

The Power of Contribution and Attribution in Assessing Educational Outcomes for Individuals, Teams, and Programs

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The Power of Contribution and Attribution in Assessing Educational Outcomes for Individuals, Teams, and Programs

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Abstract

Recent discussions have brought attention to the utility of contribution analysis for evaluating the effectiveness and outcomes of medical education programs, especially for complex initiatives such as competency-based medical education. Contribution analysis focuses on the extent to which different entities *contribute* to an outcome. Given that health care is provided by teams, contribution analysis is well suited to evaluating the outcomes of care delivery. Furthermore, contribution analysis plays an important role in analyzing program- and system-level outcomes that inform program evaluation and program-level improvements for the future. Equally

important in health care, however, is the role of the individual. In the overall contribution of a team to an outcome, some aspects of this outcome can be *attributed* to individual team members. For example, a recently discharged patient with an unplanned return to the emergency department to seek care may not have understood the discharge instructions given by the nurse or may not have received any discharge guidance from the resident physician. In this example, if it is the nurse's responsibility to provide discharge instructions, that activity is attributed to him or her. This and other activities attributed to different individuals (e.g., nurse, resident) combine

to contribute to the outcome for the patient. Determining how to tease out such attributions is important for several reasons. First, it is physicians, not teams, that graduate and are granted certification and credentials for medical practice. Second, incentive-based payment models focus on the quality of care provided by an individual. Third, an individual can use data about his or her performance on the team to help drive personal improvement. In this article, the authors explored how attribution and contribution analyses can be used in a complimentary fashion to discern which outcomes can and should be attributed to individuals, which to teams, and which to programs.

We split paradoxes so reflexively that we do not understand the price we pay for our habit. The poles of a paradox are like the poles of a battery: hold them together, and they generate the energy of life; pull them apart, and the current stops flowing.

—Parker Palmer¹

Discussions over the past several years have focused on the importance of evaluating the outcomes of medical education programs and efforts.²⁻⁴ The call for this focus is not new.⁵ In fact, competency-based medical education (CBME) has become the prevailing approach to medical education over the

past 2 decades, and it puts primary focus on ensuring that outcomes of medical education programs prepare individuals to meet the needs of patients.⁶⁻⁹ However, despite the popularity of CBME, meaningful transition to this approach, which focuses on the outcome of meeting the needs of populations that we serve, has been challenging. Stated simply, we do not reliably know if graduates are prepared for clinical practice after training because assessment of medical trainees typically lacks defensible validity and reliability, and information on education and patient care outcomes is limited at best. This problem is pervasive across the education, training, and practice continuum, and the Institute of Medicine (now the National Academy of Medicine) and the Medicare Payment Advisory Commission have bemoaned the shortcomings of residency training in meeting the needs of patients.^{10,11} Greater understanding and improvement in the area of medical education program outcomes as well as practice outcomes will require determining how some aspects of care and processes can be *attributed* to individuals, whereas other

aspects of care and processes are the result of several individuals *contributing* to the outcome. However, only the latter has received focus in recent conceptual discussions in the literature.

Scholars have recently advocated for contribution analysis as an approach to meaningfully evaluate the effectiveness and outcomes of medical education programs,^{12,13} especially for complex initiatives for which it is important to determine how several components must come together to produce an outcome, such as those of CBME.¹⁴ Contribution focuses on the extent to which different entities *contribute* to an outcome. However, the full contribution story for how an outcome is produced contains components that can be *attributed* to individuals that have varying degrees of influence on producing that outcome. For example, a recently discharged patient with an unplanned return to the emergency department to seek care may not have understood the discharge instructions given by the nurse or may not have received any discharge guidance from the resident physician. In this example,

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activities that are *attributable* to individuals (e.g., nurse, resident) combine to *contribute* to the outcome for the patient.

