


RESEARCH REPORT

Creativity in problem solving to improve complex health outcomes: Insights from hospitals seeking to improve cardiovascular care

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Funding information

Medicines Company

Abstract

Introduction: Improving performance often requires health care teams to employ creativity in problem solving, a key attribute of learning health systems. Despite increasing interest in the role of creativity in health care, empirical evidence documenting how this concept manifests in real-world contexts remains limited.

Methods: We conducted a qualitative study to understand how creativity was fostered during problem solving in 10 hospitals that took part in a 2-year collaborative to improve cardiovascular care outcomes. We analyzed interviews with 197 hospital team members involved in the collaborative, focusing on work processes or outcomes that participants self-identified as creative or promoting creativity. We sought to identify recurrent patterns across instances of creativity in problem solving.

Results: Participants reported examples of creativity at both stages typically identified in problem solving research and practice: uncovering non-obvious problems and finding novel solutions. Creativity generally involved the assembly of an “ecological view” of the care process, which reflected a more complete understanding of relationships between individual care providers, organizational sub-units, and their environment. Teams used three prominent behaviors to construct the ecological view: (a) collecting new and diverse information, (b) accepting (rather than dismissing) disruptive information, and (c) employing empathy to understand and share feelings of others.

Conclusions: We anticipate that findings will be useful to researchers and practitioners who wish to understand how creativity can be fostered in problem solving to improve clinical outcomes and foster learning health systems.

KEYWORDS

cardiovascular care, creativity, hospital quality improvement, problem solving

1 | INTRODUCTION

Improving performance often requires health care teams to employ creativity in problem solving, a key attribute of learning health

systems. Creativity is defined the process of generating approaches that are both novel and useful.^{1,2} Incorporating creativity into problem solving can help to address unique, site-specific complexities that influence performance in health care,^{3,4} and to enhance the positive

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impact of evidence-based strategies adapted from outside the organization.⁵ While some advances in health care can be applied generically across settings, researchers have documented the importance of innovation and adaptation by local implementation teams,^{6–9} and customization to patients and context is a key part of patient-centered, high-quality care.¹⁰ These observations from health care cohere with management research from other industries, which posits that when innovation depends on complex contextual information that is difficult to codify and transfer, innovation-related problem solving needs to occur where that information is held,¹¹ and by the individuals who have agency to act on these solutions.¹² That is, key innovations must be made by staff located at each implementation site.

Despite the known importance of creativity in problem solving, relatively few studies detail how workers incorporate creativity into problem solving during the natural course of work—in health care or in other industries.¹³ Prior research on creative problem solving in the workplace has been largely theoretical,^{14,15} with some empirical research deriving from industries such as new product development^{16,17} where novelty is an explicit goal of work. Such research also focuses on creative outcomes while neglecting processes that incorporate creativity as habit and routine, that is, as part of the organizational culture.^{18–21} Detailed studies of front-line problem solving in the automotive industry provide a useful framework for considering the dimensions of problem solving—including an important distinction between problem definition and generation of solutions²²—but do not focus on creativity and innovation. More research is needed to better understand how creativity manifests during complex problem solving in health care.¹⁸

Prominent learning and quality improvement models in health care assume that both problem definition and generation of solutions can be important sites of creativity. Models including Lean/Six-Sigma,²³ the Institute for Healthcare Improvement (IHI) Model for Improvement,²⁴ the strategic problem-solving process,²⁵ and user-centered design²⁶ focus on uncovering nonobvious problems through an emphasis on root cause analysis and understanding user experience. More research is needed to understand the process by which creativity manifests when grappling with the complexity and customization that health care demands.²⁰

Even as more health care organizations seek to become learning organizations by implementing structured improvement interventions,²³ reports of such efforts highlight the fact that these improvement interventions do not always achieve intended results. Health care teams must overcome distinctive and substantial barriers to creativity, including strong hierarchies, aversion to risk, highly specialized professionals, and emphasis on standardization of care to promote reliability and quality.^{27,28} There can be tension between creativity and health care performance improvement, as health care delivery often seeks to minimize variation, and the core of creativity is enhancing variation.²⁹ Yet, influencing performance in health care often requires moving beyond stability and the status quo, a process well served by incorporating creativity.²⁷ Accumulating grounded evidence on how creative problem solving manifests in a variety of health care contexts is important for advancing understanding of this phenomenon.³⁰

