are assigned to physician who submitted the claim for the interventional procedure.	Lake T, Colby M, Peterson S. Health Plans' Use of Physician Resource Use and Quality Measures. Mathematica Policy Research. 2007. Retrieved from https://www.mathematica-mpr.com/our-publications-and-findings/publications/health-plans-use-of-physician-resource-use-and-quality-measures.
Patient-Centered Medical Home			
Medical Services Initiative	A patient-centered medical home initiative for low-income, uninsured patients in Orange County, California	Patients are prospectively attributed to a medical home (clinic or private physician) at the time of enrollment based on choice or assignment. Within clinic-based medical homes, the enrollee chooses or is assigned to a specific physician to serve as their personal provider. This decision may be based on personal relationships, recommendation, language spoken by the provider, or proximity to the enrollee's home. This medical home is intended as the source for all primary care.	Roby DH, Pourat N, Pirritano MJ, Vrungos SM, Dajee H, et al. Impact of patient-centered medical home assignment on emergency room visits among uninsured patients in a county health system. Med. Care Res. Rev. 2010; 67(4):412–30.

Accountability Program	Description	Attribution Method	Related References
Minnesota's Health Care Home Initiative	An statewide initiative in Minnesota to incentivize PCPs to provide comprehensive care to their members through a medical home model	PCPs are assigned clinics using an algorithm that considers the Statewide Quality Reporting and Measurement system registry. Patients are then retrospectively attributed to clinics based on an algorithm that considers: 1. the clinic that associated with the provider in which they had the greatest number of EM encounters; 2.the number of clinic encounters that are with an MD/DO, NP, or PA; 3. date of most recent visit to clinic. In order to make an attribution, at least 10% of an enrollee's professional service encounters must be with the clinic.	Wholey D, Finch M, Shippee ND, et al. Evaluation of the State of Minnesota's Health Care Home Initiative: Evaluation Report for years 2010-2012. Minnesota Department of Health. 2014. Retrieved from http://www.health.umn.edu/sites/default/files/UM 2015 HCH Evaluation Final 07Feb2016.pdf.

Table 5. Summary of attribution approaches from proposed models identified in the literature search

Citation	Description	Attribution Method
Attribution of Episodes of Care		
Adams JL, McGlynn EA, Thomas JW, Mehrotra A. Incorporating Statistical Uncertainty in the Use of Physician Cost Profiles. BMC Health Serv Res. 2010; 10:57.	This study utilizes data from four commercial insurers in Massachusetts to analyze methods to develop physician cost profiles for the purpose of public reporting and quality improvement.	Using claims data, each episode of care was retrospectively attributed to the physician who had billed the greatest fraction (at least 30%) of the professional costs related to the episode. Physicians were then categorized as low cost, average cost, or high cost.

Citation	Description	Attribution Method
Halpern R, Kothari S, Fuldeore M. GERD-related health care utilization, therapy, and reasons for transfer of GERD patients between primary care providers and gastroenterologists in a US managed. Dig Dis Sci. 2010; 55(2):328-337.	This article analyzes health care utilization among patients with gastroesophageal reflux disease treated by PCPs and gastroenterologists.	Episodes were categorized as PCP if at least 55% of GERD-related utilization, including office visits, procedures, and GERD medication fills, was associated with a PCP physician (general practitioner, family practitioner or internal medicine). Episodes were classified as GE if at least 55% of GERD-related utilization was associated with a GE specialty code. All remaining episodes were classified as "other;" these episodes were characterized by specialty codes associated with ear, nose, and throat, emergency medicine, general surgery, and facilities
Huckfeldt P, Chan C, Hirshman S, Kofner A. Specialty Payment Model Opportunities and Assessment. CMS Alliance to Modernize Healthcare. 2015. Retrived from http://www.rand.org/content/dam/rand/pubs/research_reports/RR700/RR763/RAND_RR763.pdf.	This report examines the use episode-based payment models for oncology care.	Patient episodes were attributed to practices using two strategies: 1. Retrospective attribution based on the plurality of cancer-related visits for EM services over a 60 day period that was preceded by a 30 day period in which no cancer-related claims were reported. In cases of ties, the measurement period was extended for an additional 90 day period.

Citation	Description	Attribution Method
		2. Prospective attribution to the practice responsible for the trigger chemotherapy claim (i.e., the claim that is used to identify the initiation of the chemotherapy treatment episode). Attribution using an EM claim on the same day as trigger event was prioritized followed by the practice billing the greatest number of EM visits on the same day as a claim for a chemotherapy drug. The measurement period window was extended in the case of ties. Episodes were attributed to physicians in the hospital outpatient department if no other attribution could be made.
Ingenix. Symmetry episode treatment groups: Issues and best practices in physician episode attribution. 2007. Retrieved from https://etg.optum.com/Ingenix/Media/ETG/Symmetry_EpisodeAttribution_WP_FINAL_112007_L01.pdf.	This white paper examines different approaches and identifies best practices for attributing episodes to providers	This paper evaluates the following attribution approaches: 1. Physician Episode Attribution Using Professional Service Costs: This attribution approach identifies the responsible physician for an episode as that provider rendering the greatest amount of professional service costs during the episode

Citation	Description	Attribution Method
		2. Physician Episode Attribution Using Episode Clusters: This attribution approach identifies the responsible physician for an episode as that provider in the peer group owning the greatest number of "clusters" within the episode.
		3. Physician Episode Attribution Using Non-Acute EM Visits: This attribution approach identifies the responsible physician for an episode as that physician providing the greatest number of non-acute EM visits within the episode.
		4. Physician Episode Attribution Using a Primary Care, Population-based Approach: Responsibility for a member's qualified episodes of care may be attributed to the member's PCP—whether or not the PCP provided any of the services for that member during those episodes.