As this example illustrates, health care is the result of teamwork, which is likely why contribution analysis has rightly received attention. However, focusing on aspects of care *attributed* to individuals and providing these individuals with data related to their performance on the team also have value. Recent work by some authors of this paper has resulted in the creation of resident-sensitive quality measures. These quality measures are based on their importance to a specific illness as well as the likelihood of the action that is measured being performed by a resident and not by another member of the team or the team collectively. Thus, resident-sensitive quality measures are an example of an effort that can address outcomes of care attributable to individuals.^{15,16} While these measures are still being studied, they have potential utility given current trends in managed care payment models, such as the Merit-based Incentive Payment System, a program of the Centers for Medicare and Medicaid Services (CMS), that seek to reimburse for care provided partly on the basis of the demonstrated quality of that care provided by individuals. Furthermore, focusing on individuals may be the most effective way to drive their personal improvement.^{17,18} Additionally, without individual-level feedback, it is easy to fall prey to fundamental attribution error, a bias to view oneself as responsible for positive outcomes but not for undesirable ones.¹⁹ While program- and system-level outcomes are important for informing program evaluation and program-level improvements for the future, we can and should graduate, certify, and credential individuals, and we may be required to use managed care payment models—such as the CMS Merit-based Incentive Payment System—that are based on demonstrated quality of care provided by individuals. It is not practical to carry out processes such as certifying or credentialing at the team level; such efforts would require new decisions several times a day, each time a team member changed. Thus, it is important to be able to determine an individual's performance. In summary, while a focus on contribution is important, we also need to focus on what aspects of care can be largely *attributed* to individuals.

If we apply Parker Palmer's analogy,¹ quoted in the epigraph, to the topic at hand, we can see attribution and contribution as the 2 opposite poles of a battery. By considering both, we can generate sufficient voltage to power the understanding of outcomes in medical education for individuals as well as for teams and programs. However, if we follow the recent conversation in the medical education literature, which has focused solely on contribution analysis and advocated "moving away from attribution analysis in favor of contribution analysis,"¹² there's a risk that the "current stops flowing" to consideration of both individual- and program-level outcomes in medical education. Heeding the words of Palmer relies on the "power of 'and,'" that is, seeing the benefit that both contribution and attribution bring to analysis, making the whole greater than the sum of its parts. It is possible, perhaps even likely, that those who have written about contribution analysis also value a focus on attribution for different purposes. However, we believe that explicitly defining the role of attribution for individuals, as well as its role in the attribution-to-contribution continuum, is important for 2 reasons: realizing the full potential of attribution and making attribution transparent. Therefore, in this article, we will explore how attribution can be used to assess individuals in medical education. We will first briefly review contribution analysis to detail how this approach can be harnessed to create an argument for attribution analysis. Then we will delineate how attribution analysis can be used to discern what outcomes can and should be attributed to individuals on teams, in programs, and within systems.

Focusing on Programs and Teams: Contribution Analysis

Contribution analysis emerged in 2001 as a means of qualitatively evaluating civic programs and the outcomes they are seeking to achieve. John Mayne, who developed contribution analysis, felt that the changing culture of public administration at the time required greater accountability for the outcomes of civic programs.²⁰ He thought that contribution analysis could help "managers, researchers, and policymakers to arrive at conclusions about the contribution their program has made to

particular outcomes."²⁰ Recent years, and the continued momentum of CBME, have seen similar calls for accountability in the outcomes of medical education programs.^{2–4,21} These circumstances make contribution analysis an excellent fit for this purpose, as medical education scholars have advocated.¹²

The complex nature of the real world means there are many influences on an outcome. The goal of contribution analysis is to determine the extent to which individual entities affect an overall outcome.²² In this analysis, it is assumed there will be a given level of uncertainty present in the determination of the drivers of the outcomes of interest. As shown in Table 1, Mayne describes 6 steps in contribution analysis^{12,20}: (1) set out the causal problem to be addressed, (2) develop the postulated theory of contribution and identify risks to the theory, (3) gather the existing evidence to support the theory of contribution, (4) assess the contribution story and the contestations to it, (5) seek out additional evidence, and (6) revise and strengthen the contribution story. As detailed in the next section, Table 1 further delineates how these steps can be applied to determining the contribution of program outcomes, the attribution of individual outcomes, and the interactions between contribution and attribution in CBME.