2 | QUESTION OF INTEREST

To describe in detail how creativity emerges as health care workers engage in problem solving, we sought to characterize the processes through which creativity emerged in problem solving within hospitals seeking to reduce mortality from acute myocardial infarction (AMI) as part of a 2-year performance improvement collaborative called leadership saves lives (LSL). Mortality for AMI, now publicly reported and included in the value-based purchasing bundle,³¹ is influenced by components of care delivery that cross multiple boundaries within and outside of the hospital.^{32,33} One important contributor to lower AMI mortality is clinicians' ability to resolve open-ended problems through creative thinking.³⁴ Creative problem solving is especially relevant to AMI care teams working to reduce mortality because of the multifaceted nature of the problem, which spans multiple units and levels of hierarchy within the hospital, and extends past hospital boundaries to pre-hospital and post discharge systems. Each care setting is unique in numerous important ways, making it essential for teams to develop novel solutions that work in their own contexts (ie, apply creativity).

The LSL collaborative involved 10 hospitals in which AMI care teams engaged in a curriculum designed to foster group learning and problem solving. While teams were encouraged to be creative in their problem solving, the limitations of prior evidence meant that the intervention could not be prescriptive about exactly how creativity was expected to be cultivated. As described elsewhere,³⁵ participating hospital teams reported increased capacity for learning and problem solving, and their hospitals experienced significant decreases in risk-stratified mortality rate (RSMR) over the course of the study period, suggesting that these hospitals would be an ideal context for examining multiple instances of creative problem solving and distilling common patterns. We anticipate that findings will be useful to researchers and practitioners who wish to understand how creativity can be fostered in problem solving to improve clinical outcomes.

3 | METHODS

3.1 | Study design and setting

We conducted a qualitative study to understand how creativity was fostered during problem solving in the 10 hospitals that took part in the LSL collaborative from 2014 to 2016. As previously described,³⁵ hospitals were selected for participation from the membership of the Mayo Clinic Care Network (MCCN), a national group of medical systems committed to quality improvement through collaboration. From the 21 MCCN members (as of January 2014), hospitals were identified as candidates if they met all three eligibility criteria: (a) at least 200 AMI discharges per year to ensure sufficient experience in caring for patients with AMI, (b) average or below average national performance on 30-day RSMR between January 07, 2009 and June 30, 2012 as reported by Center for Medicare and Medicaid Services (CMS) Hospital Compare in Spring 2014, suggesting opportunity for

improvement, and (c) the largest hospital in the system, for hospitals in multihospital systems. From the list of 18 hospitals that met eligibility criteria, random sampling with a purposeful component³⁶ as used to select hospitals that were diverse in geography and teaching status. The first 10 hospitals were approached to determine receptivity; two declined and were replaced with sites similar in geography and teaching status. Hospital characteristics are presented in Table 1.

3.2 | LSL intervention

The LSL intervention, previously described in detail,³⁷ was implemented from June 2014 to June 2016. LSL was designed to foster reductions in AMI mortality by supporting the implementation of evidence-based strategies and fostering improvements in domains of organizational culture related to hospital performance. Each hospital established a guiding coalition of approximately 15 staff involved in care of patients with AMI, representing multiple departments, and including senior executives as well as front-line staff. Guiding coalition members participated in four, 1-day workshops in which they were coached through a strategic problem-solving methodology²⁵ to define a shared problem (ie, RSMR is too high) and objective (ie, reduce RSMR), and then use root cause analysis to generate, implement, and evaluate strategies designed to achieve the defined objective. Erika Linnander led intervention workshops at multiple LSL hospitals, and Erika Linnander and Leslie Curry engaged with guiding coalitions in three annual workshops that convened representatives of all 10 hospitals participating in LSL. LSL coalitions were encouraged to develop strategies that fit their unique contexts, through both tailoring existing evidence-based practices and introducing completely novel approaches. The evidence-based practices include monthly meetings with emergency medical services personnel to review AMI cases, identification of both physician and nurse champions for AMI care, nurses dedicated to the catheterization lab (not cross-staffing from other units), pharmacist rounding on all inpatients with AMI, and creative problem solving. As noted earlier, the intervention did not prescribe specific approaches to cultivate creativity. Guiding coalitions were also encouraged to foster improvements in hospital culture related to AMI performance, focusing on domains of: learning environment,³⁸ psychological safety,³⁹ senior management support,⁴⁰ commitment to the organization,⁴¹ and time for improvement efforts.³⁹