Citation	Description	Attribution Method
MaCurdy T, Theobald N, Kerwin J, Ueda K. Prototype Medicare Resource Utilization Report Based on Episode Groupers. Acumen, LLC. 2008. Retrieved from https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/Reports/downloads/MaCurdy2.pdf.	This report provides recommendations to CMS on the attribution of episodes to providers for the purpose of examining physician resource utilization	This paper evaluates the following attribution approaches: 1. Beneficiaries are attributed to the provider associated with the greatest number of Part B costs. If there are no positive costs on Part B claims assigned to an episode, then the episode is not attributed to a provider. In the case where the payments from Part B claims to two or more providers are equal, then the next rule applied breaks the tie between the providers by attributing the episode the provider with the highest costs from EM claims
		2. Beneficiaries are attributed to the provider with the most EM charges. When there is a tie in EM costs among providers, it is broken by attributing the episode to the provider with the highest Part B costs. If both EM and Part B costs are tied among providers, then the algorithm moves to numbers of EM claims followed by numbers of Part B claims.

Citation	Description	Attribution Method
MedPAC. Using episode groupers to assess physician resource use. Report to the Congress: Increasing the Value of Medicare. 2006. Retrieved from http://www.medpac.gov/documents/reports/Jun06_EntireReport.pdf?sfvrsn=0.	This report discusses different approaches for attributing episode to providers to assess physician resource use	This report examines the following approaches: Percentage of Evaluation and Management Visits, single provider: 1. 30%
		2. 35%
		3. 40%
		4. 50%
		Percentage of non-inpatient EM visits, single provider: 5. 30%
		Percentage of EM dollars, single provider: 6. 30%
		7. 35%
		8. 40%
		9. 50%
		Multiple provider, attribution by visits: 10. 35%

Citation	Description	Attribution Method
Mehrotra A, Adams J, Thomas J, McGlynn E. Cost profiles: should the focus be on individual physicians or physician groups? Health Aff (Millwood). 2010; 29(8):1532-8.	This article assesses approaches for developing physician cost profiles.	Beneficiaries receiving at least one primary care service from a PCP (defined by specialty codes for general practice, family practice, internal medicine, or geriatric medicine) were retrospectively assigned based on primary care services provided by PCPs. Beneficiaries with multiple primary care services were assigned to the ACO in which they had the greatest outpatient spending. Beneficiaries receiving no primary care services from a PCP were assigned based on primary care services provided by physicians of other specialties, nurse practitioners, or physician assistants. Beneficiaries receiving no primary care services were not assigned.
Mehrotra A, Liu H, Adams J. The costs and quality of care for three common illnesses at retail clinics as compared to other medical settings. Ann Intern Med. 2009; 151(5): 321-328.	This article examines the quality of care at retail clinics compared to other health facilities.	The total cost of an episode of care was attributed to the physician who accounted for the highest fraction (minimum 30%) of professional costs within the episode. If the physician worked in a group, the episodes assigned to a physician were also assigned to this group.

Citation	Description	Attribution Method
Metfessel B, Greene R. A nonparametric statistical method that improves physician cost of care analysis. Health Serv Res. 2012; 47(6): 2398-417.	This article analyzes methods to develop physician cost profiles using episode treatment groups.	Episodes were retrospectively attributed to provider facilities according to the location of the first EM visit in the episode: retail clinic, physician office, urgent care clinic, or emergency department.
Nyman M. Inclusion of short-term care patients affects the perceived performance of specialists: a retrospective cohort study. BMC Health Serv Res. 2015; 15:99.	This articles looks at how difference in quality measurement period length impact quality performance profiles for specialists.	Each episode was attributed to the single physician who generated the highest percentage of costs in an episode. Only episodes in which a physician was responsible for at least 30% of costs were attributed.
Sandy LG, Rattray MC, Thomas JW. Episode-based physician profiling: a guide to the perplexing. J Gen Intern Med. 2008; 23 (9): 1521-1524. 10.1007/s11606-008-0684-z.	This articles discusses the strengths and limitations of episode-based provider profiling.	This paper evaluates the following attribution approaches: 1. Episodes were assigned to the physician who accounted for 30% or more of professional and prescribing costs included in the episode.

Citation	Description	Attribution Method
		2. Episodes were attributed to a physician in a relevant specialty (e.g., internal medicine, endocrinology) who had the largest number of EM encounters during the profiling period.
National Quality Forum. National Voluntaty Consensus Standards for Cost and Resource Use. 2012. Retrieved from www.qualityforum.org/Publications/.../Cost_and_Resource_Use_Final_Report.aspx	This report provides recommendations on combining resource use data and quality to promote efficiency in health care.	This report outlines several attribution approaches that can be applied to 1. Physician Episode Attribution using Professional Service Costs. This attribution approach identifies the responsible physician for an episode as that provider rendering the greatest amount of professional service costs during the episode.

