Teamwork in Healthcare: Key Discoveries Enabling Safer, High-Quality Care

Michael A. Rosen,
Johns Hopkins University School of Medicine

Deborah DiazGranados,
Virginia Commonwealth University School of Medicine

Aaron S. Dietz,
Johns Hopkins University School of Medicine

Lauren E. Benishek,
Johns Hopkins University School of Medicine

David Thompson,
Johns Hopkins University School of Medicine

Peter J. Pronovost, and
Johns Hopkins University School of Medicine

Sallie J. Weaver
National Cancer Institute, Rockville, Maryland

Abstract

Few industries match the scale of health care. In the United States alone, an estimated 85% of the population has at least 1 health care encounter annually and at least one quarter of these people experience 4 to 9 encounters annually. A single visit requires collaboration among a multidisciplinary group of clinicians, administrative staff, patients, and their loved ones. Multiple visits often occur across different clinicians working in different organizations. Ineffective care coordination and the underlying suboptimal teamwork processes are a public health issue. Health care delivery systems exemplify complex organizations operating under high stakes in dynamic policy and regulatory environments. The coordination and delivery of safe, high-quality care demands reliable teamwork and collaboration within, as well as across, organizational, disciplinary, technical, and cultural boundaries. In this review, we synthesize the evidence examining teams and teamwork in health care delivery settings in order to characterize the current

state of the science and to highlight gaps in which studies can further illuminate our evidence-based understanding of teamwork and collaboration. Specifically, we highlight evidence concerning (a) the relationship between teamwork and multilevel outcomes, (b) effective teamwork behaviors, (c) competencies (i.e., knowledge, skills, and attitudes) underlying effective teamwork in the health professions, (d) teamwork interventions, (e) team performance measurement strategies, and (f) the critical role context plays in shaping teamwork and collaboration in practice. We also distill potential avenues for future research and highlight opportunities to understand the translation, dissemination, and implementation of evidence-based teamwork principles into practice.

Keywords

teamwork; health care; collaboration; health systems

In 1999, the Institute of Medicine issued a report that changed how health systems, providers, and researchers understand the occurrence of medical errors (Kohn, Corrigan, & Donaldson, 1999). Since the report's release, the U.S. health care industry continues to undergo large-scale transformation to improve the value of care (Young, Olsen, & McGinnis, 2010). One factor, identified as a common contributor to medical errors, is the fragmented nature of how health care is delivered. Interventions and reforms vary but frequently include efforts to improve the coordination of care delivery (e.g., McDonald et al., 2014). Consequently, psychological research on how team members form cohesive social units, interdependently function, and adapt over time to achieve shared goals and manage complex work contributes to educational, technological, and work redesign interventions to improve care delivery, patient outcomes, and, ultimately, public health (Thomas, 2011).

Why Study Health Care Teams?

Research on teams and teamwork processes within health care is important for two main reasons. First, the quality of teamwork is associated with the quality and safety of care delivery systems. This represents an opportunity for team researchers to contribute to solving large societal challenges. Second, the health care industry provides the means to develop and test theories on a large scale, across a wide range of team types. Each of these opportunities is elaborated on in the following two sections.

The Importance of Teamwork to the Quality and Safety of Care Delivery

Academics, policymakers, and the public are increasingly aware of the magnitude of preventable patient harm in U.S. health care, which may exceed 250,000 deaths per year (Makary & Daniel, 2016). These harms include hospital-acquired infections (Klevens et al., 2007), patient falls (Miake-Lye, Hempel, Ganz, & Shekelle, 2013), diagnostic errors (Newman-Toker & Pronovost, 2009), and surgical errors (Howell, Panesar, Burns, Donaldson, & Darzi, 2014), among others (Pham et al., 2012). Each manifests through complex interactions in the sociotechnical care delivery system.

Communication failures are both an independent cause of preventable patient harm and a cross-cutting contributing factor underlying other harms. Transitions of care (i.e., between care areas or shift changes) in acute care settings are leading opportunities for communication failures directly causing patient harm. They are high-risk interactions in which critical information about the patient's status and plan of care can be miscommunicated, leading to delays in treatment or inappropriate therapies. These transitions are associated with approximately 28% of surgical adverse events (Gawande, Zinner, Studdert, & Brennan, 2003). Additionally, care team member interactions contribute to specific clinical harms. Poor communication of medication name, dose, route of delivery, and timing of administration between physicians, pharmacists, nurses, and patients can lead to medication errors (Keers, Williams, Cooke, & Ashcroft, 2013). Hierarchy (e.g., between professional roles, and over occupational tenure) can inhibit the assertive communication necessary for effective recovery from error (Sutcliffe, Lewton, & Rosenthal, 2004) such as violation of evidence-based treatment protocols.

The teamwork and communication challenges in health care manifest the problem of coordination neglect in organizational systems (Heath & Staudenmayer, 2000). Managing complex work usually involves breaking it into tasks and delegating components of the work. However, across industries, there is a strong tendency to emphasize the division of labor and ignore mechanisms of coordination and integration (Heath & Staudenmayer, 2000). Health care delivery is inherently interdependent and increasingly complex. No one individual can assure a patient receives the highest standard of care, nor can he or she protect the patient from all potential harms stemming from increasingly complex and powerful therapies. However, despite high levels of interdependence, health care has underinvested in structured and evidence-based practices for managing teams and coordinating care (Kohn et al., 1999).

Health Care as a Vehicle to Advance the Science of Teams

Like the innovative and foundational work on military teams or aviation crews in past decades, health care provides a unique setting for team researchers to develop and test theories of team effectiveness. There is a wide variety of team types and configurations across the health care industry. From tightly coupled colocated surgical or trauma teams, to virtual teams of consultants contributing to a diagnosis, to loosely coupled teams working to manage chronic care, and even translational science teams working to integrate basic science researchers and community members, teamwork in health care spans the spectrum. Care delivery involves a multitude of professional roles, configured in different structures and completing varied tasks. Team sizes range from dyadic (e.g., care providers and patients involved in shared decision making) to extensive multiteam systems (MTSs; e.g., quality and safety in improvement teams within a health system; Weaver et al., 2014). Care teams vary in most of the features linked to team performance, including authority and skill differentiation, temporal stability, and physical and temporal distribution. Care teams complete tasks ranging from complex problem solving and planning (e.g., diagnosis and treatment planning during multidisciplinary rounds) to intensive psychomotor work requiring coordination (e.g., surgical procedures). In short, teams in health care span the full spectrum of team taxonomies. The majority of team research in health care focuses on acute

care settings and tightly coupled colocated action teams (e.g., surgical teams, trauma and emergency medicine teams). The discoveries described in this article are rooted primarily in studies of these types of health care teams and efforts to translate team performance principles discovered in similar action-oriented teams (e.g., aviation) to teams working in acute care settings like hospitals and prehospital emergency medical services. Although many of the discoveries presented in this article may generalize to nonaction types of teams in health care (e.g., primary care, multidisciplinary care teams that include lay patient navigators), there is relatively limited empirical teamwork science upon which to base that assertion. An increasing emphasis on population health, including preventative and chronic care, means there are opportunities for psychology researchers to contribute more broadly. Specifically, by strengthening our understanding of teams and teamwork processes in more complex organizational systems (e.g., MTSs) that must work interdependently over longer time horizons we will be better able to manage care in these settings; for example, understanding how to build teams to manage the transition to palliative care for terminal patients (Waldfogel et al., 2016) or better integrating mental health services into primary care in rural care settings in which clinical team members may not be physically colocated with patients or one another (Grumbach & Bodenheimer, 2004). Teams research can help to inform important issues by partnering with and learning from other research communities, including public health, health services, and health care delivery scientists, implementation science, and others interested in understanding an improving teamwork and coordination across the health care continuum. Unique and complex team configurations, as well as ongoing transformations in health care delivery systems, provide wide-ranging opportunities about which team researchers can work to generate new knowledge.

Purpose of This Review

In this review, we highlight the contributions of psychological research to the advancement of evidence-based teamwork practices in care delivery. As detailed in Figure 1, Panel A, this review is guided by the input-mediator-output framework (Ilgen, Hollenbeck, Johnson, & Jundt, 2005) and our collective experience conducting research and applied teamwork improvement projects in health care. We draw from recent and comprehensive empirical and narrative reviews of the science of teams in health care published between December 2000 and December 2017 that were identified through keyword searches of PubMED and PsycINFO to synthesize what is known about the team inputs (i.e., structure and context, teamwork competencies), team processes, measurement and improvement strategies, and, ultimately, the impact these things have on care delivery outcomes. We close with future directions and opportunities for psychologists to continue contributing to the science of teams in health care. Table 1 provides a summary of key discoveries and associated future directions for research.

Discovery 1: Structure and Context Matter to Understanding the Quality of Teamwork

Discovery 1 pertains to structural and contextual issues impacting teamwork. These are considered inputs in our IMO framework. Knowledge, skills, and attitudes (KSAs) are not

the only determinates of teamwork. The structure of the task and the context in which teams function are critical to understanding and improving teamwork. Health care teams are primarily project (e.g., quality improvement teams), management, or work (e.g., care delivery) teams (Lemieux-Charles & McGuire, 2006). Moreover, work teams can be divided into subcategories—those teams who focus on a patient population (e.g., geriatrics or pediatrics) or disease type (e.g., diabetes or stroke), and those teams who focus on a care delivery setting (e.g., primary, acute,home). This section summarizes structural and contextual influences on teamwork.

Structure: Team Composition and Task Interdependence

Team composition is the configuration of attributes of a team's members (Levine & Moreland, 1990). Team composition influences teamwork processes and outcomes through surface-level or deep-level constructs. Surface-level variables are overtly identifiable (e.g., age, race, training discipline), whereas deep-level variables are underlying psychological variables (e.g., personality, attitudes) discoverable only after interacting with someone (Bell, 2007). Team composition research in health care has focused primarily on role diversity. For example, Lingard and colleagues (2004) studied differences in attitudes about teamwork between professions in the surgical services, finding variations between roles about how conflict should be resolved in the operating room. Team composition has served as the basis of improvement interventions as well. For example, interprofessional or multidisciplinary rounds in the acute care settings are clinical problem-solving and planning episodes including one or more physician, nurses, and other professionals (e.g., pharmacists), often conducted at the bedside to engage patients and their loved ones. The introduction of multidisciplinary rounds significantly improves quality measures for congestive heart failure and pneumonia (O'Mahony, Mazur, Charney, Wang, & Fine, 2007), decreases length of stay for trauma patients (Dutton et al., 2003), and improves communication and shared awareness between nurses and physicians. Including a pharmacist on physician rounds in an intensive care unit reduces prescribing orders by 66% (Leape et al., 1999), because needed expertise about medications has been added to the team. These structural interventions do not inherently ensure that good teamwork will occur. Role boundary conflicts can emerge when teamwork is poor (e.g., team members overstepping professional boundaries; Kvarnström, 2008).