3.3 | Data collection

We collected qualitative data about the use of creativity in problem solving in LSL hospitals using in-depth, in-person interviews³⁶ at the start of the LSL intervention, and at 6 months and 18 months into the 2-year intervention. A team of interviewers who included individuals with backgrounds in qualitative research, health care management, and clinical care conducted interviews with staff involved in the guiding coalition as well as other clinicians and hospital executives, using a standardized interview guide (Data S1). The interview guide asked about implementation of creative problem-solving strategies as

TABLE 1 Hospital characteristics (n = 10 hospitals)

Census region	Frequency	%
South	3	30
Northeast	1	10
Midwest	4	40
West	2	20
Teaching status		
Teaching	2	20
Non-teaching	8	80
Size (number of hospital beds)		
100-299	2	20
300-499	3	30
500+	5	50

part of a broader set of interview questions examining the hospital's experience with LSL. Amanda Brewster and Leslie Curry were members of the team that conducted interviews. Interview participants were aware of the LSL intervention and aware that research was being conducted to understand the process of implementing the LSL intervention as well as its impact. Interviews took place at the hospitals where participants worked, generally in a quiet room. A total of 197 individuals participated in one or more interviews, with 162 interviews at baseline, 118 at 6 months, and 113 at 18 months into the intervention, for a total of 393 interviews (Table 2). The number of individual interviewees per hospital ranged from 15 to 26. Interviews lasted approximately 45 minutes and were audiotaped and professionally transcribed. The research procedures were reviewed and determined to be exempt by the Yale University Institutional Research Board.

3.4 | Data analysis

Interview transcripts were analyzed by a 6-member multidisciplinary team using the constant comparative method of analysis.⁴² The current analysis of creative problem solving focused on content in which participants discussed work processes that they self-identified as creative or promoting creativity, that is, ideas that were both novel and useful. Participants did not have to use the terms "creative" or "creativity" explicitly. Content could be coded as referring to creative problem solving if participants were providing examples in response to the structured interview questions on creative problem solving strategies, or if participants discussed processes for generating novel and useful ideas in response to other interview questions. We considered that participants would be best positioned to assess whether something was creative in the context of their environments, and therefore relied on participants' own judgements regarding novel and useful elements of the phenomenon. Each transcript was coded independently by at least three analysts, with discrepancies reconciled through negotiated consensus. A hybrid coding approach⁴³ in which we began with a small number of a priori codes based on key LSL program elements

TABLE 2 Interview participant characteristics

Position	N	Percent
Nurse	54	27%
Physician	42	21%
Management and administration	32	16%
Quality improvement	22	11%
Emergency medical services	13	7%
Pharmacist	13	7%
Physician assistant/advanced practice nurse	6	3%
Other	15	8%
Total	197	

and added new codes as additional themes emerged during coding. Iterative coding and analysis occurred across each wave of data collection, with refinement and review by the full team of six analysts, until a final code structure was established and reapplied to the full dataset. We used Atlas.ti to facilitate coding and organization of data. The analysis team included members with diverse perspectives, representing expertise in health services research, management, organizational theory, social work, nursing, medicine, and anthropology. We sought to generate recurrent themes that characterize essential aspects of creative problem solving in hospital contexts, examining instances in which creativity emerged in uncovering nonobvious problems or finding novel solutions.

4 | RESULTS

Across hospitals, participant descriptions of creativity in problem solving generally entailed the use of three prominent behaviors: (a) collecting new and diverse information, (b) accepting (rather than dismissing) disruptive information, and (c) employing empathy (ie, to understand or feel what another person is experiencing from within their frame of reference, that is, the capacity to place oneself in another's position). Each of the three behaviors appeared at times sufficient to advance creative problem solving by fostering a broad, inclusive new view of AMI care, which we term an "ecological view" (Figure 1). The following sections detail the three behaviors, followed by the emergent concept of an ecological view of AMI care.