Citation	Description	Attribution Method
		2. Physician Episode Attribution using Episode Clusters. This attribution approach identifies the responsible physician for an episode as that provider in the peer group owning the greatest number of "clusters" within the episode.
		3. Physician Episode Attribution using Non-Acute EM Visits. This attribution approach identifies the responsible physician for an episode as that physician providing the greatest number of non-acute EM visits within the episode.
		4. Physician Episode Attribution using a Primary Care, Population-based Approach. This approach requires two important steps: 1) Identification of a PCP for each member. 2) Identify the patient's assigned PCP during the episode period.

Citation	Description	Attribution Method
Thomas JW, Ward K. Economic profiling of physician specialists: use of outlier treatment and episode attribution rules. Inquiry. 2006;43(3):271–282.	This article analyzes methods to attribute patients to physician in order to develop economic profiles.	Episodes were retrospectively assigned to one or more physicians using one of the following approaches:1. 20% rule- 20% or more of professional and prescribing costs for an episode
		2. 30% rule- 30% or more of professional and prescribing costs for an episode
		3. 50% rule- 50% or more of professional and prescribing costs for an episode.

Citation	Description	Attribution Method
Timbie J, Hussey P, Adams J. Impact of socioeconomic adjustment on physicians' relative cost of care. Med Care. 2013; 51(5): 454-60.	This study examines the impact of socioeconomic status adjustment on episode-based physician cost profiling.	Episodes of care and their associated costs were retrospectively attributed to the physician having a plurality of professional costs (subject to a minimum of 30 percent of total professional costs) within the episode.
Attributing Patients to Hospitals, Physician Networks, or ACOs		
Anderson L, Flottemesch T. Patient medical group continuity and healthcare utilization. Am J Manag Care. 2012; 18(8): 450-7.	This article analyzes the continuity of care over a 5 year period among patients insured by HealthPartners.	Patients were retrospectively attributed using claims data to the medical group where they had the greatest number of primary care visits. In case of ties, patients were attributed to the medical group where the most recent visit occurred. Primary care visits were defined by location and specialty of the billing physician and included the following specialties: family medicine, internal medicine, pediatrics, geriatrics, and obstetrics and gynecology. Nurse practitioner and physician assistant visits were also included. Patients without primary care visits in a year were not attributed in that year.

Citation	Description	Attribution Method
Bynum JPW, Bernal-Delgado E, Gottlieb DJ, Fisher ES. Assigning ambulatory patients and their physicians to hospitals: a method for obtaining population-based provider performance measurements. Health Serv Res. 2007;42(1):45–62.	This study analyzes the validity of using claims data to assign Medicare FFS beneficiaries to physicians and hospitals for the purpose of developing population-based estimates of provider costs and quality.	Patients were retrospectively assigned to their predominant ambulatory physician. This was defined as the generalist (internist, geriatrician, family, or general practitioner) or specialist with whom the patient had the most ambulatory visits during the 2 years after an index visit to any provider in 1998. If there were no visits to generalists or specialists, patients were assigned to other physician types (e.g., dermatologists or surgeons). If the number of visits to physicians of equal priority was tied, the physician with the greatest time span between the first and last visits was chosen to favor longitudinal patient–physician relationships. If a patient had only one visit to each, then the most recent was chosen.

Citation	Description	Attribution Method
Everett C, Thorpe C. Division of primary care services between physicians, physician assistants, and nurse practitioners for older patients with diabetes. Med Care Res Rev. 2013; 70(5):531-41.	This study analyzes the division of services between PCPs for Medicare patients with diabetes.	Patients were first assigned to the primary care clinic that provided the majority of their face-to-face visits, then to the provider (physician or PA/NP) that delivered the majority of visits within that clinic. In the event of a tie, patients were assigned to the clinic/provider with the most recent visit. Patient panels grouped patients assigned to the same usual provider of care within a clinic.

Citation	Description	Attribution Method
Fisher ES, Staiger DO, Bynum JPW, Gottlieb DJ. Creating accountable care organizations: the extended hospital medical staff. Health Aff (Millwood) 2007;26(1):w44–57. DOI: 10.1377/hlthaff.26.1.w44.	This study analyzes whether it is feasible to use hospitals and their extended medical staff as the locus of performance assessment and accountability	Patients and physicians were assigned to hospitals using a three-year period of claims data. 60% of physicians were assigned to the hospital where they provided care to the greatest number of inpatients. Physicians who did not treat inpatients were assigned to hospitals according to where the plurality of their patients were admitted. Patients were assigned to the physicians who provided the most ambulatory care. Patients were then assigned to hospitals on the basis of their physicians' designation. Secondary hospitals were defined as the single other hospital most frequently used by a primary hospital's ambulatory cohort.

Citation	Description	Attribution Method
Hirth R, Turenne M. Provider Monitoring and Pay-for-Performance When Multiple Providers Affect Outcomes: An Application to Renal Dialysis. Heal Serv Res. 2009; 44(5.1): 1585-602.	This study analyzes the affect of dialysis facilities and nephrologists resource use on patient outcomes.	Patients were retrospectively attributed to providers and facilities using the unique physician identification number code reported on dialysis claims. Patients could be attributed to more than physician and/or facility.