Context: External Leadership and Culture

Health care teams function in a variety of contexts. Research to date has focused on the role of culture and organizational leadership external to the team in health care team functioning. Although culture and external leadership are distinct concepts, they are tightly intertwined in practice as leaders influence collective perceptions of values and priorities. The hospital in which a team functions has its own culture, and each hospital unit may have its own micro culture. Each of these contexts influence how teams function and shape team member interactions (DiazGranados, Dow, Appelbaum, Mazmanian, & Retchin, 2017).

From a patient safety lens, learning from error is a critical organizational capacity requiring staff to be comfortable recognizing, reporting, and discussing challenging situations.

Nembhard and Edmondson (2006) investigated the effects of leader inclusiveness (i.e., the words or deeds of leaders that may support others' contributions) on the relationship between status and psychological safety in teams. Results indicated that leader inclusiveness helped to overcome some of the negative effects (i.e., low psychological safety) of status in health care teams. These team dynamics are critical for creating a safe environment for individuals and teams to learn from their mistakes.

Tucker and Edmondson (2003) conducted a study on hospital nursing care processes and found that nurses, key members of the interprofessional health care team, engaged in certain strategies when solving problems that they encountered. First, they did whatever it took to continue the patient-care task, and they did this without probing into what caused the problem. Second, nurses tended to ask for help from those socially close to them; this allowed nurses to help preserve their "reputation regarding his or her competence at handling the daily rigors of nursing" (p. 61). These strategies have implications, whether overt or subtle, on how teams function and particularly on how learning occurs as a response to errors or problems.

Organizational context influences team processes and outcomes (Lemieux-Charles & McGuire, 2006). Organizational culture provides the operating conditions (e.g., norms of interaction; Edmondson, Bohmer, & Pisano, 2001) that promote effective teamwork.

Discovery 2: The Competencies Underlying Teamwork in Health Care Settings Are Identifiable

Discovery 2 pertains to the formal definitions of teamwork KSAs (inputs in the IMO framework) and their identification as targets for intervention, particularly for training interventions. The body of work examining teamwork processes in health care, combined with models of team performance and effectiveness developed in psychology and organizational science (e.g., Ilgen et al., 2005; Weaver, Feitosa, & Salas, 2013; Zaccaro, Marks, & DeChurch, 2012), provided the foundation for identifying individual- and group-level KSAs that underlie effective teamwork in clinical care settings (e.g., Dow, DiazGranados, Mazmanian, & Retchin, 2013; Fernandez, Kozlowski, Shapiro, & Salas, 2008; McDonald et al., 2014). Models of teamwork competencies in health care have shed light on the KSAs necessary for teaming effectively in (a) interdisciplinary contexts in which coordination, communication, and collaboration must occur across disciplines with different training, professional norms, and specialized languages; and (b) in contexts in which teamwork must occur asynchronously across boundaries over prolonged periods of time.

Differentiating Technical Versus Nontechnical Skills in Health Care

Seminal work in team science differentiated teamwork from taskwork, emphasizing that team members needed competencies in both to fully contribute to team outcomes (Cannon-Bowers, Tannenbaum, Salas, & Volpe, 1995). Team scientists have long taken this for granted as a core, evidence-based principle of team performance. Evidence derived from studies of lab, military, and aviation teams identified team/collective orientation, mission analysis and planning, mutual performance monitoring, backup behavior, adaptability, and

leadership as critical teamwork competencies (Salas, Rosen, Burke, & Goodwin, 2009). However, work examining the bifurcation of technical competencies (e.g., procedural clinical care, clinical decision making) from nontechnical (e.g., social and cognitive) competencies among clinicians has helped to expand the scientific understanding of the broad range of KSAs underlying team performance under high stakes in which team membership may change rapidly, and in which performances may be episodic, offering limited practice or experience working together.

The Non-Technical Skills in Medical Education Special Interest Group (NOME SIG), an international consortium of clinicians, educators, and researchers, developed a consensus definition that describes nontechnical skills as

> a set of social (communication and team work) and cognitive (analytical and personal behavior) skills that support high quality, safe, effective and efficient interprofessional care within the complex healthcare system. (Gordon, Baker, Catchpole, Darbyshire, & Schocken, 2015, p. 572)

Early models of nontechnical skills in anesthesia, surgery, and similar care contexts evolved mainly from models of teamwork in other high-risk industries, including aviation, military operations, and energy production (e.g., Yule, Flin, Paterson-Brown, & Maran, 2006). These models focused primarily on individual-level interpersonal competencies (e.g., communication, seeking diverse input and feedback, offering and seeking help) and cognitive competencies (e.g., monitoring, decision making). For example, the NOME SIG identified nontechnical skills that clinicians should receive training in and eight additional skills for team leaders (see Table 2; Gordon et al., 2015). Arguably, some of these early competency models focused on episodic team performances, such as teamwork during surgical procedures or during a code team resuscitation, and most were presented in the context of efforts to enhance patient safety.

Teamwork Competencies in Nonepisodic Care Contexts

Other frameworks defined nontechnical competencies in care contexts that called for managing interdependent work over longer periods of time in looser team structures. For example, clinical care in critical care or floor units of a hospital, long-term care, or rehabilitation often unfolds over multiple days, or months, and involves a core team of clinicians delivering the majority of bedside care (i.e., nurses, technicians, attending physician) and a medium to large number of consulting clinicians who join the care team during brief episodes centered around specific tasks (e.g., rounds) or for specific purposes (e.g., consults, rehabilitative or therapeutic services). Criticai incident studies demonstrated overiap between the nontechnical competencies that these settings required and those identified in models developed for surgery, anesthesia, and aviation, but they also pointed to several key differences (Reader & Cuthbertson, 2011). For example, in these contexts, expertise is often highly distributed, formal leadership (e.g., attending physicians), and team membership changes often, leadership styles may differ among formal leaders, and communication across specialties or interdependent units is often informal, unstandardized, and fragmented. In the health services and medical education literatures, the related concept of interprofessional collaboration emerged from the organizational sociology literature and

also helped to identify key teamwork competencies (D'Amour, Ferrada-Videla, San Martin Rodriguez, & Beaulieu, 2005). This work emphasized the importance of team-level competencies like adaptability, implicit and explicit coordination, shared leadership, and conflict resolution as components of effective teamwork in dynamic environments (Salas et al., 2009).

Teamwork Competency Frameworks in Health Care Education Policy and Practice

Although earlier calls exist, a report by the Institute of Medicine Committee on the Health Professions Education Summit (2003) legitimized teamwork competencies as a standard component of graduate and continuing professional education in the health professions. The report identified the capacity to "work in interdisciplinary teams … to cooperate, collaborate, communicate, and integrate care in teams to ensure that care is continuous and reliable" (p. 45) as a core competency that all clinicians should possess regardless of discipline. The ensuing movement to develop tools and methods to help students and current practitioners to strengthen their teamwork competencies is reflected in both the interprofessional education (IPE) movement and the TeamSTEPPS program, an evidence-based toolkit jointly developed by the Agency for Healthcare Research and Quality and Department of Defense. The Interprofessional Education Collaborative (IPEC), a consortium of health profession educational associations, issued a revised report identifying overarching domains and subcompetencies that collectively comprise the core competencies for interprofessional collaborative practice (see Table 1; IPEC, 2016). The IPEC competencies have been adopted in both curriculum and accreditation standards in the United States and internationally.

Although the IPEC framework focuses on undergraduate and graduate education, the TeamSTEPPS framework defines core teamwork competencies for both trainees and existing clinicians. The TeamSTEPPS framework draws from the Big Five model of team performance developed by Salas and colleagues (2005) to identify four core teamwork skill domains, including communication, leadership, situation monitoring, and mutual support. The framework emphasizes the interplay among these core skills and that doing more of one will not fully compensate for limited capacity in another.

Teaming Over Time in Complex Delivery Systems: Teamwork and Care Coordination Models

Recent available data indicate that over half of Americans have at least one chronic condition, with over one third having two or more chronic conditions. Patients with chronic conditions like cancer, mood or anxiety disorders, high blood pressure, asthma, and diabetes see multiple providers and account for nearly 71% of domestic health care spending in the United States (Gerteis et al., 2014). Patients with the greatest number of chronic conditions see 14 different physicians and fill 50 prescriptions, on average, per year (Warshaw, 2006). Coordinating care for these patients requires teamwork across multiple disciplines (e.g., internal/family medicine, specialists, home health providers, social services) and

organizations in order to provide whole person care. As specialization increases, patient care and efforts to improve care have become the work of MTSs (DiazGranados, Dow, Perry, & Palesis, 2014; Weaver et al., 2014). Figure 1, Panel B, illustrates some of the complex ways in which MTSs can be configured. However, limited research to date examines the competencies that matter most for teams and individuals working in such MTSs. For example, individual-level skills in sharing leadership, boundary spanning, systems thinking, and brokerage/negotiation are likely important (Long, Cunningham, & Braithwaite, 2013; Van Houdt, Heyrman, Vanhaecht, Sermeus, & De Lepeleire, 2013). The teams and organizational behavior literatures offer some nascent insight into what these competency areas may be (Shuffler, Jimenez-Rodriguez, & Kramer, 2015), but this is an area in which studies of health care teams and delivery systems offer an opportunity to advance the science of teams and more complex MTSs. Additionally, expanding our understanding of the competencies related to working as part of virtual teams and with health information technology (HIT) as an agent-based team member are critical for preparing clinicians for working in increasingly networked delivery systems (President's Cancer Panel, 2016). Lastly, the need for research examining team competency assessment strategies and the impact on patient and provider outcomes (Institute of Medicine, 2015), as well as contextual factors that shape teamwork processes in practice, continues (Salas & Rosen, 2013).