Focusing on Individuals: Attribution Analysis

We believe that the contribution analysis process can be used to define attribution analysis as well, seeking to build an evidentiary argument for what activities can be largely or entirely attributed to individuals. Indeed, in his conceptualizations of contribution analysis, Mayne made the case that contribution begins with what can be attributed to individual entities; clearly, attribution is seen to be a part of the contribution story.^{20,23} The full contribution story of how an outcome is produced includes individuals, activities, and entities to whom varying degrees of influence in producing that outcome are *attributed*. However, discussions of applying contribution analysis in medical education have approached contribution and attribution as more of a dichotomy, advocating contribution over attribution.^{12,24} This tendency may be because of the focus on outcomes of

Table 1

Mayne's 6 Steps of Contribution Analysis Applied to Contribution of Program Outcomes, Attribution of Individual Outcomes, and Interactions Between Contribution and Attribution in Competency-Based Medical Education

Step	Contribution analysis (Mayne ²⁰)	Contribution analysis to determine outcomes for programs	Attribution analysis to determine outcomes for individuals	Contribution-attribution interaction considerations
1	Set out the causal problem to be addressed.	Recognize how influencing factors may shape the implementation of the program.	Set out the attributable factor to the individual trainee on the team.	Competent individuals (attribution) can come together to form an incompetent team (contribution), but teams can be competent even when 1 team member is incompetent. ²⁷
2	Develop the postulated theory of contribution and identify risks to the theory.	Identify the factors that are most likely to influence the outcomes, as well as the assumptions and risks anticipated for the outcomes.	Explain and justify why these tasks are attributable to individual trainees, taking into account who else could be completing the tasks.	The capabilities and management style of the team leader affect the morale and motivation of the team in a positive or negative way; in the former, there may be more help given to other team members by those not primarily assigned to tasks. ²⁸
3	Gather the existing evidence to support the theory of contribution.	Gather as much concrete evidence as possible (e.g., quantitative, qualitative), including focusing on what pathways look like for residents as they progress and how curricular activities associated with the program contribute to development of these pathways.	Gather evidence demonstrating the linkage of the tasks to individual trainee actions, realizing that context is important: While the superficial elements of the task may change, the core elements remain stable. ^{29,30}	In the real world, most tasks are completed collectively by more than 1 individual member of the team (contribution). There are parts of tasks that may or may not be more attributable to individual members on that team. It is important to consider this overlap.
4	Assess the contribution story and the contestations to it.	Put steps 1 through 3 together, ensuring the context is thoroughly described, the theory of change is plausible, results are explained, and other possible factors are discussed.	Look at the big picture context created to this point and evaluate whether the attribution is valid. Work should include attempting to discern whether the process measure under consideration is truly attributable to an individual trainee rather than to another member of the team or to the team as a collective.	Assess whether activities felt to be attributable to individuals are done by those individuals or by others (either individuals or teams). Determine if activities performed by the team should actually be the responsibility of an individual on the team instead.
5	Seek out additional evidence.	Find additional data as necessary.	Continue to seek out more information to support the claim that the process measure is attributable to the individual trainee.	As noted in step 3, parts of tasks may be more attributable to individual members on a team than to the team as a whole. The importance of consideration of this overlap is reflected in this step, which seeks out additional evidence to consider this overlap and its resultant interactions.
6	Revise and strengthen the contribution story.	Use the new evidence from step 5 to create a stronger contribution story.	Reconsolidate the new information gathered in step 5 to create a clearer alignment of the relationship between the individual trainee and the task measured.	This is the final opportunity in a given iteration to consider the following: (1) Which activities that should be attributable to individuals are actually done by individuals and which are done by others (either individuals or teams)? (2) Which activities performed by the team should actually be performed by teams and which should be owned by an individual on the team?