Citation	Description	Attribution Method
Lewis VA, McClurg AB, Smith J, Fisher ES, Bynum JP. Attributing patients to accountable care organizations: performance year approach aligns stakeholders' interests. Health Aff (Millwood). 2013;32(3):587-95.	This study evaluates approaches for defining the patient population of Medicare ACOs by simulating the formation of ACOs based on Medicare FFS claims data.	The study compared the following two approaches: Prospective- Patients' use of service in the previous year was used to prospectively assign patient to providers during the performance year

Citation	Description	Attribution Method
		Performance Year- Patients were retrospectively attributed to providers on the basis of their service utilization during the performance year period The study also varied inclusion specifications such as only attributing patients to PCPs.
		Patients were then assigned to the hospital where their physician provided inpatient services or where a plurality of that physician's patient panel had medical admissions.
McWilliams J. Outpatient care patterns and organizational accountability in Medicare. JAMA Intern Med. 2014; 174(6): 938-45.	This article uses Medicare claims data to assess the capacity of hypothetical ACOs.	Beneficiaries were attributed to the ACO that provided the accounted for the greatest proportion of outpatient primary care spending.
Pollack C, Bekelman J, Liao K, Armstrong K. Hospital racial composition and the treatment of localized prostate cancer. Cancer. 2011; 117(24): 5569-78.	This study investigates racial differences in the treatment of men with prostrate cancer.	1. Patients were attributed to the hospital from which they had the most distinct visits

Citation	Description	Attribution Method
		2. Patients were also attributed to the first hospital where they were seen either on their date of diagnosis or the first hospital in which they were seen after the date of diagnosis
Pollack C, Weissman G. Physician social networks and variation in prostate cancer treatment in three cities. Heal Serv Res. 2012; 47(1.2): 380-403.	This study analyzes physician networks and whether they are associated with variations in prostate cancer treatment.	In order to construct physician networks, patients were attributed to several providers:1. Diagnosing urologist. The urologist who billed for a claim on the date of the patient's diagnosis. If no claim was submitted, the patient was attributed to the urologist who saw the patient nearest to the date of diagnosis in the 3 months prior. If no urologist was identified, attribution was made to the urologist who saw the patient nearest to the date of diagnosis in the 3 months following diagnosis.
		2. Majority urologist was defined as the urologist who billed for claims on the most days in the 9 months following diagnosis.

Citation	Description	Attribution Method
		3. PCP was defined as the internal medicine (without subspecialty training), family practice, or general practice physician who billed for the greatest number of visits.
		4. Plurality provide- Patients were attributed to doctors who billed for the greatest numbers of EM visits in the 12 months prior to the date of diagnosis, regardless of their clinical specialty.
		5. Radiation oncologists. For patients who underwent external beam radiation and brachytherapy, attribution was also made to the provider who performed the clinical planning and simulation.
Attribution Using Statistical Modeling		

Citation	Description	Attribution Method
Atlas SJ, Chang Y, Lasko TA, Chueh HC, Grant RW, Barry MJ. Is This "My" Patient? Development and Validation of a Predictive Model to Link Patients to Primary Care Providers. Journal of General Internal Medicine. 2006;21(9):973-978. doi:10.1111/j.1525-1497.2006.00509.x.	In this study, 18 PCPs from MGHN reviewed patient records and designated each patient as "My Patient" or "Not My Patient" in order to develop and validate an approach to link patients to PCPs.	PCPs retrospectively attributed patients to their patient panel by reviewing all records for outpatient visits over a 3 year period. This information was then used to develop an algorithm with logistic regression modeling to attribute patients to providers. The model contained the following variables: PCP designee in registration field, physician practice style, patient age, months since last visit with physician, and patient's residence listed as in state.
Atlas S, Grant R, Ferris T. Patient–physician connectedness and quality of primary care. Ann Intern Med. 2009; 150(5): 325-35.	This article analyzes whether patient connectedness influences measures of physician performance.	The following steps were used to attribute patients to providers: 1. Patient registered with a MGH PCP, 2. Patient had at least one visit to PCP, 3. Patients connected through algorithm. In cases, where a patients was registered with and visited a resident, patients were attributed to a practice group.

Citation	Description	Attribution Method
Lasko TA, Atlas SJ, Barry MJ, Chueh HC. Automated identification of a physician's primary patients. J Am Med Inform Assoc. 2006;13:74–9.	In this study, 18 PCPs from MGHN reviewed patient records and designated each patient as "My Patient" or "Not My Patient" in order to develop and validate an approach to link patients to PCPs.	PCPs retrospectively attributed patients to their patient panel by reviewing all records for outpatient visits over a 3 year period. This information was then used to develop an algorithm with logistic regression modeling to attribute patients to providers. The model contained the following variables: waiting fraction, visit difference, days since last visit, idle ratio, practice style, and future difference.
Attribution in International Contexts		
Kang HC, Hong JS. Do differences in profiling criteria bias performance measurements? Economic profiling of medical clinics under the Korea National Health Insurance program: An observational study using claims data. BMC Health Serv Res. 2011; 11: 189.	This study analyzes how differences in two case-mix classification systems influence the calculation of cost-efficiency indexes for outpatient clinics in South Korea	1. Korean Classification of Diseases- All cases were attributed to clinics. Patients were classified using a 3 digit disease code and subdivided into surgical and non-surgical groups.
		2. Korean Outpatient Group- Only cases with one of the 300 most frequent disease groups are attributed to clinics.

Citation	Description	Attribution Method
Lavergne M. Understanding geographic variation in health care costs in British Columbia. 201. Dissertation, University of British Columbia. Retrieved from https://circle.ubc.ca/handle/2429/52302.	This study examines variations in care through an analysis of multispecialty physician networks in British Columbia, Canada.	For this analysis, patients were assigned to the individual PCP responsible for the plurality of their primary care over the study period. This was measured by fee-adjusted dollars billed within general practice service codes, summed over the study period. In the case of a tie, the patients were assigned to the primary care provider with the most recent visit. Any remaining unlinked residents were assigned to the physician (primary care or specialist) who provided the highest total volume of ambulatory physician services. This was measured by dollars billed for visits, laboratory tests, and diagnostic tests provided in locations other than emergency departments, inpatient hospital or day surgery. Services provided in outpatient and/or ambulatory clinics located in hospitals were included. Residents who had no ambulatory contact with a physician were not linked to a usual provider of primary care, but could be linked to a network if they had hospital service use.