Discovery 3: Teamwork Processes in Health Care Include Rapid Learning, Listening Intently, Adapting, and Speaking Up Among Clearly Defined Team Members and Loose Collaborators

Discovery 3 pertains to current knowledge about effective teamwork process behaviors in health care. Conceptual models of the processes underlying team performance in health care are exemplars in translating and adapting generalized psychological theories to new contexts, specific problems, and emerging scientific gaps. Models of team performance in various health care contexts have successfully adapted and extended established models of team performance (e.g., Dow et al., 2013; Fernandez et al., 2008). Observational and interventional studies reinforce that many affective, cognitive, behavioral processes that matter for other teams operating in high-risk, dynamic environments also matter for teams delivering clinical care (Dietz et al., 2014; Manser, 2009). However, this body of work also highlights that health care teams, like other teams operating in high-risk, dynamic environments with rapid and dynamic performance cycles, engage in (a) adaptive coordination (Bogdanovic, Perry, Guggenheim, & Manser, 2015); (b) critical task execution while learning and synthesizing new or emerging information (Schraagen, 2011); (c) intentional listening, translation of information coming from disciplines with highly specialized languages, and explicit reasoning (Tschan et al., 2009); and (d) speaking up deliberately in contexts in which psychological safety may be low and hierarchical norms strong (Nembhard & Edmondson, 2006). As was the case in the general scientific literature on teams (Salas, Cooke, & Rosen, 2008), there is a lack of standard terminology for team process behaviors in health care (Nestel, Walker, Simon, Aggarwal, & Andreatta, 2011). However, the general categories of team process behaviors from the science of teams (i.e.,

action, transition, and interpersonal; Marks, Mathieu, & Zaccaro, 2001) accurately characterizes much of the work in health care.

Discovery 4: Team Performance Can Be Validly Measured Across Complex Settings

Discovery 4 pertains to the assessment of teamwork, or mediators in the IMO framework. As teamwork competencies become the focus for accreditation by educational, professional, and regulatory organizations, valid measurement is needed to evaluate and assess performance, determine the impact of team improvement initiatives, and provide structure with regards to how teams receive performance feedback. Real-time measurement can also prompt immediate self-correction or external interventions to enhance performance.

The array of performance settings, compositional structures, and competency requirements has prompted a proliferation of team measurement tools; 73 unique tools have been identified in internal medicine alone (Havyer et al., 2014). In health care, like most domains, team performance data are typically collected through surveys and direct observations.

Survey studies involve asking team members to rate themselves, the team, and/or their organization. They are used to measure attitudinal competencies (e.g., trust) but can measure perceptions of the quality of team member interactions (Keebler et al., 2014). Safety culture surveys are the most widely used approach to measuring team dynamics in health care (Havyer et al., 2014), in part because of hospital accreditors in the United States requiring institutional leadership to "regularly evaluate the culture of safety and quality using valid and reliable tools" (Joint Commission, 2012, p. 1). Safety culture surveys with strong psychometric evidence include the Hospital Survey on Patient Safety Culture (Agency for Healthcare Research and Quality, 2016) and the Safety Attitudes Questionnaire (Sexton et al., 2006). In addition to gauging perceptions of overall safety, these surveys measure constructs related to communication, leadership, and coordination and collaboration within and across units. With respect to safety, culture scores are inversely related to adverse events, with areas related to handoffs and transitions of care, teamwork within units, and teamwork across units having the strongest relationship (Mardon, Khanna, Sorra, Dyer, & Famolaro, 2010). A limiting factor of survey research, however, is the respondent biases that may influence findings.

Unlike surveys, observational approaches measure team performance in real time. The use of external raters adds objectivity to measurement. The majority of observational tools in health care have been developed and applied to specific clinical work areas, with surgery and resuscitation being the most common (Dietz et al., 2014). Further, these tools have been developed to assess teamwork at individual (Fletcher et al., 2003; Yule et al., 2006) and team levels of analysis (Mishra, Catchpole, & McCulloch, 2009). Most observational tools in health care rely on low-resolution time scales, in which behaviors are assessed at the conclusion of an observation period (Dietz et al., 2014). Such scales, which fail to capture the moment-to-moment fluctuations in performance, are useful for summative evaluations that convey a team's proficiency or performance relative to other teams or their prior performance for a given task (Rosen et al., 2012). A key drawback surrounding observation

is the substantial amount of time required to train raters to reliably use a measurement tool, resulting in significant costs even before considering the protected time needed for staff to conduct ratings. Further, health care tasks are often emergent, and the sequence of behavioral interdependencies cannot be predicted, complicating the logistics of observational measurement.

Discovery 5: Health Care Team Training Competencies Can Be Systematically Improved

Discovery 5 pertains to interventions designed to improve teamwork competencies (inputs) or mediators in the IMO framework. Teamwork matters to numerous outcomes and the competencies underlying teamwork are identifiable. As a result, significant efforts have been dedicated to providing health care workers opportunities to systematically build teamwork competencies.

Team Training

Defined as a learning strategy comprising a set of tools and methods that learners use to systematically acquire teamwork KSAs (Hughes et al., 2016; Salas, DiazGranados, et al., 2008), team training is a widely implemented and well-evidenced intervention for building health care team competencies (Buljac-Samardzic, Dekker-van Doorn, van Wijngaarden, & van Wijk, 2010; Weaver, Dy, & Rosen, 2014). It has been used both as an individual- and team-level intervention to improve outcomes at multiple levels of analysis including individual (e.g., attitudes), team (e.g., efficiency), and organizational (e.g., safety culture) levels. Recent estimates suggest that as many as 75% of medical students now receive some form of team training (Beach, 2013). Additionally, more than 1.5 million health care workers have completed the TeamSTEPPS program (Global Diffusion of Healthcare Innovation Working Group, 2015).

A recent meta-analysis of 129 studies synthesized the evidence supporting health care team training (Hughes et al., 2016) using a multilevel training evaluation framework assessing programs across four criteria: reactions, learning, transfer, and results. *Reactions* refer to the affective and utility judgments of participants after completing a training program (Alliger, Tannenbaum, Bennett, Traver, & Shotland, 1997). Reactions can impact learning and retention of training content as participants who both enjoy (affect) and perceive training to be jobrelevant (utility) are more likely to retain what they have learned and use it at work (Brown, 2005). *Learning* refers to whether trained KSAs changed because of participating in training. *Transfer criteria* assess whether newly acquired or improved KSAs are utilized in the job context. *Results* refer to the beneficial changes observed within the organization because of training. In health care, results include any number of outcomes including patient safety and quality indicators (e.g., reduced length of stay), patient satisfaction, or cost savings. Hughes et al. (2016) showed that training impacts all four criteria. Moreover, the authors demonstrated evidence that their relationships are sequential in nature such that positive training reactions are associated with greater learning, which translates into improved teamwork on the job and subsequently benefits the health care facility and its patients. These findings demonstrate the cascading impact of team training. However, based

on the general transfer of training literature (Ford, Baldwin, & Prasad, 2017), the greatest impact may come from a bundled approach to team training interventions that embed effective teamwork within the organization (e.g., include structured tools, work process changes, and other interventions to support sustained improvements).

On-the-Job Tools and Strategies

Health care team improvement tools can be categorized as checklists, goal sheets, and case analyses. Their purpose is to improve communication by making team processes, goals, and case discussion explicit (Buljac-Samardzic et al., 2010). For example, standardized handoff protocols are a type of structured team interaction (i.e., checklist) used to overcome information loss occurring between care transitions. These protocols encourage greater information exchange and improve patient, provider, and organizational outcomes (Keebler et al., 2016).

Tools to improve team effectiveness are attractive because they are often presented as easy and unit-specialized alternatives to other more involved and time-consuming team interventions, such as training. It is often assumed that they will be understood and swiftly adopted. Thus, team tools are implemented with little instruction on their use in daily practice (Buljac-Samardzic et al., 2010). Further, staff may hesitate to adopt tools and strategies until they understand their value and how workflow will change as a result. Team improvement tools and strategies must be integrated into the unit or organizational culture and workflow.

Moderating Conditions

It is necessary to understand the conditions that influence team intervention effectiveness. Leadership is a critical element in creating and sustaining the culture change necessary for adoption of team improvement tools and strategies. Implementation of surgical briefings and debriefings illustrates this clearly. Briefings allow for teams to ensure that all members understand goals, understand everyone's roles and responsibilities, and have a chance to voice concerns. Debriefing affords a valuable learning opportunity for teams to discuss their performance with the expectation to improve during the next performance period. Briefings and debriefings have been widely implemented in surgery, but surgical teams with leadership involvement and visible support are more likely to sustain the practice over time (Paull et al., 2009). Structured briefings and debriefings are an effective team strategy, but they, like all other interventions, require strong leadership to realize their benefits. Once implemented, wide variation in the mindful engagement of staff in the use of structured communication tools is possible (Johnston et al., 2014). Across organizations, the amount of improvement in patient outcomes realized by the introduction of structured communication tools is significantly moderated by the preexisting culture of the organization such that organization high in safety culture see large benefits and those low in safety culture see little to no benefit (Haynes et al., 2011). Safety culture (i.e., the degree to which safety concerns are prioritized relative to other goals) is heavily influenced by leadership (Ruchlin, Dubbs, & Callahan, 2004) and is critical to avoid the perception of structured communication tools as administrative tasks of little value (Catchpole & Russ, 2015).

Well-planned, well-supported, and well-received team interventions still require consideration of the organization's capability of sustaining the new tool, strategy, or work structure. To achieve long-term solutions, organizational policies, reward structures, and culture must align to support the expected values and behaviors. New staff must understand norms surrounding team tools and strategies. This includes periodic refresher training for all staff as teamwork related skills can decay (Arthur, Day, Bennett, & Portrey, 2013). Linking teamwork practices to regulatory requirements and policy has shown to improve sustainment (Armour Forse, Bramble, & McQuillan, 2011). Team training can improve performance, but it is sustained over time through efforts to ensure continued KSA proficiency and tying expectations to organizational policy.

Discovery 6: Teamwork Quality Impacts Patient, Staff, and Organizational Outcomes

Discovery 6 pertains to the relationship between the quality of teamwork mediators and outcomes in the IMO framework. Meta-analytic synthesis of decades of psychological research has established the important empirical relationships between team process (LePine, Piccolo, Jackson, Mathieu, & Saul, 2008), team cognition (DeChurch & Mesmer-Magnus, 2010), team affect (Gully, Incalcaterra, Joshi, & Beaubien, 2002), and performance outcomes. These findings have been replicated and extended in the health care context, focusing on important value-based health transformation outcomes. Specifically, major discoveries include conceptual and empirical connections between the quality of teamwork and patient outcomes, and health care worker outcomes.