CBME programs. As discussed previously, we view this conversation of attribution and contribution as a “both, and” rather than an “either, or” for medical education; both lenses can be very useful, depending on the desired focus. Indeed, Mayne conceptualized a continuum between attribution and contribution.

Mayne's attribution–contribution continuum

In his early work, Mayne described a results chain where an “activity”

produces 3 types of progressively more distal outcomes.²⁰ This chain, shown on the left side of Figure 1, begins with the “output/reach,” akin to process measures in medicine (e.g., patient has an asthma action plan documented with primary care provider). A little further out are “intermediate outcomes,” akin to medicine’s quality measures of the same name (e.g., steroid courses each year and pulmonary function testing). Most distal are “end outcomes,” akin to true outcome measures in medicine (e.g., number

of emergency department visits or hospitalizations for asthma each year). As in medicine, Mayne’s model considers the additional factors beyond the individual that affect results further downstream. For example, intermediate and end outcomes can be affected by patient inhaler technique, access to medications, and the presence of dusts and molds in the home.

The second column of Figure 1 shows an example of the results chain for

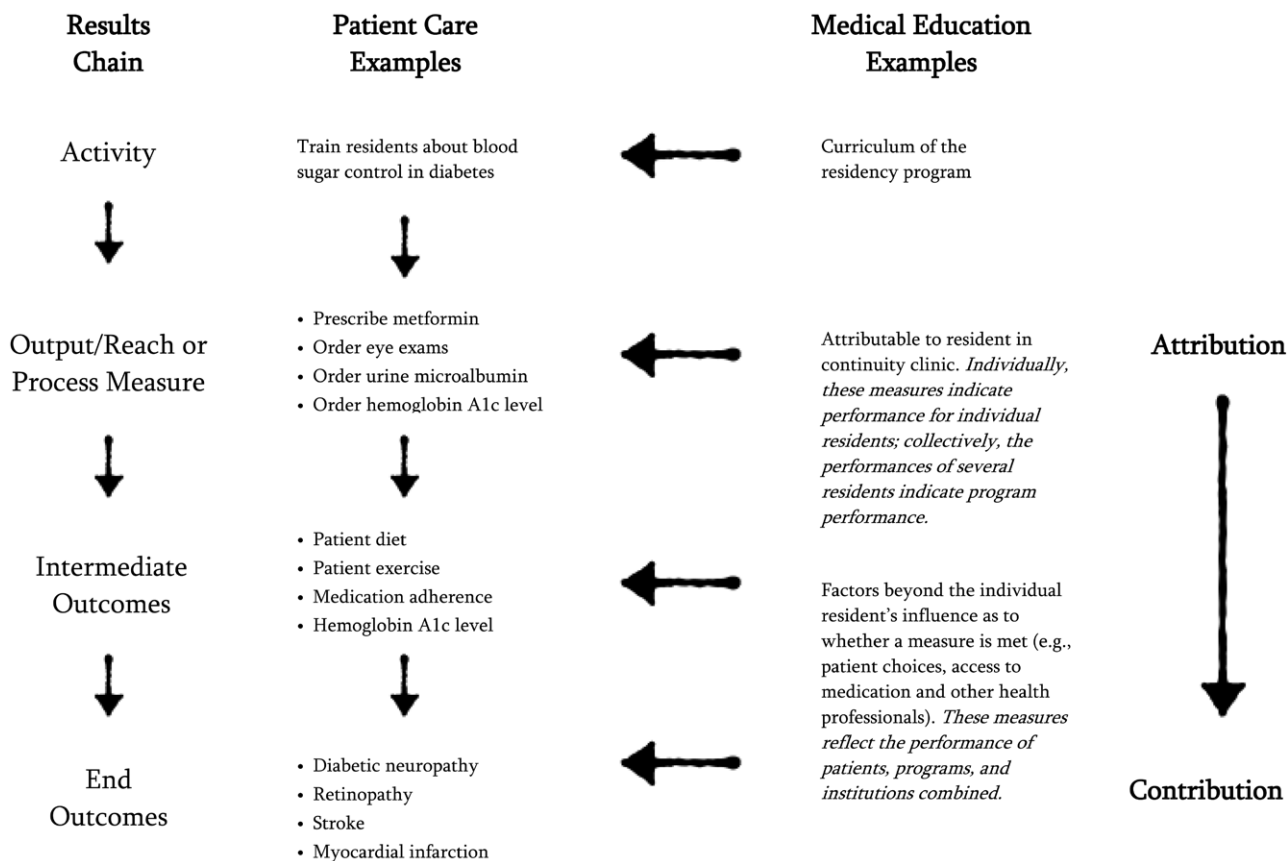


Figure 1 Process and outcome measures for patients, individuals, and programs. This results chain shows attribution and contribution in medical education for the activity of training residents about blood sugar control in diabetes. Starting with output/reach or process measures, which are attributable to individuals, the chain is completed with end outcomes, which result from many individuals' contributions.

blood sugar control in a patient with diabetes, an activity that residents (the focus of this example) can learn. When only the resident caring for a patient with diabetes is considered, the following can be used to determine that resident's performance: process measures such as ordering the proper medication regimen (e.g., metformin) and appropriate screening (e.g., eye exams, urine microalbumin). As Figure 1 shows, these activities can be mostly attributed to the individual resident (i.e., the resident either ordered or did not order a urine microalbumin). Moving down the results chain, intermediate outcome measures include actual patient diet and exercise, medication adherence, and hemoglobin A1c levels; end outcome measures include diabetic neuropathy, retinopathy, stroke, and myocardial infarction. These intermediate and end outcomes include factors that cannot be controlled by an individual resident (e.g., access to medications, patient medication adherence, actual patient diet) *contributing* to whether or not the measures are achieved. Thus,

these measures are best positioned to be considered through the lens of contribution rather than attribution.¹³