Citation	Description	Attribution Method
Roos NP. Linking Patients to Hospitals: Defining Urban Hospital Service Populations. Medical Care. 1993; 31(5): YS6–15.	This articles analyzes variations in the delivery of health services by defining urban hospital service areas.	Patients were retrospectively attributed to the physician (PCP or specialist) with whom they had the greatest number of ambulatory, out-of-hospital contacts in 1983. Patients were then linked to the hospital where they were seen most frequently by their assigned physician. If they had no hospital visits, then they were attributed to hospital based on where their physician most frequently contacted other patients. When patients could be linked to two or more hospitals, the patient was attributed to the hospital where their assigned physician practiced most often
		Other attribution approaches were also tested including: assigning patients to hospitals based on the plurality of the physicians contacted

Citation	Description	Attribution Method
Stukel T, Glazier R, Schultz S. Multispecialty physician networks in Ontario. Open Med. 2013; 7(2):e40-e55.	This study analyzes multispecialty physician networks to understand how naturally occurring relationships among physicians can be leveraged to foster accountability.	A patient was attributed to the PCP (general practitioner, family practitioner, or pediatrician) with whom he or she had been rostered at the midpoint of the study period. If a patient was not on a roster, he or she was linked to the PCP who provided the greatest amount of primary care services according to billing codes. Remaining unattributed residents were linked to any provider (PCP prioritized) who billed for the greatest number of ambulatory services. Residents without any ambulatory services were not attributed to a physician. Residents were then linked to the hospital where their physician was assigned. Unlinked patients were directly attributed to a hospital if they were admitted or visited an ED.

Citation	Description	Attribution Method
Provost S, Pérez J. An algorithm using administrative data to identify patient attachment to a family physician. Int J Fam Med. 2015; 2015.	The study analyzes an algorithm for attributing to patients to family practitioners using administrative data.	Attribution of patients to providers were done based on an algorithm that first considered a patient's enrollment status to the family group provider. In cases in which patients were not enrolled, patients were attributed to the provider the patient saw for a complete medical examination conducted during a two-year period. If an attribution could still not be made, patients were assigned based on concentration of visits to the same provider over time.
Analyses of Multiple Attribution Approaches		
Damberg C, Sorbero M, Hussey PS, Lovejoy S, Liu H, Mehrotra A. Exploring Episode-Based Approached for Medicare Performance Measurement, Accountability, and Payment. Office of the Assistant Secretary of Planning and Evaluation. 2009. Retrieved from http://aspe.hhs.gov/health/reports/09/mcperform/report.pdf.	This report assesses various episode-based attribution approaches as they related to performance measurement, accountability, and payment in Medicare.	This report analyzed the following attribution approaches: 1. Episode EM visit plurality, at least 30%
		2. Episode professional payment plurality, at least 30%, single physician
		3. Episode professional payment, multiple physician, at least 25%

Citation	Description	Attribution Method
		4. Facility payment plurality, single facility, at least 30%
		5. Facility payment, multiple facility, at least 25%
		6. Episode professional payment plurality and facility payment plurality, at least 30% for each
Delmarva Foundation for Medical Care. Enhancing Physician Quality Performance Measurement and Reporting Through Data Aggregation: The Better Quality Information (BQI) to Improve Care for Medicare Beneficiaries Project. Delmarva Foundation for Medical Care. 2008. Retrieved from http://www.wchq.org/measures/documents/BQI_Final_Report_10_2008.pdf.	This report analyzes the validity and reliability of various attribution approaches for Medicare FFS beneficiaries using claims data.	Patients were retrospectively attributed to physicians using one of the following strategies: A) Potential for Multiple Physicians per Patient 1. One-touch rule- patient is attributed to every physician with whom he/she had at least one EM visit
		2. Two-touch rule- patient is attributed to every physician with whom he/she had at least two EM visits
		3. 30% rule- patient is attributed to every physician who submitted at least 30% of total office visits
		B) One Physician per patient: 1. 50% rule- patient is attributed to the physician who submitted at least 50% of total office visits. If two physicians each have, then the patient is randomly assigned to one physician.

Citation	Description	Attribution Method
		2. Maximum frequency- patient is assigned to the physician with the highest claims based on EM visits. In the case of a tie, a patient is assigned to the physician seen during the most recent visit.
Dowd B, Li C, Swenson T, Coulam R, Levy J. Medicare's Physician Quality Reporting System (PQRS): quality measurement and beneficiary attribution.Medicare & medicaid research review. 2014; 4(2).	This study evaluates the use of the PQRS reporting system to supplement existing attribution algorithms.	Patients were retrospectively attributed to providers using the following approaches: 1. Patients were attributed to the provider who accounted for the plurality of a patient's non-hospital EM visit
		2. Patients were attributed to a provider who reported a measure through the Physician Quality Reporting System
HealthPartners. Assigning Accountability to Health Care Costs: An Observational Study of Assigning Health Care Accountability. 2016. Retrieved from https://www.healthpartners.com/ucm/groups/public	Health Partners is an integrated health care provider and insurance company based in Minnesota. This study involved the analysis of the	The following retrospective attribution approaches were analyzed using claims data: 1. Most Visits: All Settings – The highest percentage of primary care visits in all care settings