4.1 | Collecting new and diverse information

Collecting new and diverse information was a behavior that routinely contributed to creativity in problem solving for LSL coalitions. Sometimes the new information came from assembling new data or analyzing data in new ways; for example, conducting new analyses of mortality data helped LSL coalitions at several hospitals to expand their conception of their AMI mortality challenges to include non-STEMI patients (patients with non-ST segment elevation myocardial

infarction). This was a significant shift, as most prior quality improvement efforts had focused exclusively on STEMI patients. As an example, a cardiologist on one hospital's team undertook a close and systematic review of AMI deaths, as part of a root cause analysis recommended in the LSL intervention, and noticed that non-STEMI care seemed to offer greater opportunities for improvement, explaining:

With STEMI's there was never any waiting... but in non-STEMI's [there were] delays... STEMI's, they all die after you've revascularized them. You've done everything you could... But the non-STEMI's are coming in. Somebody thought they were stable, and then they deteriorate which makes you think you've got really more of an opportunity with them. (Hospital J, Physician).

In other cases, new and diverse information came from the LSL coalitions engaging personnel who had not previously been involved in problem solving related to AMI mortality. For example, an emergency medicine physician in one hospital described how input from personnel outside the LSL coalition informed plans for introducing a dedicated cardiology physician assistant (PA) role that would remain on site at all times. After the hospital's LSL coalition coalesced around the idea to add this role, the coalition sought out opinions from different stakeholders elsewhere in the organization, who brought to light a wide range of issues that would need to be worked out in order to successfully implement this solution. A physician on the LSL coalition described:

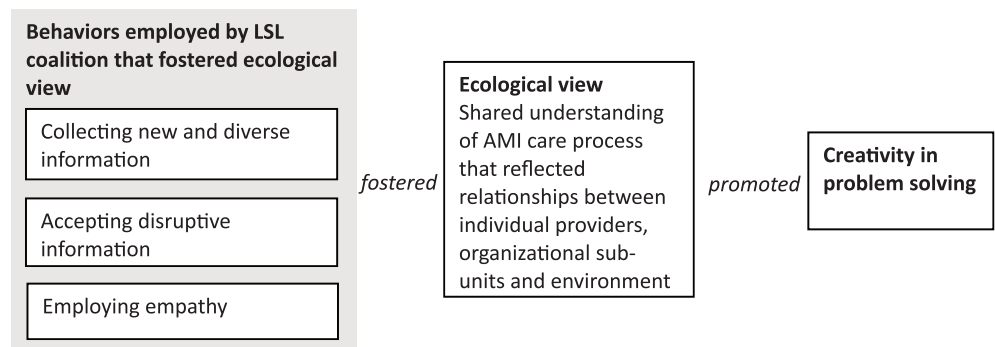
Then [a senior administrator] presented the other stuff, that I never thought of. Who technically has ownership of that PA?... How does the funding for that position come from everyone, if the revenue goes through one of our different cardiology groups?... I never thought of that. I said, "Give me a body, and have them there 24/7."...Then the cardiologists say, "Well, it's great. What we do with the PAs when they're not in the cath lab?... That creative problem solving comes from listening to everyone's different opinions, and having the ability to separate me from the project. Taking out my own biases. (Hospital B, Emergency Medicine Physician).

Synthesizing diverse views allowed the team to gain a more accurate understanding of implementation challenges, enhancing the practical utility and likely impact of their ideas.

4.2 | Accepting (rather than dismissing) disruptive information

Leveraging new and diverse information sources for creative problem solving typically required a second, distinct behavior:

FIGURE 1 Concepts identified as important to creative problem solving. Working from the right-hand side of the figure, creativity in problem solving was promoted by the assembly of a new, ecological view of AMI care. At least one of three behaviors was typically used by LSL coalitions to foster this ecological view



accepting (rather than dismissing) disruptive or unwelcome information. In describing instances where new information contributed to the development of novel and useful solutions, participants routinely described processes to overcome resistance to new information. For example, after the LSL coalition at Hospital J shifted to thinking about non-STEMI care as a potential problem to address, team members identified another problem: high-risk non-STEMIs were difficult to identify. After getting input from other physicians and nurses and reviewing non-STEMI risk guidelines from the American College of Cardiology, the LSL coalition recommended two major changes to improve care for patients with non-STEMI AMI: a new protocol to equip nurses to initiate care for inpatients with evolving AMIs, and a new set of algorithms and procedures for attending cardiologists to more consistently review at-risk cases. These new procedures met with initial resistance from other cardiologists within the hospital, but the opponents “knew that they couldn’t just blow it off completely,” according to an LSL coalition member, because the LSL coalition had carefully documented a previously unrecognized pattern of non-STEMI deaths pointing to the need for change. The LSL coalition helped to engineer this acceptance of information that diverged from prior beliefs by employing data, methodology, and a respected cardiologist as the messenger that would be compelling to the cardiologists.