Teamwork and Patient Care Outcomes

A growing body of literature links the quality of teamwork to the quality and safety of health care delivery (Schmutz & Manser, 2013). Work in this area has focused on three domains: (a) the quality (i.e., degree to which patients receive treatment consistent with current guidelines and professional knowledge) and safety (i.e., risk of preventable patient harm) of care, (b) patient experience (i.e., self-reported outcomes), and (c) clinical patient outcomes.

First, a variety of studies confirm the pervasive nature of communication and coordination risks. Observational studies in surgical services indicate that approximately 30% of team interactions include a communication failure of some type (Lingard et al., 2004) and that patients receiving care with poor teamwork are almost five times as likely to experience complications or death (odds ratio = 4.82, 95% confidence interval [CI] [1.30, 17.87]; Mazzocco et al., 2009). A large Australian study found preventable patient deaths were twice as likely to be caused by a communication failure as an error of technical competence (Wilson et al., 1995).

Second, positive associations between the quality of teamwork in inpatient facilities and patients' self-reported satisfaction with their care have been established (Lyu, Wick, Housman, Freischlag, & Makary, 2013), with patients receiving care from higher performing teams being more satisfied. Although patient satisfaction has always been considered important, it has recently been connected to hospital reimbursement.

Third, studies demonstrate the association between teamwork within care areas and clinical patient outcomes. Patients receiving care from teams with higher levels of role clarity, mutual trust, and quality information exchange experience lower levels of postoperative pain, higher postoperative functioning, and shorter lengths of stay (Gittell et al., 2000). A large-scale survey by the U.K. National Health Service revealed that degree to which health care workers reported conducting their work in effective teams was associated with a range of patient outcomes, including rates of errors, and patient mortality (Lyubovnikova, West, Dawson, & Carter, 2015).

Teamwork and Health Care Worker Outcomes

Effective teams not only protect patients from risks and improve outcomes—they also create a more positive, engaging, and resilient workplace. Hospitals in which staff report higher levels of teamwork (i.e., clear roles and mindful management of interdependencies) have lower rates of workplace injuries and illness, experiences of workplace harassment and violence, as well as lower levels of staff intent to leave the organization (Lyubovnikova et al., 2015). The teamwork climate of a work unit is highly related to the level of engagement that staff feel in their work, such that units with high teamwork climate also have staff with a strong commitment to, and sense of, ownership over their job responsibilities (Daugherty Biddison, Paine, Murakami, Herzke, & Weaver, 2015). Teamwork quality is also inversely related to the level of burnout experienced by staff (Bowers, Nijman, Simpson, & Jones, 2011). Units with poor teamwork tend to have staff with higher levels of fatigue with their roles. Further, greater role clarity among multidisciplinary community mental health teams in the United Kingdom was associated with higher job satisfaction (Carpenter, Schneider, Brandon, & Wooff, 2003).

These relationships between teamwork and workforce outcomes are similar to those found in other industries. However, teamwork serves an additional role in health care. Workers involved in patient safety events are second victims of preventable patient harm (Wu, 2000). When a patient is harmed because of the actions or inactions of health care workers, it can be personally and professionally devastating for the clinicians involved. Suicide is a disproportionately high cause of death for physicians in the United States when compared with the population as a whole or other professions, and suicidal ideation among surgeons is almost twice as likely (odds ratio = 1.87, $p < .001$) in the 3 months following involvement in an incident of preventable patient harm (Shanafelt et al., 2011). Similarly, medical residents' involvement in medical errors is associated with decreased quality of life, increased burnout, and increased odds of screening positive for depression (odds ratio = 3.29, 95% CI [1.90, 5.64]; West et al., 2006). Although comparatively little research exists in this domain, dysfunctional team dynamics (e.g., blaming an individual for a system-based error and ostracizing that individual) play a critical role in exacerbating negative personal and professional consequences staff experience as a result of preventable patient harm (Seys et al., 2013).

Improving teamwork among health care workers is increasingly viewed as a viable strategy for managing the numerous workforce challenges, including recruiting and retaining skilled staff during nursing (Buerhaus, 2008) and physician shortages (Dall, West, Chakrabarti, &

Iacobucci, 2015). Additionally, the financial viability of health care organizations in the United States is tightly coupled with the quality and safety of care they provide, which further highlights their increased need to effectively manage patient outcomes as well as workforce issues.

Future Directions

Psychological and organizational research has advanced our understanding of how to develop clinicians, prepare organizations, structure tasks, and implement metrics to foster effective teamwork, enhance care coordination, and strive toward optimal outcomes for patients and workers. Here, we suggest several avenues for future research to further our understanding of team functioning and how to best implement and disseminate this evidence in health care.

First, much research examines health care teams working within the same organization or on a given procedure or task (e.g., resuscitation teams, surgical teams). Scarce research investigates teamwork over longer time frames in complex MTS structures. Care is interprofessional and involves the interdependent work of multiple care teams (e.g., primary care, radiology, and oncology). Care may be led by a designated care coordinator or patient navigator, but often it is not. This leaves many patients or loved ones to do the invisible work of coordination: synthesizing complicated, sometimes conflicting, information from multiple clinicians; navigating the complicated payment system; and bridging boundaries between different clinicians and teams (Ancker et al., 2015). Initial literature defines MTSs (DiazGranados et al., 2014; DiazGranados, Shuffler, Savage, Dow, & Dhindsa, 2017; Weaver et al., 2014), but studying health care delivery through this lens can advance our understanding of how MTSs perform, the competencies that matter in an MTS, how MTSs should be developed and sustained, and the contextual and structural issues impacting MTS effectiveness. Linking complex patient outcomes (e.g., hospital readmission, mortality, care experience, and costs) to the work of a single care delivery team ignores the complex MTS and individual collaborators providing care. Future research should address conceptual and measurement issues. For example, how can the complex MTS structure in which care is delivered for a patient with multiple chronic conditions be validly characterized? How can health care providers develop a sense of MTS membership, and how does their interpretation of MTS goals (e.g., overarching patient goals and priorities related to quality vs. quantity of life) and local team-level goals (e.g., condition specific treatment goals) influence care processes and outcomes?

Second, teams research in health care offers an opportunity to advance the science of virtuality in teams (Gilson, Maynard, Jones Young, Vartiainen, & Hakonen, 2015). Telemedicine promises to enhance access to multidisciplinary care and address the severe shortages in specialist and primary care clinicians. The concept of "virtual collaborative" care teams has been adopted widely in policy and payment models in the United States. However, few studies examine the impact of virtuality on teamwork processes and patient outcomes. For example, teleconsults and virtual participation in multidisciplinary treatment planning is expanding, particularly in rural and low-resource care delivery settings. How does virtuality influence the sharing of novel information, dissenting opinions, voice, and, in

turn, the quality of decision making? Could expanding virtual participation of patients and their loved ones in these discussions enhance shared decision making?

Third, future research should address the impact of professional fault lines (i.e., the tendency for providers to more strongly identify with team members with similar professional backgrounds; Lau & Murnighan, 2005) in health care teams, how leadership is most effectively shared among clinical teams, and the impact on care coordination and patient outcomes. This would inform evidence-based IPE practices for students and practicing health care professionals, as well as multilevel intervention strategies to improve multidisciplinary care. The nature and type of multidisciplinarity is likely to increase with the growing prevalence of more complex role structures (e.g., the trend toward increasing specialization and adoption of advanced practice nurses; O'Grady, 2008). Understanding and managing fault lines in complex team structures will be critical for realizing the benefits of diverse teams.

Fourth, future research should focus on advancing the science of measurement for teams. Despite the amount of measurement tools available, there is a dearth of criterion validity evidence (Havyer et al., 2014); the science of team measurement in health care needs to prioritize how well specific measures are predictive of patient and organizational outcomes (Havyer et al., 2014). A key challenge when synthesizing findings both within and across clinical domains is the lack of integration among the theoretical and competency models underlying measurement (Jeffcott & Mackenzie, 2008). Even within the same clinical domain, there are prominent differences in what competencies are considered relevant and how they are operationalized (Mishra et al., 2009; Undre, Sevdalis, Healey, Dam, & Vincent, 2007). This presents a need for future research investigating what attributes of the measurement system produce the most valid and reliable ratings with the lowest level of logistical costs (Dietz et al., 2014).

Team performance measurement systems in health care also need to keep pace with the evolving nature of compositional and interdependency structures; they need to be more practical without sacrificing psychometric rigor. Sensor-based measurement is an emerging field that holds great promise for balancing the tradeoffs to survey and observational approaches (Rosen, Dietz, Yang, Priebe, & Pronovost, 2015). Sensor-based measures refer to automated data collection tools (e.g., infrared sensors, radio frequency identification tags) used to dynamically capture sociometric data (i.e., behavior, team member composition, speech content). Activity traces can complement sensor-based measures to understand patterns of behavior between team members because they capture the byproduct of information system use (e.g., paging system, e-mail activity, electronic health record [HER] entries).

Sensor-based methods have been applied in health care to measure attributes related to team inputs (e.g., Big Five personality traits; Olguín, Gloor, & Pentland, 2009), processes/mediators (e.g., predictability of interactions and movement; Kannampallil et al., 2011), and outcomes (e.g., patient length of stay as predicted by physical effort; Olguín et al., 2009). Key barriers to implementation are privacy concerns associated with being monitored, clinician buy-in (Rosen et al., 2015), equipment cost, and general issues connecting streams

of discrete behavioral data to the abstract constructs of teamwork competencies. Further, these systems may be more or less appropriate for measuring teamwork depending on the (a) specificity of team performance expectations, and (b) physical distribution of team members (Rosen et al., 2015). Best practices call for multiple forms of measurements (Baker & Salas, 1997), and sensor-based measures provide another methodology to understand health care team performance.