The measures detailed in Figure 1 are not only relevant for patients but also for residents and their training programs as well as individual practitioners after training and their institutions. As this discussion illustrates, quality measures that can be used in medical education can and should be the same as those used in quality improvement efforts, such as the CMS Merit-based Incentive Payment System. Performance on the process measures reflects the individual provider; performance collectively, across multiple providers, indicates the outcomes of the program or clinic. Performance on the intermediate and end outcome measures reflects the performance of the patient, training program or clinic, and institution combined.

Defining attribution analysis

Given the continuum between attribution and contribution, we believe contribution analysis can be applied to individuals.

Specifically, we believe the same steps used in contribution analysis can be applied to individuals to define attribution analysis and to determine specific components of individuals' performances that can be attributed to them. This approach provides education scholars with a method for collecting evidence when they are attempting attribution studies rather than plugging in multiple variables and seeing "what sticks." We detail the steps for our proposed attribution analysis using residents as an example; we also compare these steps with the parallel steps of contribution analysis in Table 1:

1. *Set out the causal problem to address in individual performance.* For residents, this includes tangible tasks that residents—rather than other members of the health care team—regularly complete. At this early step, it is important to consider whether the proposed attributable task should be within the scope of work of the individual of interest. The individual may only perform this task to compensate for a dysfunctional

microsystem or interprofessional team in which the person (or people) who should be performing the task is not doing so. Such potential attributable factors should be excluded and focus placed on improving the microsystem or team performance.

2. *Develop the postulated theory of attribution and identify risks to the theory.* Explain and justify why these tasks are attributable to residents, taking into account who else could be completing the tasks.
3. *Gather the existing evidence to support the theory of attribution.* Evidence should demonstrate that selected tasks actually reflect resident actions.
4. *Assess the attribution story and the contestations to it.* Look at the big picture context created to this point and evaluate whether the attribution is valid in the context of the clinical learning environment. This evaluation should include attempting to understand whether the process measure under consideration is truly highly attributable to the resident rather than to another member of the team or to the team as a collective.
5. *Seek out additional evidence.* Continue to seek out more information to support the claim that the process measure is attributable to the resident, for example, by conducting chart reviews and/or direct observation combined with discussions with a variety of stakeholders such as families and other members of the health care team.
6. *Revise and strengthen the attribution story.* Integrate the new information gathered in step 5 to create a clearer alignment of the relationship between the resident and the task measured.