In other situations, accepting disruptive information involved elevating the weight given to input from frontline personnel lower in the organizational hierarchy. The LSL guiding coalitions included perspectives not traditionally included in hospital process improvement discussions, such as EMS representatives external to the hospital. The perception that these representatives occupied positions that were more peripheral to the hospital and lower in the organizational hierarchy could have set up their perspectives to be dismissed. This risk was exemplified by the concerns of a paramedic on one LSL coalition, who reported initially feeling skeptical about the value he could add to a group that included high status individuals such as cardiovascular surgeons and department heads, who were seen as intimidating. (“I’m like, what’s pre-hospital’s role? I mean this is a big, huge hospital system.”) Over time though, this paramedic saw that his perspective was actively accepted, and he was empowered to share his opinions with the group. Intentional

emphasis on the importance of EMS by the LSL intervention facilitator aided this effort:

One of the first things [the team facilitator] brought up was the statistics on pre-hospital, how much they’re involved... Then I have [a physician] sitting right next to me, who looks at me and says, “What do you think about it? What can we do to improve the pre-hospital side of things?” To me that brought me right into the team. (Hospital A, Paramedic).

Although hospital leaders were generally aware of the need to improve pre-hospital processes, listening to and valuing the input from the EMS representative was key for the LSL coalition at Hospital A to understand the specific problems occurring at the interface of pre-hospital and hospital care, a situation seen at other LSL hospitals as well. Once the problems had been identified, solutions could be introduced. In the case of Hospital A, the solution was for the hospital to hire an EMS liaison with experience as a paramedic to manage communication between pre-hospital, emergency department, and other staff from the hospital who need to be activated to care for AMI patients. This solution was so widely recognized as effective in facilitating coordination across these systems that the hospital leadership agreed to fund a second liaison position.

Experience at another hospital illustrated how the hospital’s senior management played an important role in getting team members to take new information seriously and thereby spurred creativity in problem solving. As part of the LSL project, this hospital started documenting the wait times for EKG results. These new data showed that slow EKG results routinely delayed AMI care. The EKG wait time measure represented new and disruptive information for the hospital, because EKG wait time had not previously been tracked or understood to delay AMI care. Senior managers within the hospital held firm on the need to substantially reduce EKG wait times, even after multiple barriers to solving this problem were identified: from limitations on which staff could perform EKGs, to transmission of results being slowed by wireless connectivity drops in different parts of the floor, to EKG results being printed in an area where they weren’t immediately noticed. The stance of leaders, who were encouraging but very firm about the need to improve on the EKG wait time measure, forced ED teams to develop creative solutions rather than accept the inevitability of delays. The introduction of new, disruptive information about EKG wait times, coupled with active endorsement by

multiple managers, represented a departure from previous quality improvement efforts in which teams were seen to resign themselves to the status quo. One manager explained:

[In earlier improvement efforts] I would hear an answer from one team that says, “No. This can’t be done.” [Now] I think we have leaders who... are very good at saying, “Why not?” Then when we start looking at “why not,” we often find that, oh yeah, maybe it’s possible... If [the leader] says I’m satisfied with, “This can’t be done,” then you’re not going to have much creative thinking. (Hospital I, Manager).

Taking the data on EKG wait times as a serious indicator of problems led to a variety of creative solutions being implemented in the ED over the course of the LSL project, including training new categories of staff members to perform EKGs, putting existing communication technologies to new uses, establishing a new space where EKGs could be performed when the ED was full, and printing EKGs in a new location, near the physicians who needed to interpret them. The changes were effective: the proportion of at-risk patients receiving EKGs within the target time of 10 minutes rose from under 30% to 80%.

4.3 | Employing empathy

Employing empathy—having problem-solving staff consciously shift their mindsets to empathize with the experiences of colleagues or patients—was the third behavior regularly observed to foster creative problem solving for LSL coalitions. An example of empathizing with colleagues at referring facilities was reported by participants from Hospital F, which served as a referral center for AMI patients across a large region. As part of the LSL initiative, a nurse from the LSL coalition visited facilities that frequently transferred AMI patients to the hospital and followed the transfer process alongside providers at one referring facilities, which allowed her to experience the frustration of transfers from the referring facility’s perspective (ie, empathize). She described the experience as follows:

I got myself involved in [a patient transfer] with their emergency physician, trying to help coordinate the transfer of that patient [from the outlying facility to our hospital]. It was amazing how complicated our system had made it to get a patient transferred. I was able to be that advocate and see it from that view and then experience that frustration from that provider standpoint. (Hospital F, Nurse).