Fifth, HIT plays an increasingly important role in care delivery (President's Cancer Panel, 2016; Samal et al., 2016). Electronic Health Records (EHRs) are a recent standard in most care delivery systems, yet limited research examines HIT as an agent-based team member, coordination mechanism, or artifact of team cognition. Numerous studies catalogue the limitations of EHRs, but there is limited evidence identifying HIT features that improve team functioning or help to bridge gaps between patients and providers. HIT also presents an opportunity to study how teams adapt and experience change. Case studies of EHR implementation (Gross et al., 2016), analyses of EHR mediated electronic referrals for specialty care (Hysong et al., 2011), studies examining interoperability (or lack thereof) among HIT systems (Samal et al., 2016), and studies of patient portals (Ge, Ahn, Unde, Gage, & Carr, 2013) indicate a need to better understand team resilience during change and how to coordinate, communicate, and develop (and update) accurate shared mental models in a distributed, asynchronous fashion. Additionally, understanding how information systems can reinforce and support teamwork competencies and behaviors targeted in training programs is ripe for investigation. Sixth, future research should consider the value of team and MTS performance models in examining care transitions and develop multilevel interventions to strengthen teaming across boundaries. For example, handoffs have been topic of research and improvement efforts for decades, with little evidence of large scale reduction in preventable patient harm related to handoffs. Improvement interventions typically focus at the point of handoff—a discrete time and place—and use training and structured verbal, written, and electronic protocols to support team interactions. These interventions can work but are challenging to scale, spread, and sustain. Future research and interventions should address more macro patterns of coordination between units and facilities.

Conclusions

It is an exciting time to study teams in health care. The practical need for knowledge about teams has never been more salient, and the opportunities to contribute to the general science of teams are unparalleled. The health care system touches all of our lives, and the quality of the teamwork within that system impacts the experiences we have and the outcomes we see. Psychologists can have a large and positive impact in this industry in transition both for those who work in it and those whose well-being depends upon it.

Biographies

Michael A. Rosen

Deborah DiazGranados

Aaron S. Dietz

Lauren E. Benishek

David Thompson

Peter J. Pronovost

Sallie J. Weaver

References

Agency for Healthcare Research and Quality. (n.d.). Team STEPPS: National implementation. Retrieved from http://teamstepps.ahrq.gov/aboutnationalIP.htm

Agency for Healthcare Research and Quality. (2016, 11). Hospital survey on patient safety culture. Retrieved from http://www.ahrq.gov/professionals/quality-patient-safety/patientsafetyculture/hospital/index.html

Alliger GM, Tannenbaum SI, Bennett W, Traver H, & Shotland A (1997). A meta-analysis of the relations among training criteria. Personnel Psychology, 50, 341–358. 10.1111/j.1744-6570.1997.tb00911.x

Ancker JS, Witteman HO, Hafeez B, Provencher T, Van de Graaf M, & Wei E (2015). The invisible work of personal health information management among people with multiple chronic conditions: Qualitative interview study among patients and providers. Journal of Medical Internet Research, 17(6), e137 10.2196/jmir.4381 [PubMed: 26043709]

Armour Forse R, Bramble JD, & McQuillan R (2011). Team training can improve operating room performance. Surgery, 150, 771–778. 10.1016/j.surg.2011.07.076 [PubMed: 22000190]

Arthur W, Day EA, Bennett W, & Portrey AM (Eds.). (2013). Individual and team skill decay: The science and implications for practice. New York, NY: Routledge.

Baker DP, & Salas E (1997). Principles for measuring teamwork: A summary and look toward the future In Brannick MT, Salas E, & Prince C (Eds.), Team performance assessment and measurement: Theory, methods, and applications (pp. 331–355). Mahwah, NJ: Lawrence Erlbaum Associates.

Beach S (2013, 8 2). Annual medical school graduation survey shows gains in team training. Retrieved from www.aamc.org/newsroom/newsreleases/351120/080213.html

Bell ST (2007). Deep-level composition variables as predictors of team performance: A meta-analysis. Journal of Applied Psychology, 92, 595–615. 10.1037/0021-9010.92.3.595 [PubMed: 17484544]

Bogdanovic J, Perry J, Guggenheim M, & Manser T (2015). Adaptive coordination in surgical teams: An interview study. BMC Health Services Research, 15, 128 10.1186/s12913-015-0792-5 [PubMed: 25889397]

Bowers L, Nijman H, Simpson A, & Jones J (2011). The relationship between leadership, teamworking, structure, burnout and attitude to patients on acute psychiatric wards. Social Psychiatry and Psychiatric Epidemiology, 46, 143–148. 10.1007/s00127-010-0180-8 [PubMed: 20082064]

Brown KG (2005). An examination of the structure and nomological network of trainee reactions: A closer look at "smile sheets." Journal of Applied Psychology, 90, 991–1001. 10.1037/0021-9010.90.5.991 [PubMed: 16162071]

Buerhaus PI (2008). Current and future state of the U.S. nursing workforce. Journal of the American Medical Association, 300, 2422–2424. 10.1001/jama.2008.729 [PubMed: 19033594]

Buljac-Samardzic M, Dekker-van Doorn CM, van Wijngaarden JD, & van Wijk KP (2010). Interventions to improve team effectiveness: A systematic review. Health Policy, 94, 183–195. 10.1016/j.healthpol.2009.09.015 [PubMed: 19857910]

Cannon-Bowers J, Tannenbaum S, Salas E, & Volpe C (1995). Defining team competencies: Implications for training requirements and strategies In Guzzo R & Salas E (Eds.), Team effectiveness and decision making in organizations (pp. 333–380). San Francisco, CA: Jossey-Bass.

Carpenter J, Schneider J, Brandon T, & Wooff D (2003). Working in multidisciplinary community mental health teams: The impact on social workers and health professionals of integrated mental health care. British Journal ofSocial Work, 33, 1081–1103. 10.1093/bjsw/33.8.1081

Catchpole K, & Russ S (2015). The problem with checklists. British Medical Journal Quality & Safety, 24, 545–549. 10.1136/bmjqs-2015-004431

Dall T, West T, Chakrabarti R, & Iacobucci W (2015). The complexities of physician supply and demand: Projections from 2013 to 2025. Washington, DC: Association of American Medical Colleges.

D'Amour D, Ferrada-Videla M, San Martin Rodriguez L, & Beaulieu M-D (2005). The conceptual basis for interprofessional collaboration: Core concepts and theoretical frameworks. Journal of Interprofessional Care, 19(Suppl. 1), 116–131. 10.1080/13561820500082529 [PubMed: 16096150]

Daugherty Biddison EL, Paine L, Murakami P, Herzke C, & Weaver SJ (2015). Associations between safety culture and employee engagement over time: A retrospective analysis. British Medical Journal Quality & Safety, 25, 31–37. 10.1136/bmjqs-2014-003910

DeChurch LA, & Mesmer-Magnus JR (2010). The cognitive underpinnings of effective teamwork: A meta-analysis. Journal of Applied Psychology, 95, 32–53. 10.1037/a0017328 [PubMed: 20085405]

DiazGranados D, Dow AW, Appelbaum N, Mazmanian PE, & Retchin SM (2017). Interprofessional practice in different patient care settings: A qualitative exploration. Journal of Interprofessional Care, 32, 151–159. 10.1080/13561820.2017.1383886 [PubMed: 29083254]

DiazGranados D, Dow AW, Perry SJ, & Palesis JA (2014). Understanding patient care as a multiteam system In Shuffler ML, Rico R, & Salas E (Eds.), Pushing the boundaries: Multiteam systems in research and practice (pp. 95–113). Houston, TX: Emerald Group Publishing Limited.

DiazGranados D, Shuffler M, Savage N, Dow AW, & Dhindsa HD (2017). Defining the prehospital care multiteam system In Keebler JR, Lazzara EH, & Misasi P (Eds.), Human factors and ergonomics of prehospital emergency care. Boca Raton, FL: CRC Press.

Dietz AS, Pronovost PJ, Benson KN, Mendez-Tellez PA, Dwyer C, Wyskiel R, & Rosen MA (2014). A systematic review of behavioural marker systems in healthcare: What do we know about their attributes, validity and application? British Medical Journal Quality & Safety, 23, 1031–1039. 10.1136/bmjqs-2013-002457

Dow AW, DiazGranados D, Mazmanian PE, & Retchin SM (2013). Applying organizational science to health care: A framework for collaborative practice. Academic Medicine, 88, 952–957. 10.1097/ACM.0b013e31829523d1 [PubMed: 23702530]

Dutton RP, Cooper C, Jones A, Leone S, Kramer ME, & Scalea TM (2003). Daily multidisciplinary rounds shorten length of stay for trauma patients. The Journal of Trauma, 55, 913–919. 10.1097/01.TA.0000093395.34097.56 [PubMed: 14608165]

Edmondson A, Bohmer R, & Pisano G (2001). Speeding up team learning. Harvard Business Review, 79, 125–134.

Fernandez R, Kozlowski SWJ, Shapiro MJ, & Salas E (2008). Toward a definition of teamwork in emergency medicine. Academic Emergency Medicine, 15, 1104–1112. 10.1111/j.1553-2712.2008.00250.x [PubMed: 18828831]

Fletcher G, Flin R, McGeorge P, Glavin R, Maran N, & Patey R (2003). Anaesthetists' non-technical skills (ANTS): Evaluation of a behavioural marker system. British Journal of Anaesthesia, 90, 580–588. 10.1093/bja/aeg112 [PubMed: 12697584]

Ford JK, Baldwin TP, & Prasad J (2017). Transfer of training: The known and the unknown. Annual Review of Organizational Psychology and Organizational Behavior, 5, 201–225. 10.1146/annurev-orgpsych-032117-104443

Gawande AA, Zinner MJ, Studdert DM, & Brennan TA (2003). Analysis of errors reported by surgeons at three teaching hospitals. Surgery, 133, 614–621. 10.1067/msy.2003.169 [PubMed: 12796727]

Ge Y, Ahn DK, Unde B, Gage HD, & Carr JJ (2013). Patient-controlled sharing of medical imaging data across unaffiliated healthcare organizations. Journal ofthe American Medical Informatics Association, 20, 157–163. 10.1136/amiajnl-2012-001146

Gerteis J, Izrael D, Deitz D, LeRoy L, Ricciardi R, Miller T, & Basu J (2014). Multiple Chronic Conditions Chartbook. Rockville, MD: Agency for Healthcare Research and Quality.