Citation	Description	Attribution Method
/@hp/@public/documents/documents/cntrb_031064.pdf	primary care commercial claims for approximately 800,000 HealthPartners members in order to evaluate attribution approaches.	2. Most Visits: Office or Outpatient – The highest percentage of primary care visits in office and outpatient settings.
		3. Most EM Visits – The highest percentage of primary care EM visits.
		3a. Most Visits: Expanded EM – The highest percentage of expanded primary care EM visits.
		4. Majority of EM Visits – Greater than 50% of primary care EM visits.
		5. Majority of Dollars: All Settings – Greater than 50% of primary care dollars.
Hussey P, Sorbero M, Mehrotra A. Using Episodes of Care as a Basis for Performance Measurement and Payment: Moving from Concept to Practice. Heal Aff (Project Hope). 2009; 28(5): 1406-17.	This article identifies key issues related to defining episodes and determining which provider is accountable for an episode	The following attribution approaches were evaluated: 1. The physician with the highest percentage of professional payments, over a minimum of 30%
		2. Any physician with at least 25% of professional payments
		3. The physician with the highest number of EM visits, over a minimum of 30%

Citation	Description	Attribution Method
		4. The facility with the highest percentage of facility payments, over a minimum of 30%
		5. All facilities with at least 25% of facility payments
		6. The facility with the highest percentage of facility payments and the physician with the highest percentage of professional payments, each over a minimum of 30%
Leapfrog Group, Bridges to Excellence. Measuring Provider Efficiency, Version 1.0. 2004. Retrieved from http://www.commonwealthfund.org/publications/other/2004/dec/measuring-provider-efficiency--version-1-0--a-collaborative-multi-stakeholder-effort.	This white paper provides an overview of best practices to improve the measurement or provider efficiency. As part of the recommendations, the pros and cons of several general attribution strategies are described.	1. Highest Cost Clinician- Of the clinician fees within each episode's total claims activity, the clinician with the highest percentage of expenses is assigned responsibility for the total episode.
		2. Clinician's Expense Percentage Threshold Episode - Responsibility is determined based on an established threshold percentage of total eligible clinician fees.
		2a. Single Clinician with Greatest Share of Professional Costs, with Threshold: responsibility is assigned to physician with the greatest share of eligible fees, but must also be greater than a threshold level

Citation	Description	Attribution Method
		3. PCP and Specialist Assignment For HMO and POS: episode assignment is based on either method one or two above, but the episodes would also be assigned to the member's PCP, regardless of whether the PCP had any claims activity within the episode.
		4. Virtual PCPs/Specialists: For non-gate keeper models, the assignment is made to a PCP who is involved in an episode, regardless of the percentage of clinician fees, or based on the overall historical claims history
		5. Assignment to All Involved Clinicians: For every provider involved in every episode, the provider is assigned responsibility for each episode.
		6. Major Procedure Provider: For cases where a "significant" procedure occurs within the case, the provider that renders the service is assigned responsibility for the episode, regardless of the level of involvement of other clinicians.
		7. Most Face-to-Face Encounters

Citation	Description	Attribution Method
Mehrotra A, Adams JL, Thomas JW, McGlynn EA. The effect of different attribution rules on individual physician cost profiles. Ann Intern Med. 2010;152(10):649–54.	This study analyzes 12 different attribution approaches for determining physician cost profiles.	In this analysis, attributions were made retrospectively, but varied on the basis of the components: a. Unit of analysis: Episode- costs are assigned separately for each condition, Patient- all costs for a patient are assigned to one or more physicians; b. Signal of responsibility: Cost- professional costs; Visits- EM visits; c. Number of physicians: Single, Multiple, d. Threshold: Majority- 50% or more, Plurality- 30% or more; Varying the components above, the researchers analyzed the following attribution approaches:1. Episode, cost, plurality
		2. Episode, cost, majority
		3. Episode, visit, plurality
		4. Episode, visit, majority
		5. Patient, cost, plurality
		6. Patient, cost, majority
		7. Patient, visit, plurality
		8. Patient, visit, majority

Citation	Description	Attribution Method
		9. Episode, cost, multiple-physician
		10. Episode, visit, multiple-physician
		11. Patient, cost, multiple-physician
		12. Patient, visit, multiple-physician
Pham H, O'Malley A. Primary care physicians' links to other physicians through Medicare patients: the scope of care coordination. Ann Intern Med. 2009; 150(4): 236-42.	This study analyzes the number of physicians providing primary care to Medicare patients.	Patients were attributed using the following strategies: 1. PCP that billed the greatest number of EM visits (Plurality assignment)
		2. PCP that billed for at least 50% of EM visits in the year 2005. Ties were resolved in both strategies by assignment to the physician who billed for the greatest total charges for that beneficiary.