Further building from Mayne's conceptualization of attribution, completing these steps will help to infer "probabilistic causation" between an individual's actions and the measure.²⁵ Mayne asserts that 5 criteria must be met to establish this probabilistic causation: plausibility, implementation according to plan, evidentiary confirmation of key elements, taking other influencing factors into account, and disproving alternate explanations.

In previous work, we have taken some of the 6 steps of this attribution analysis

plan in developing resident-sensitive quality measures.^{15,16} By taking this focus, we sought to address the requirements of step 1 and develop the postulated theory of attribution component of step 2. We then gathered existing evidence for this theory (step 3) and identified risks to it (the other component of step 2) by assembling content experts (residents and supervisors) to brainstorm and prioritize potential resident-sensitive quality measures. Our current work with these measures will achieve steps 4 through 6 and include implementing them in the clinical setting to determine if residents or others perform the work under consideration. We will also be able to ascertain whether these measures are indeed important to the quality of care for our initial diagnoses of interest.

The Power of Harnessing Both Contribution and Attribution

Using both contribution and attribution analyses, we can evaluate a program as a collective while also measuring the progress of the individuals that regulators must certify. Creating and using these measures will help to further resident education but can also be built upon by considering feedback from patients and team members (e.g., nurses) to create measures for more intangible skills, such as communication and patient rapport. This approach creates valuable feedback for individual improvement with tangible goals while also providing actionable feedback to programs to better facilitate the education of their staff. This "both, and" rather than "either, or" thinking is evoked in the epigraph.

Conclusion

The challenge of linking educational outcomes to patient care outcomes—our greatest challenge on the education horizon—may well be served by using contribution *and* attribution analyses as the first step toward pulling apart and examining the intertwined performance strands. Such an approach allows us to see how each strand (attribution of individual performance) is intertwined in team performance and how the whole thread (contribution analysis) links team performance to care outcomes for patients. In these efforts, medical education may benefit from following the trajectory of quality improvement, which began as a focus on individual

responsibility for outcomes but evolved to focus on team responsibility with shared accountability among individuals and teams.²⁶

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References

- 1 Palmer P. *The Courage to Teach: Exploring the Inner Landscape of a Teacher's Life*, 20th Anniversary Edition. San Francisco, CA: Jossey-Bass; 2017.
- 2 Weiss AP. Measuring the impact of medical research: Moving from outputs to outcomes. *Am J Psychiatry*. 2007;164:206–214.
- 3 Weinstein DF, Thibault GE. Illuminating graduate medical education outcomes in order to improve them. *Acad Med*. 2018;93:975–978.
- 4 Chahine S, Kulasegaram KM, Wright S, et al. A call to investigate the relationship between education and health outcomes using Big Data. *Acad Med*. 2018;93:829–832.
- 5 McGaghie WC MG, Sajid AW, Telder TV. *Competency-Based Curriculum*