Seeing transfers from the perspective of referring facilities revealed several flaws in the process, which were delaying patient care and led to the development of new approaches to streamline communication with referring facilities.

Another example of empathizing with colleagues was seen at Hospital D, where the director of cardiac services discussed the importance of understanding, in detail, the perspective of EKG technicians in order to address problems with EKG processes. He encouraged his team to go observe the EKG techs at work, to understand “steps to their job” and consider how to help them:

The first part is, don’t be afraid to call and say, “I have a problem.” The second part is...go back, and [ask] what does the EKG tech do? They didn’t know... [I said] maybe you ought to go with them for a while. You gotta go figure out...what are the steps to their job, and how can we make it more efficient, help them in quality? We learned together. We problem solve together. (Hospital D, Physician).

An example of empathizing with patients motivating creative problem solving was reported by a nurse coordinator explaining what happened when the LSL coalition reviewed the hospital’s discharge education materials for patients with AMI. It was clear that the materials were inadequate to help patients effectively discharge (“It was horrid. I can’t even believe that’s what we were giving patients”). The team knew that improved materials were needed, but felt overwhelmed by the range of options. Ultimately, they took an approach of trying to put themselves in the patient’s shoes, which led to the development of a patient education resource that was regarded as the best patient education tool in the hospital:

We just had to sit down and really problem solve and be the patient in the matter. What is going to make a difference? What’s going to grab my attention as a patient to better adhere to my discharge instructions and understand them? All the praise goes to [three team members] because they put together the best patient education tools that we have in the hospital. (Hospital F, Nurse).

4.4 | Ecological view

While we observed three distinctive behaviors fostering creative problem solving, as described in the sections above, the behaviors tended to accomplish the same thing: the assembly of a broad, inclusive new view of AMI care, which we term an “ecological view.” This ecological view, fostered by teams collecting new and diverse information, accepting (rather than dismissing) disruptive information, and employing empathy, routinely contributed to LSL coalitions creatively uncovering nonobvious problems and finding novel solutions. Figure 1 outlines our concept of how creativity in problem solving was driven by development of an ecological view of the care process.

We adopt the biological metaphor of ecology, which is often used in the study of organizations (Freeman 2006),⁴⁴ to connote the development of a shared understanding of AMI care that reflected the

relationships among a wide range of different individual care providers, organizational sub-units, and their environment. Organization scholars commonly analyze populations of organizations in an ecological context. We use the term “ecological view” to describe the emergence of self-awareness inside the organization of this ecological context, as some of these providers and relationships were previously unknown, or known to only some but not all team members. The ecological view, in turn, infused the problem-solving process with creativity—allowing team members to see the contours of problems that not previously been identified and to develop novel solutions.

5 | DISCUSSION

In instances where creativity emerged during the problem-solving process within LSL hospitals, a characteristic process was observed in which team members generated an ecological view of the AMI care process, reflecting a more complete understanding of relationships between care providers, organizational sub-units, and their environment. The ecological view of AMI care sparked teams to define previously unrecognized problems, and to develop novel, tailored solutions. The experiences of the LSL hospitals indicated that identifying nonobvious problems represented an important site of creativity in the problem-solving process. While our results stem from an initiative to improve AMI mortality, they could apply to initiatives to improve outcomes for other complex conditions involving care that spans disciplines, departments, and organizations, such as stroke, heart failure, and diabetes.

The emergence of the ecological view that supported creativity in problem solving was regularly fostered by at least three different behaviors: collecting new information, accepting disruptive information, and employing empathy. Although the role of the ecological view in creative problem solving was not theorized during the development or delivery of the LSL intervention, several of the LSL intervention components explicitly encouraged behaviors that we observed to promote an ecological view, and could be helpful for other hospitals seeking to promote creativity in problem solving. Specifically, the LSL intervention team facilitated the development of guiding coalitions with diverse membership, advised hospital teams to conduct root cause analyses, which fed the collection of new information, and coached on group processes to promote psychological safety to foster the process of surfacing disruptive information from individuals whose perspectives might not be known. Efforts to encourage empathy were not an intentional component of the LSL intervention although raising awareness of psychological safety could have heightened participants' focus on the feelings of others. Empathy—the exercise of intentionally placing oneself in a new perspective—emerged as an especially powerful tactic to leverage exposure to new information. This is consistent with prior research on problem solving in manufacturing, which identifies advantages of observing, first-hand, a mechanical part in the situation where it is malfunctioning, as a way of getting richer information.²² In the context of our study, the immersive quality of exercises in empathy may have provided richer

information, and also emotional cues, which enhanced LSL coalition members' motivation to act on novel ideas that would have dissipated in the face of less compelling experiences. Intrinsic motivation has been theorized as an important contributor to individual creativity.¹