Gilson LL, Maynard MT, Jones Young NC, Vartiainen M, & Hakonen M (2015). Virtual teams research: 10 years, 10 themes, and 10 opportunities. Journal ofManagement, 41, 1313–1337. 10.1177/0149206314559946

Gittell JH, Fairfield KM, Bierbaum B, Head W, Jackson R, Kelly M, Zuckerman J (2000). Impact of relational coordination on quality of care, postoperative pain and functioning, and length of stay: A nine-hospital study of surgical patients. Medical Care, 38, 807–819. 10.1097/00005650-200008000-00005 [PubMed: 10929993]

Global Diffusion of Healthcare Innovation Working Group. (2015). Global diffusion of healthcare innovation study: Accelerating the journey. Retrieved from http://wish-qatar.org/summit/2015-summit/

Gordon M, Baker P, Catchpole K, Darbyshire D, & Schocken D (2015). Devising a consensus definition and framework for nontechnical skills in healthcare to support educational design: A modified Delphi study. Medical Teacher, 37, 572–577. 10.3109/0142159X.2014.959910 [PubMed: 25244065]

Gross AH, Leib RK, Tonachel R, Bowers DM, Burnard RA, Rhinehart C, Bunnell CA (2016). Teamwork and electronic health record implementation: A case study of preserving effective communication and mutual trust in a changing environment. Journal of Oncology Practice/ American Society of Clinical Oncology, 12, 1075–1083. 10.1200/JOP.2016.013649

Grumbach K, & Bodenheimer T (2004). Can health care teams improve primary care practice? Journal of the American Medical Association, 291, 1246–1251. 10.1001/jama.291.10.1246 [PubMed: 15010447]

Gully SM, Incalcaterra KA, Joshi A, & Beaubien JM (2002). A meta-analysis of team-efficacy, potency, and performance: Interdependence and level of analysis as moderators of observed relationships. Journal of Applied Psychology, 87, 819–832. 10.1037/0021-9010.87.5.819 [PubMed: 12395807]

Havyer RD, Wingo MT, Comfere NI, Nelson DR, Halvorsen AJ, McDonald FS, & Reed DA (2014). Teamwork assessment in internal medicine: A systematic review of validity evidence and outcomes. Journal of General Internal Medicine, 29, 894–910. 10.1007/s11606-013-2686-8 [PubMed: 24327309]

Haynes AB, Weiser TG, Berry WR, Lipsitz SR, Breizat AHS, Dellinger EP, Safe Surgery Saves Lives Study Group. (2011). Changes in safety attitude and relationship to decreased postoperative morbidity and mortality following implementation of a checklist-based surgical safety intervention. BMJ Quality & Safety in Health Care, 20, 102–107. 10.1136/bmjqs.2009.040022

Heath C, & Staudenmayer N (2000). Coordination neglect: How lay theories of organizing complicate coordination. Research in Organizational Behavior, 22, 153–191. 10.1016/S0191-3085(00)22005-4

Howell AM, Panesar SS, Burns EM, Donaldson LJ, & Darzi A (2014). Reducing the burden of surgical harm: A systematic review of the interventions used to reduce adverse events in surgery. Annals of Surgery, 259, 630–641. 10.1097/SLA.0000000000000371 [PubMed: 24368639]

Hughes AM, Gregory ME, Joseph DL, Sonesh SC, Marlow SL, Lacerenza CN, Salas E (2016). Saving lives: A metaanalysis of team training in healthcare. Journal of Applied Psychology, 101, 1266–1304. 10.1037/apl0000120 [PubMed: 27599089]

Hysong SJ, Esquivel A, Sittig DF, Paul LA, Espadas D, Singh S, & Singh H (2011). Towards successful coordination of electronic health record based-referrals: A qualitative analysis. Implementation Science; IS, 6, 84 10.1186/1748-5908-6-84 [PubMed: 21794109]

Ilgen DR, Hollenbeck JR, Johnson M, & Jundt D (2005). Teams in organizations: From input-process-output models to IM0I models. Annual Review of Psychology, 56, 517–543. 10.1146/annurev.psych.56.091103.070250

Institute of Medicine. (2015). Measuring the impact of interprofessional education on collaborative practice and patient outcomes. Washington, DC: National Academies Press.

Institute of Medicine Committee on the Health Professions Education Summit. (2003). The core competencies needed for health care professionals In Greiner AC & Knebel E (Eds.), Health professions education: A bridge to quality (pp. 45–74). Washington, DC: National Academies Press.

Interprofessional Education Collaborative [IPEC]. (2016). Core competencies for interprofessional collaborative practice: 2016 update. Retrieved from http://www.aspph.org/app/uploads/2014/04/IPEC-2016-UpdatedCoreCompetencies-Report-FINAL-RELEASE.pdf

Jeffcott SA, & Mackenzie CF (2008). Measuring team performance in healthcare: Review of research and implications for patient safety. Journal of Critical Care, 23, 188–196. 10.1016/j.jcrc.2007.12.005 [PubMed: 18538211]

Johnston FM, Tergas AI, Bennett JL, Valero V, III, Morrissey CK, Fader AN, Wick EC (2014). Measuring briefing and checklist compliance in surgery: A tool for quality improvement. American Journal of Medical Quality, 29, 491–498. 10.1177/1062860613509402 [PubMed: 24270170]

Joint Commission. (2012, 1). Revisions to LD. 03.01.01. Retrieved from http://www.jointcommission.org/assets/1/6/Pre-Pubs_LD.03.01.01_HAP.pdf

Kannampallil T, Li Z, Zhang M, Cohen T, Robinson DJ, Franklin A, Patel VL (2011). Making sense: Sensor-based investigation of clinician activities in complex critical care environments. Journal of Biomedical Informatics, 44, 441–454. 10.1016/j.jbi.2011.02.007 [PubMed: 21345380]

Keebler JR, Dietz AS, Lazzara EH, Benishek LE, Almeida SA, Toor PA, Salas E (2014). Validation of a teamwork perceptions measure to increase patient safety. British Medical Journal Quality & Safety, 23, 718–726. 10.1136/bmjqs-2013-001942

Keebler JR, Lazzara EH, Patzer BS, Palmer EM, Plummer JP, Smith DC, Riss R (2016). Meta-analyses of the effects of standardized handoff protocols on patient, provider, and organizational outcomes. Human Factors, 58, 1187–1205. 10.1177/0018720816672309 [PubMed: 27821676]

Keers RN, Williams SD, Cooke J, & Ashcroft DM (2013). Causes of medication administration errors in hospitals: a systematic review of quantitative and qualitative evidence. Drug Safety, 36, 1045–1067. 10.1007/s40264-013-0090-2 [PubMed: 23975331]

Klevens RM, Edwards JR, Richards CL, Jr, Horan TC, Gaynes RP, Pollock DA, & Cardo DM (2007). Estimating health care-associated infections and deaths in US hospitals, 2002. Public Health Reports, 122, 160–166.10.1177/003335490712200205 [PubMed: 17357358]

Kohn LT, Corrigan JM, & Donaldson MS (Eds.). (1999). To err is human: Building a safer health system (Vol. 6). Washington, DC: National Academies Press.

Kvarnström S (2008). Difficulties in collaboration: A critical incident study of interprofessional healthcare teamwork. Journal of Interprofessional Care, 22, 191–203. 10.1080/13561820701760600 [PubMed: 18320453]

Lau DC, & Murnighan JK (2005). Interactions within groups and subgroups: The effects of demographic faultlines. Academy of Management Journal, 48, 645–659. 10.5465/AMJ.2005.17843943

Leape LL, Cullen DJ, Clapp MD, Burdick E, Demonaco HJ, Erickson JI, & Bates DW (1999). Pharmacist participation on physician rounds and adverse drug events in the intensive care unit. Journal of the American Medical Association, 282, 267–270. 10.1001/jama.282.3.267 [PubMed: 10422996]

Lemieux-Charles L, & McGuire WL (2006). What do we know about health care team effectiveness? A review of the literature. Medical Care Research and Review, 63, 263–300. 10.1177/1077558706287003 [PubMed: 16651394]

LePine JA, Piccolo RF, Jackson CL, Mathieu JE, & Saul JR (2008). A meta-analysis of teamwork processes: Tests of a multidimensional model and relationships with team effectiveness criteria. Personnel Psychology, 61, 273–307. 10.1111/j.1744-6570.2008.00114.x

Levine JM, & Moreland RL (1990). Progress in small group research. Annual Review of Psychology, 41, 585–634. 10.1146/annurev.ps.41.020190.003101

Lingard L, Espin S, Whyte S, Regehr G, Baker GR, Reznick R, Grober E (2004). Communication failures in the operating room: An observational classification of recurrent types and effects. Quality & Safety in Health Care, 13, 330–334. 10.1136/qshc.2003.008425 [PubMed: 15465935]

Long JC, Cunningham FC, & Braithwaite J (2013). Bridges, brokers and boundary spanners in collaborative networks: A systematic review. BMC Health Services Research, 13, 158 10.1186/1472-6963-13-158 [PubMed: 23631517]

Lyu H, Wick EC, Housman M, Freischlag JA, & Makary MA (2013). Patient satisfaction as a possible indicator of quality surgical care. Journal of the American Medical Association Surgery, 148, 362–367. 10.1001/2013.jamasurg.270 [PubMed: 23715968]

Lyubovnikova J, West MA, Dawson JF, & Carter MR (2015). 24-karat or fool's gold? Consequences of real team and co-acting group membership in healthcare organizations. European Journal of Work and Organizational Psychology, 24, 929–950. 10.1080/1359432X.2014.992421

Makary MA,& Daniel M (2016). Medical error-the third leading cause of death in the U.S. British Medical Journal, 353, i2139. [PubMed: 27143499]

Manser T (2009). Teamwork and patient safety in dynamic domains of healthcare: A review of the literature. Acta Anaesthesiologica Scandinavica, 53, 143–151. 10.1111/j.1399-6576.2008.01717.x [PubMed: 19032571]

Mardon RE, Khanna K, Sorra J, Dyer N, & Famolaro T (2010). Exploring relationships between hospital patient safety culture and adverse events. Journal of Patient Safety, 6, 226–232. 10.1097/PTS.0b013e3181fd1a00 [PubMed: 21099551]

Marks MA, Mathieu JE, & Zaccaro SJ (2001). A temporally based framework and taxonomy of team processes. Academy of Management Review, 26, 356–376.