- Development in Medical Education: An Introduction. Geneva, Switzerland: World Health Organization; 1978.
- 6 Frank JR, Snell LS, Cate OT, et al. Competency-based medical education: Theory to practice. *Med Teach*. 2010;32:638–645.
 - 7 Iobst WF, Sherbino J, Cate OT, et al. Competency-based medical education in postgraduate medical education. *Med Teach*. 2010;32:651–656.
 - 8 Carraccio C, Wolfsthal SD, Englander R, Ferentz K, Martin C. Shifting paradigms: From Flexner to competencies. *Acad Med*. 2002;77:361–367.
 - 9 Carraccio C, Englander R, Gilhooly J, et al. Building a framework of entrustable professional activities, supported by competencies and milestones, to bridge the educational continuum. *Acad Med*. 2017;92:324–330.
 - 10 Medicare Payment Advisory Commission. Report to the Congress: Improving Incentives in the Medicare Program. Washington, DC: Medicare Payment Advisory Commission; June 2009.
 - 11 Eden J, Berwick D, Wilensky G. Graduate Medical Education That Meets the Nation's Health Needs. Washington, DC: Institute of Medicine of the National Academies; 2014.
 - 12 Van Melle E, Gruppen L, Holmboe ES, Flynn L, Oandasan I, Frank JR; International Competency-Based Medical Education Collaborators. Using contribution analysis to evaluate competency-based medical education programs: It's all about rigor in thinking. *Acad Med*. 2017;92:752–758.
 - 13 Moreau KA, Eady K. Connecting medical education to patient outcomes: The promise of contribution analysis. *Med Teach*. 2015;37:1060–1062.
 - 14 Dauphinee WD. Educators must consider patient outcomes when assessing the impact of clinical training. *Med Educ*. 2012;46:13–20.
 - 15 Schumacher DJ, Holmboe ES, van der Vleuten C, Busari JO, Carraccio C. Developing resident-sensitive quality measures: A model from pediatric emergency medicine. *Acad Med*. 2018;93:1071–1078.
 - 16 Schumacher DJ, Martini A, Holmboe E, et al. Developing resident-sensitive quality measures: Engaging stakeholders to inform next steps. *Acad Pediatr*. 2019;19:177–185.
 - 17 Sandars J, Cleary TJ. Self-regulation theory: Applications to medical education: AMEE guide no. 58. *Med Teach*. 2011;33:875–886.
 - 18 Schon DA. *The Reflective Practitioner: How Professionals Think in Action*. New York, NY: Basic Books, Inc; 1983.
 - 19 Klein J. Attribution biases in assigning blame for medical error. *Med Educ*. 2017;51:982–983.
 - 20 Mayne J. Addressing attribution through contribution analysis: Using performance measures sensibly. *Can J Program Eval*. 2001;16:1–24.
 - 21 Weinstein DF. Optimizing GME by measuring its outcomes. *N Engl J Med*. 2017;377:2007–2009.
 - 22 Patton MQ. A utilization-focused approach to contribution analysis. *Evaluation*. 2012;18:364–377.
 - 23 Dybdal L, Nielsen SB, Lemire S. Contribution analysis applied: Reflections on scope and methodology. *Can J Program Eval*. 2010;25:29–57.
 - 24 Govaerts MJB, van der Vleuten CPM, Holmboe ES. Managing tensions in assessment: Moving beyond either-or thinking. *Med Educ*. 2019;53:64–75.
 - 25 Mayne J. Contribution analysis: Addressing cause and effect. In: Forss K, Marra M, Schwartz R, eds. *Evaluating the Complex: Attribution, Contribution and Beyond*. New Brunswick, NJ: Transaction Publishers; 2011.
 - 26 Dekker S. *Just Culture: Restoring Trust and Accountability in Your Organization*. 3rd ed. Boca Raton, FL: CRC Press; 2016.

References cited in Table 1 only

- 27 Lingard L. Paradoxical truths and persistent myths: Reframing the team competence conversation. *J Contin Educ Health Prof*. 2016;36:S19–S21.
- 28 Baker DP, Salas E, King H, Battles J, Barach P. The role of teamwork in the professional education of physicians: Current status and assessment recommendations. *J Qual Patient Saf*. 2005;31:185–202.
- 29 Horsley T, Regehr G. When are two interventions the same? Implications for reporting guidelines in education. *Med Educ*. 2018;52:141–143.
- 30 Cianciolo AT, Regehr G. Learning theory and educational intervention: Producing meaningful evidence of impact through layered analysis. *Acad Med*. 2019;94:789–794.