The behaviors we identified promoting an ecological view are not new to the quality improvement literature—other commonly used quality improvement models such as Lean and Six Sigma emphasize collection of new data and inclusion of diverse perspectives in understanding variability, waste, and poor performance.^{45,46} Empathy for end-users features as a component of the design-thinking process, which is being used by some health care organizations for quality improvement.²⁶ Our results, however, provide real-world examples of how these concepts foster creative problem solving in the context of a quality improvement intervention that targeted an outcome measure influenced by complex processes. While we reported the three behaviors that featured most prominently in participants' descriptions of examples where an ecological view emerged to promote creativity in problem solving during the LSL intervention, it is possible that other behaviors and supporting structures may promote the emergence of an ecological view in different settings. Notably, in the hospitals we studied, these three behaviors depended on support from a critical mass of team members in diverse clinical and managerial roles as well as hospital senior leadership. It is hard to say whether individual clinicians or staff members could enhance their own creative problem-solving capabilities by applying these behaviors in isolation.

Our results should be interpreted in light of several study limitations. First, with 10 hospitals, our sample was relatively small, although hospitals were selected to be diverse in terms of geography, size, and teaching status, and each hospital tackled several dimensions of AMI care, thus accumulating a larger number of examples of problem solving. Further, the robust, longitudinal qualitative design allowed for deep characterization of the improvement process in each hospital. Second, hospitals in the study were exposed to a leadership development curriculum that encouraged a structured approach to problem solving; the process of creativity in problem solving may proceed differently in hospitals that had not been supported in this way. Third, we were not able to collect data on whether particular interventions introduced by the LSL hospitals were effective, or sustained over time beyond the study period, which prevents us from concluding whether solution quality was improved by creative problem solving in this study. We do know that LSL hospitals reduced AMI RSMR more quickly than the national average over the same time period,³⁵ suggesting that LSL hospitals did make changes that improved RSMR during the study period.

Our results provide a refined depiction of the creative problem-solving process based on empirical observations across multiple hospitals. These findings suggest that health systems seeking to promote creative problem solving could encourage the three behaviors we have documented to advance an ecological view of care processes. As exploratory research, these findings point toward several opportunities for further study. First, it would be useful to examine the creative problem-solving process in a different set of hospitals, working to improve a different outcome, to confirm the generalizability of our

findings. A next step could include quantitatively testing the hypothesis that forming an ecological view is indeed constitutive of the creative problem-solving process, and improves solution quality. Doing this could involve developing a survey-based measure of the extent to which quality improvement teams have developed an ecological view of their target process, and evaluating the creativity and effectiveness of their solutions.

6 | CONCLUSIONS

Creativity is crucial to performance improvement in health care, and evidence from other industries has linked individual traits such as motivation and values, as well as organizational traits such as leadership style, team climate, and decentralized structure to creative performance.^{14,18,47} Seeking to illuminate the process by which creative problem solving occurs in health care, we observed a characteristic process that occurred across different hospitals, in which distinctive patterns of acquiring and processing new information contributed to creativity. These distinctive behaviors can be fostered by health care leaders seeking to improve performance on consequential clinical outcomes, including AMI mortality.

ACKNOWLEDGMENTS

Funding for the Leadership Saves Lives (LSL) collaborative and its evaluation was provided through a research grant to Yale University from The Medicines Company, Parsippany, New Jersey. The authors thank the hospitals and guiding coalition members that participated in LSL for their time and dedication.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

How to cite this article: Brewster AL, Lee YSH, Linnander EL, Curry LA. Creativity in problem solving to improve complex health outcomes: Insights from hospitals seeking to improve cardiovascular care. *Learn Health Sys*. 2022;6(2):e10283. <https://doi.org/10.1002/lrh2.10283>