Mazzocco K, Petitti DB, Fong KT, Bonacum D, Brookey J, Graham S, Thomas EJ (2009). Surgical team behaviors and patient outcomes. American Journal of Surgery, 197, 678–685. 10.1016/j.amjsurg.2008.03.002 [PubMed: 18789425]

McDonald KM, Schultz E, Albin L, Pineda N, Lonhart J, Sundaram V, Davies S (2014). Care coordination measures atlas update (AHRQ Publication No. 14–0037-EF). Retrieved from https://www.ahrq.gov/professionals/prevention-chronic-care/improve/coordination/atlas2014/index.html

Miake-Lye IM, Hempel S, Ganz DA, & Shekelle PG (2013). Inpatient fall prevention programs as a patient safety strategy: A systematic review. Annals of Internal Medicine, 158, 390–396. [PubMed: 23460095]

Mishra A, Catchpole K, & McCulloch P (2009). The Oxford NOTECHS System: Reliability and validity of a tool for measuring teamwork behaviour in the operating theatre. Quality & Safety in Health Care, 18, 104–108. 10.1136/qshc.2007.024760 [PubMed: 19342523]

Nembhard IM, & Edmondson AC (2006). Making it safe: The effects of leader inclusiveness and professional status on psychological safety and improvement efforts in health care teams. Journal of Organizational Behavior, 27, 941–966. 10.1002/job.413

Nestel D, Walker K, Simon R, Aggarwal R, & Andreatta P (2011). Nontechnical skills: An inaccurate and unhelpful descriptor? Simulation in Healthcare, 6, 2–3. 10.1097/SIH.0b013e3182069587 [PubMed: 21330843]

Newman-Toker DE, & Pronovost PJ (2009). Diagnostic errors—The next frontier for patient safety. Journal of the American Medical Association, 301, 1060–1062. 10.1001/jama.2009.249 [PubMed: 19278949]

O'Grady ET (2008). Advanced practice registered nurses: The impact on patient safety and quality In Hughes RG (Ed.), Patient safety and quality: An evidence-based handbook for nurses. Rockville,
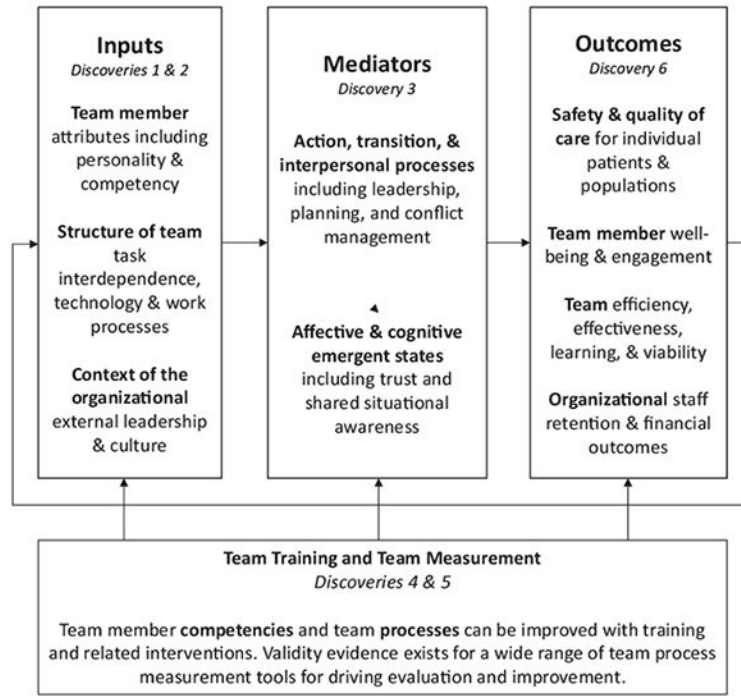
MD: Agency for Healthcare Research and Quality Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK2641/

Olguín DO, Gloor PA, & Pentland A (2009, 4). Wearable sensors for pervasive health care management. Proceedings of 3rd International Conference on Pervasive Computing Technologies for Health Care 10.4108/icst.pervasivehealth2009.6033

O'Mahony S, Mazur E, Charney P, Wang Y, & Fine J (2007). Use of multidisciplinary rounds to simultaneously improve quality outcomes, enhance resident education, and shorten length of stay. Journal of General Internal Medicine, 22, 1073–1079. 10.1007/s11606-007-0225-1 [PubMed: 17486384]

Paull DE, Mazzia LM, Izu BS, Neily J, Mills PD, & Bagian JP (2009). Predictors of successful implementation of preoperative briefings and postoperative debriefings after medical team training. American Journal of Surgery, 198, 675–678. 10.1016/j.amjsurg.2009.07.008 [PubMed: 19887198]

Pham JC, Aswani MS, Rosen M, Lee H, Huddle M, Weeks K, & Pronovost PJ (2012). Reducing medical errors and adverse events. Annual Review of Medicine, 63, 447–463. 10.1146/annurev-med-061410-121352

President's Cancer Panel. (2016). Improving cancer-related outcomes with connected health: A report to the President of the United States. Bethesda, MD: National Cancer Institute.

Reader TW, & Cuthbertson BH (2011). Teamwork and team training in the ICU: Where do the similarities with aviation end? Critical Care (London, England), 15, 313 10.1186/cc10353

Rosen MA, Dietz AS, Yang T, Priebe CE, & Pronovost PJ (2015). An integrative framework for sensor-based measurement of teamwork in healthcare. Journal of the American Medical Informatics Association, 22, 11–18. [PubMed: 25053579]

Rosen MA, Schiebel N, Salas E, Wu TS, Silvestri S, & King HB (2012). How can team performance be measured, assessed, and diagnosed In Salas E & Flush K (Eds.), Improving patient safety through teamwork and team training (pp. 59–79). New York, NY: Oxford University Press.

Ruchlin HS, Dubbs NL, & Callahan MA (2004). The role of leadership in instilling a culture of safety: Lessons from the literature. Journal of Healthcare Management, 49, 47–58. 10.1097/00115514-200401000-00009 [PubMed: 14768428]

Salas E, Cooke NJ, & Rosen MA (2008). On teams, teamwork, and team performance: Discoveries and developments. Human Factors, 50, 540–547. 10.1518/001872008X288457 [PubMed: 18689065]

Salas E, DiazGranados D, Klein C, Burke CS, Stagl KC, Goodwin GF, & Halpin SM (2008). Does team training improve team performance? A meta-analysis. Human Factors, 50, 903–933. 10.1518/001872008X375009 [PubMed: 19292013]

Salas E, & Rosen MA (2013). Building high reliability teams: Progress and some reflections on teamwork training. British Medical Journal Quality & Safety, 22, 369–373. 10.1136/bmjqs-2013-002015

Salas E, Rosen MA, Burke CS, & Goodwin GF (2009). The wisdom of collectives in organizations: An update of the teamwork competencies In Salas E, Goodwin GF, & Burke CS (Eds.), Team effectiveness in complex organizations (pp. 39–82). New York, NY: Routledge.

Salas E, Sims DE, & Burke CS (2005). Is there a "big five" in teamwork? Small Group Research, 36, 555–599. 10.1177/1046496405277134

Samal L, Dykes PC, Greenberg JO, Hasan O, Venkatesh AK, Volk LA, & Bates DW (2016). Care coordination gaps due to lack of interoperability in the United States: A qualitative study and literature review. BMC Health Services Research, 16, 143 10.1186/s12913-016-1373-y [PubMed: 27106509]

Schmutz J, & Manser T (2013). Do team processes really have an effect on clinical performance? A systematic literature review. British Journal of Anaesthesia, 110, 529–544. 10.1093/bja/aes513 [PubMed: 23454826]

Schraagen JM (2011). Dealing with unforeseen complexity in the OR: The role of heedful interrelating in medical teams. Theoretical Issues in Ergonomics Science, 12, 256–272. 10.1080/1464536X.2011.564481

Sexton JB, Helmreich RL, Neilands TB, Rowan K, Vella K, Boyden J, Thomas EJ (2006). The Safety Attitudes Questionnaire: Psychometric properties, benchmarking data, and emerging research. BMC Health Services Research, 6, 44 10.1186/1472-6963-6-44 [PubMed: 16584553]

Seys D, Scott S, Wu A, Van Gerven E, Vleugels A, Euwema M, Vanhaecht K (2013). Supporting involved health care professionals (second victims) following an adverse health event: A literature review. International Journal of Nursing Studies, 50, 678–687. 10.1016/j.ijnurstu. 2012.07.006 [PubMed: 22841561]

Shanafelt TD, Balch CM, Dyrbye L, Bechamps G, Russell T, Satele D, Oreskovich MR (2011). Special report: Suicidal ideation among American surgeons. Archives of Surgery (Chicago, Ill.: 1990), 146, 54–62.

Shuffler ML, Jimenez-Rodriguez M, & Kramer WS (2015). The science of multiteam systems: A review and future research agenda. Small Group Research, 46, 659–699. 10.1177/1046496415603455

Sutcliffe KM, Lewton E, & Rosenthal MM (2004). Communication failures: An insidious contributor to medical mishaps. Academic Medicine, 79, 186–194. 10.1097/00001888-200402000-00019 [PubMed: 14744724]

Thomas EJ (2011). Improving teamwork in healthcare: Current approaches and the path forward. British Medical Journal Quality & Safety, 200, 647–650.

Tschan F, Semmer NK, Gurtner A, Bizzari L, Spychiger M, Breuer M, & Marsch SU (2009). Explicit reasoning, confirmation bias, and illusory transactive memory. Small Group Research, 40, 271–300. 10.1177/1046496409332928

Tucker AL,& Edmondson AC (2003). Why hospitals don'tlearn from failures: Organizational and psychological dynamics that inhibit system change. California Management Review, 45, 55–72. 10.2307/41166165

Undre S, Sevdalis N, Healey AN, Darzi A, & Vincent CA (2007). Observational teamwork assessment for surgery (OTAS): Refinement and application in urological surgery. World Journal of Surgery, 31, 1373–1381. 10.1007/s00268-007-9053-z [PubMed: 17487527]

Van Houdt S, Heyrman J, Vanhaecht K, Sermeus W, & De Lepeleire J (2013). An in-depth analysis of theoretical frameworks for the study of care coordination. International Journal of Integrated Care, 13, e024. [PubMed: 23882171]

Waldfogel JM, Battle DJ, Rosen M, Knight L, Saiki CB, Nesbit SA, Dy SM (2016). Team leadership and cancer end-of-life decision making. Journal of Oncology Practice, 12, 1135–1140. 10.1200/ JOP.2016.013862 [PubMed: 27601512]

Warshaw G (2006). Introduction: Advances and challenges in care of older people with chronic illness. Generations (San Francisco, Calif.), 3, 5–10.

Weaver SJ, Che XX, Pronovost PJ, Goeschel CA, Kosel KC, & Rosen MA (2014, 9). Improving patient safety and care quality: A multiteam system perspective In Shuffler ML, Rico R, & Salas E (Eds.), Pushing the boundaries: Multiteam systems in research and practice (pp. 35–60). West Yorkshire, England: Emerald 10.1108/S1534-085620140000016002

Weaver SJ, Dy SM, & Rosen MA (2014). Team-training in healthcare: A narrative synthesis of the literature. British Medical Journal Quality & Safety, 23, 359–372. 10.1136/bmjqs-2013-001848

Weaver SJ, Feitosa J, & Salas E (2013). The science of teams: The theoretical drivers, models, and competencies of team performance for patient safety In Salas E & Frush K (Eds.), Improving patient safety through teamwork and team training (pp. 3–26). New York, NY: Oxford University Press.