Citation	Description	Attribution Method
Pham HH, Schrag D, O'Malley AS, Wu B, Bach PB. Care patterns in Medicare and their implications for pay for performance. N Engl J Med. 2007;356(11):1130-1139. doi:10.1056/NEJMsa063979.	Medicare Claims This study is an analysis of Medicare claims data for FFS beneficiaries that were treated by physicians who responded to the Community Tracking Physician Survey in 2000 and 2001.	Patients were retrospectively attributed to physicians using the following approaches: 1. Plurality Algorithm- Patients were assigned to the physician (or practice) with whom they had the most EM visits in a given year. To resolve ties, PCPs were prioritized followed by the physician who billed for the greatest number of charges.
		2. Plurality PCP algorithm- excludes specialists and assigns patients on the basis of primary care EM visits
		3. Majority provider algorithm- assigns patients according to the plurality of EM visits with the additional criterion that plurality must be at least 50%
		4. Multiple provider algorithm- patients were assigned to all providers who billed for at least 25% of their EM visits
Ramsey GW. Evaluating policies using agent–based simulations: investigating policies for continuity of care. International Journal of Simulation and Process Modelling. 2014; 9(4): 255-269.	This study uses agent-based simulations to evaluate different approaches to promote the continuity of care for patients with type 2	Patients were attributed to physicians using one of the following approaches: 1. Continuous care- each patient is randomly assigned a specific physician model for continuous care across visits

Citation	Description	Attribution Method
	diabetes.	2. Opportunistic care- each patient on each visit is opportunistically (randomly) assigned to a physician
Scholle S, Roski J, Dunn D. Availability of data for measuring physician quality performance. Am J Manag Care. 2009; 15(1):67-72.	This study evaluates how different attribution approaches influence the availability of data to assess the quality of care provided by PCPs.	The following methods to attribute patient measures to PCPs were evaluated in the study: 1. A patient was attributed to a physician if the patient had 1 or more visits during the time period
		2.Patients were retrospectively attributed to physicians that conducted at least 30% of ambulatory visits
		3. Patients were retrospectively attributed to physicians that conducted at least 50% of ambulatory visits
Scholle SH, Roski J, Dunn DL, et al. Availability of data for measuring physician quality performance. Am J Manag Care. 2009; 15(1):67–72.	This articles evaluates physician quality performance using administrative data from 9 health plans.	The following retrospective attribution approaches were analyzed: 1. A patient was attributed to a PCP if the patient had 1 or more outpatient visits during the prescribed time frame.

Citation	Description	Attribution Method
		2. A patient was attributed to a physician if the patient completed at least 30% of his or her ambulatory visits with that physician.
		3. A patient was attributed to a physician if the patient completed at least 50% of his or her ambulatory visits with that physician.
Sharma G, Fletcher K, Zhang D. Continuity of outpatient and inpatient care by primary care physicians for hospitalized older adults. JAMA. 2009; 301(16): 1671-80.	This article examines the continuity of care in hospitalized Medicare patients.	Patients were attributed using two approaches: 1. Beneficiaries were retrospectively attributed to the PCPs (a general practitioner, family physician, general internist, or a geriatrician) who had billed an outpatient EM code for the patient on three or more occasions in the year prior to the hospitalization.
		2. Beneficiaries were also retrospectively attributed to any physician who had billed at least one outpatient EM code in the prior year.
Thomas JW. Economic profiling of physicians: does omission of pharmacy claims bias performance measurement? Am J Manag Care. 2006;12(6):341–351.	This article evaluates the development of physician economic profiles using pharmaceutical claims.	Patients were retrospectively attributed to physicians using claims data: 1. Physicians accounted for at least 50% of the combined professional and prescribing costs
		2. Physicians accounted for at least 30% of the

Citation	Description	Attribution Method
		combined professional and prescribing costs
		3. Physicians accounted for at least 50% of professional costs
		4. Physicians accounted for at least 30% of professional costs
Thorpe C, Johnson H, Dopp A. Medication oversupply in patients with diabetes. Res Social Adm Pharm. 2015; 11(3): 382-400.	This study analyzes the supply of medications among diabetes patients managed by a large, multispecialty physician group.	The study analyzed the following approaches: 1.Plurality Provider Algorithm- Patients were prospectively attributed to the group accounting for the greatest number of EM visits in a given year;
		2. The "Diabetes Care Home" method- Patients were attributed to a provider group in a given year if they had ≥2 EM visits to a PCP or one visit to a PCP and one visit to an endocrinologist, over the current and prior year.

Citation	Description	Attribution Method
Wagner E, Coleman K, Reid RJ, Phillips K, Sugarman JR. Guiding Transformation: How Medical Practices can Become Patient-Centered Medical Homes: The Commonwealth Fund. 2012. Retrieved from http://www.collaboration healthcare.com/7-24-12CommonwealthMedicalPracticeto MedicalHomeFebruary2012.pdf	This reports provides guidelines on how to establish patient-centered medical homes	Patients are prospectively attributed to a PCP using the following steps: 1. Assign all patients who have only ever seen one provider to that provider. 2. Develop a list of patients with their last three to five providers seen. 3. Assign patients who have seen a provider the majority of times to the majority provider. 4. Allow clinic teams to talk through the rest of the patients and where they belong. Providers and patients then review assignments and approve links.
Other		
Cebul RD. Using electronic medical records to measure and improve performance. Trans Am Clin Climatol Assoc. 2008; 119:65–75.	This study analyzes the use of EMRs to measure the quality of primary care.	Patients were retrospectively attributed to a PCP according to where they received the majority of EM visits. PCPs then confirmed that the patients attributed to them were their patients.
Garnick DW, Fowles J, Lawthers AG, Weiner JP, Parente ST, Palmer RH. Focus on quality: profiling physicians' practice patterns. J Ambul Care Manage. 1994; 17(3):44–75.	This article describes the use of Medicare data to develop physician practice profiles.	Patients were retrospectively attributed to a PCP (internist, family practitioner, general practitioner) who provided the majority of care in terms of "face-to-face" visits. Total charges were used to resolve ties.