West CP, Huschka MM, Novotny PJ, Sloan JA, Kolars JC, Habermann TM, & Shanafelt TD (2006). Association of perceived medical errors with resident distress and empathy: A prospective longitudinal study. Journal of the American Medical Association, 296, 1071–1078. 10.1001/jama. 296.9.1071 [PubMed: 16954486]

Wilson RM, Runciman WB, Gibberd RW, Harrison BT, Newby L, & Hamilton JD (1995). The quality in Australian health care study. The Medical Journal of Australia, 163, 458–471. [PubMed: 7476634]

Wu AW (2000). Medical error: The second victim. The Western Journal of Medicine, 172, 358–359. 10.1136/ewjm.172.6.358 [PubMed: 10854367]

Young PL, Olsen L, & McGinnis JM (2010). Value in health care: Accounting for cost, quality, safety, outcomes, and innovation: Workshop summary. Washington, DC: National Academies Press.

Yule S, Flin R, Paterson-Brown S, & Maran N (2006). Non-technical skills for surgeons in the operating room: A review of the literature. Surgery, 139, 140–149. 10.1016/j.surg.2005.06.017 [PubMed: 16455321]

Zaccaro SJ, Marks MA, & DeChurch LA (2012). Multiteam systems: An introduction In Zaccaro SJ, Marks MA, & DeChurch LA (Eds.), Multiteam systems: An organizational form for dynamic and complex environments (pp. 3–32). New York, NY: Taylor & Francis.

A: Input – Mediator – Outcomes (IMO) Framework

Inputs
Discoveries 1 & 2

Team member attributes including personality & competency

Structure of team task interdependence, technology & work processes

Context of the organizational external leadership & culture

Mediators
Discovery 3

Action, transition, & interpersonal processes including leadership, planning, and conflict management

Affective & cognitive emergent states including trust and shared situational awareness

Outcomes
Discovery 6

Safety & quality of care for individual patients & populations

Team member well-being & engagement

Team efficiency, effectiveness, learning, & viability

Organizational staff retention & financial outcomes

Team Training and Team Measurement
Discoveries 4 & 5

Team member **competencies** and team **processes** can be improved with training and related interventions. Validity evidence exists for a wide range of team process measurement tools for driving evaluation and improvement.

B: Multi-team System (MTS) Interdependencies

Component Team 1

I M O

Component Team 3

I M O

Component Team 5

I M O

Component Team 2
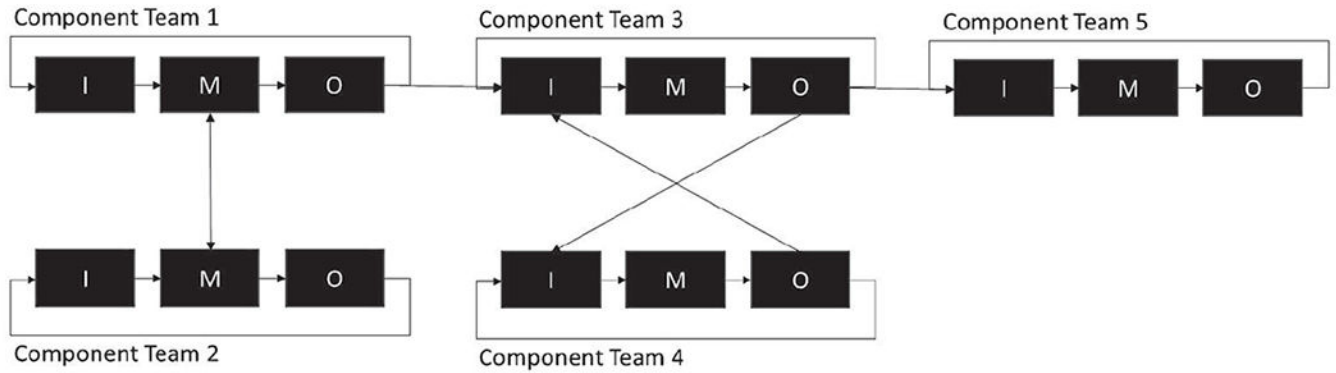
I M O

Component Team 4

I M O

Figure 1.
Illustration of team science frameworks guiding this review. Panel A depicts the input-mediator-output (IMO) framework guiding the team science discoveries. Discovery 1 focuses on organizational context factors (inputs) impacting team effectiveness. Discoveries 2 and 3 focus on what is known about effective teamwork competencies (inputs) and processes (mediators). Discovery 4 focuses on how team processes are measured, and Discovery 5 on how competencies and processes are improved. Discovery 6 focuses on evidence linking teamwork to outcomes. Panel B illustrates multiteam system (MTS) interdependence structures in healthcare organizations. Component team (CT) 1 and CT 2 exhibit intensive coordination, such as a primary care team and group of consultants

working collaboratively on diagnosis and treatment planning; CTs 1, 3, and 5 exhibit sequential interdependence, such as care teams within a preoperative surgical clinic, operating room, and recovery unit caring for surgical patients; CTs 3 and 4 exhibit reciprocal interdependence, such as physical therapy and nursing teams working to ambulate patients within an inpatient care unit.

Table 1

Summary of Key Discoveries and Future Directions

Discovery	Description/state of the science	Future directions
Structure and context matter to understanding the quality of teamwork	The structure of the team and task, in addition to the context in which the team works and the task is conducted, have important implications on what constitutes effective teamwork processes that lead to desired outcomes. / Research has demonstrated the influence of structural and contextual changes on improved quality measures. For example, the use of multidisciplinary rounds to improve patient outcomes or the influence of leadership culture on team learning.	Explore teamwork over longer periods of time in complex organizational structures like multiteam systems. In addition, examine how patient care can benefit from more macro-level patterns of teamwork via team and MTS models.
The KSAs underlying teamwork in health care settings are identifiable	Undergraduate, graduate, and continuing education competency models in healthcare include teamwork-oriented domains (e.g., communication, situation monitoring, mutual support, a team orientation), though most evaluation has occurred in acute, rather than chronic care, contexts.	Identifying and assessing competencies necessary for multiteam systems, virtual teams, and with health information technology, as well as managing disciplinary/other fault lines, and impact on patient and provider outcome
Teamwork processes in healthcare include rapid learning, listening intently, adapting, and speaking up among clearly defined team members and loose collaborators	Observational and interventional studies reinforce that many of the affective, cognitive, behavioral processes that matter for other types of teams operating in high-risk, dynamic environments also matter for teams delivering clinical care (e.g., adaptive coordination, group-level learning while executing, translating and synthesizing new information, explicit reasoning, and speaking up	Identifying interventional strategies beyond training that facilitate these processes among larger MTSs and looser collaborators over time
Team performance can be validly measured across complex settings	Content and construct validity have been established for team performance measurement tools in a wide range of care settings using survey and observational measurement methods.	Determine what attributes of the measurement system produce the most valid and reliable ratings with the lowest level of logistical costs. / Explore the potential of unobtrusive and sensor-based methods of measuring teamwork.
Health care team training competencies can be systematically improved	Both formal training and on-the-job tools can be leveraged to strategically and purposefully improve team competencies.	Examine HIT, including EHRs and telemedicine, as possible on-the-job tools reinforce competencies and behaviors targeted in training to help teams better coordinate, communicate, and develop accurate shared mental models throughout distributed, asynchronous performance.
	Leadership and sustainment strategies are chief among the conditions that influence the effectiveness of team interventions. Leadership must model and support desired team competencies within health care workers. Furthermore, organizational policies, reward structures, and culture all must be aligned to achieve long-term team improvement solutions.	
Teamwork quality impacts patient, staff, and organizational outcomes	Failures in teamwork are associated with a large proportion of the high rate of preventable patient harm, the quality of care provided by organizations, and staff fatigue, burnout, and turnover.	A more precise understanding of how within team, and between team processes interact to impact outcomes.

Note. MTS = Multi-Team System; KSA = Knowledge, Skills, Attitudes; HIT = Health Information Technology; EHR = Electronic Health Record.

Table 2

Example Teamwork Competency Frameworks for Health Care Professionals

Framework	Competencies	Definition or examples of associated KSAs
Core Competencies for Interprofessional Collaborative Practice (Interprofessional Education Collaborative, 2016)	Interprofessional practice values	Work with individuals of other professions to maintain a climate of mutual respect and shared values
	Roles/responsibilities	Use knowledge of own role and other professions to appropriately assess and address the health care needs of patients to promote/advance health of populations
	Interprofessional communication	Communicate with patients, families, communities, and professionals in a responsive and responsible manner that supports a team approach to the promotion and maintenance of health and the prevention and treatment of disease
	Teams and teamwork	Apply relationship-building values & principles of team dynamics to perform effectively in different roles to plan, deliver, and evaluate patient/population centered care, population health programs, and policies (11 subcompetencies)
Nontechnical skills in healthcare competency framework (Gordon, Baker, Catchpole, Darbyshire, & Schocken, 2015)	Communication	Uses language clearly, organizes information, ensures shared understanding
	Team working & interprofessional skills	Exchanges relevant information within the team, focuses on the patient and their care when conflict arises, values team input
	Personal behaviors	Displays personal attributes of compassion, integrity and honesty, applies critical self-appraisal, welcomes feedback on performance, identifies when stress may pose a risk, recognizes fatigue and considers appropriate actions to negate risk
	Analytical skills	Gathers, analyses information to support risk awareness, changes trajectory facing significant risks, identifies options, re-evaluates based on situational awareness
TeamSTEPPS framework (Agency for HealthCare Research and Quality, n.d.)	Team structure	Identifies multiteam system components that must work together to ensure safety
	Communication	Structured process by which information is clearly and accurately exchanged among team members
	Leadership	Ability to maximize the activities of team members by ensuring that team actions are understood, changes in information are shared, and team members have the necessary resources
	Situation monitoring	Process of actively scanning and assessing situational elements to gain information or understanding or to maintain awareness to support team functioning
	Mutual support	Ability to anticipate and support team members' needs through accurate knowledge about their responsibilities and workload

Note. KSA = Knowledge, Skills, Attitudes.