Citation	Description	Attribution Method
Hillman BJ, Olson GT, Griffith PE, Sunshine JH, Joseph CA, et al. Physicians' utilization and charges for outpatient diagnostic imaging in a medicare population. JAMA. 1992; 268(15):2050–54.	The article analyzes physicians' utilization of and charges of diagnostic imaging.	Patients were attributed to the nonradiologist provider who submitted a claim for the index imaging study. If no claims were submitted by nonradiologists, patients were attributed to the provider who referred the patient to a radiologist.
Hussain T, Chang H, Veenstra C, Pollack C. Fragmentation in specialist care and stage III colon cancer. Cancer. 2015; 121(18):3316-24.	This study explores whether receiving oncology care at more than one hospital is associated with cost and outcomes.	Patients were attributed to a provider in each of the following categories: 1. For surgical care, the operative surgeon was identified as the patient's surgeon, and the location of the procedure was the patient's surgical hospital. For the patients who had more than 1 colon cancer surgery, the assignment of surgical care was based on the first operation.
		2. For oncologic care, patients were assigned to the medical oncologists who billed for the plurality of their visits in the year following their diagnosis and were then designated the hospital at which these oncologists were most likely to practice. Oncologists were assigned to the hospital at which they billed for the most inpatient care. Oncologists who did not bill any inpatient claims were assigned to the hospital to which most of their patients were admitted.

Citation	Description	Attribution Method
Kralewski J, Dowd B, Knutson D, Tong J, Savage M. The relationships of physician practice characteristics to quality of care and costs. Health Serv. Res. 2015; 50(3):710–29.	This study analyzes the association between practice characteristics and quality	Beneficiaries were retrospectively attributed to practices if they received a plurality of their nonhospital evaluation and management (E&M) visits from a physician associated with the practice
Nyweide D, Weeks W. Relationship of primary care physicians' patient caseload with measurement of quality and cost performance. JAMA. 2009; 302(22):2444-50.	This study analyzes whether PCPs see sufficient numbers of patients to detect meaningful differences in the quality of care they provide to Medicare patients.	Patients were retrospectively attributed to all PCPs (defined as defined as internists, family practitioners, general practitioners, or geriatricians) in which they had a least one outpatient visit.
O'Malley A. Interspecialty communication supported by health information technology associated with lower hospitalization rates for ambulatory care–sensitive conditions. J Am Board Fam Med. 2015; 28(3): 404-17.	This article analyzes the association between primary care practice capabilities and hospitalizations for Medicare patients with certain chronic diseases.	Beneficiaries were retrospectively attributed to the physician who provided the plurality of their outpatient EM visits. Emergency physicians, hospitalists, surgeons, and certain medical subspecialties unlikely to serve as a patient's usual PCPs were excluded

Citation	Description	Attribution Method
Perloff J. Comparing the Cost of Care Provided to Medicare Beneficiaries Assigned to Primary Care Nurse Practitioners and Physicians. Health Serv Res. 2015; In Press.	This article analyzes differences in the cost of care provided to Medicare patients assigned to NPs and physicians.	Beneficiaries were retrospectively attributed to the single largest provider (pcp) of EM services in terms of cost. A 30% minimum threshold was imposed. In order to resolve ties, one pcp was randomly selected.
Perloff J, Meagher J, Bishop C, Tompkins C. Time to Readmission Among Chronically Ill Community-Resident Beneficiaries: Variations by Geographic Area and Provider Type FINAL Report. 2010. Retrieved from https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/Reports/downloads/perloff_commdwellers_adverseeventschronillness_2010.pdf.	This report assesses the affect of continuity of care on the likelihood for readmissions among chronically ill patients.	Beneficiaries were retrospectively attributed to the single largest provider of EM services.
Peterson G, Xia Z, Hughes J, Wilcox L. Working Paper: Rewarding Physicians for Their Patients' Health Outcomes: What can Medicare Learn from Education's Value-Added Models. Mathematica Policy Research. 2012. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.261.3604&rep=rep1&type=pdf.	This report draws from education research to assess how approaches to reward teacher performance can be applied to value-based purchasing in health care.	Patient were retrospectively attributed only to the doctor who provided the most EM services to that patient during the year.

Citation	Description	Attribution Method
Romaire M, Haber S, Wensky S, McCall N. Primary care and specialty providers: an assessment of continuity of care, utilization, and expenditures. Med Care. 2014; 52(12): 1042-9.	This study analyzes health service use among Medicare patients by primary provider type (PCP or specialist).	Beneficiaries were attributed to the PCP who the beneficiary saw for the plurality of their FFS EM ambulatory visits. Attribution could be made to a PCP or certain types of specialist physicians.
Weiner JP, Parente ST, Garnick DW, Fowles J, Lawthers AG, Palmer RH. Variation in office-based quality. a claims-based profile of care provided to medicare patients with diabetes. JAMA. 1995; 273(19):1503–8.	This study conducts physician profiles for diabetes care to analyze variations in quality	Beneficiaries were retrospectively attributed to the PCP who provided more face-to-face office visits than any other provider or group. Ties were resolved by assigning patients to the PCP who provided the most intensive services (as defined by the relative value of visits and procedures).

National Quality Forum
1030 15th St NW, Suite 800
Washington, DC 20005
http://www.qualityforum.org