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Pearls and Pitfalls of Team Science

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Abstract

Formidable health problems are often best addressed by teams of scientists with varied expertise. This diversity among team members and complexities in managing teams can lead to challenges in designing, funding, conducting, and reporting research. Team science difficulties can be addressed by sophisticated planning, frequent reassessment and realignment of team strategies with goals, and consistent transparent communication. This article addresses specific strategies to build and sustain research teams, manage team meetings, strategically develop publications and grants, thrive in the

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midst of disciplinary and individual team member differences, embrace new ideas and change to maintain creativity, and build future team scientists and projects. The potential value in team science justifies the effort required to build and maintain efficient and effective research teams.

Keywords: team science, interdisciplinary communication, research productivity

Team science allows investigators to combine previously disconnected ideas and resources to address important health problems (Fortunato et al., 2018). Team science has become more common, including among National Institutes of Health (NIH)–funded projects (Fortunato et al., 2018; Lauer, 2018). Team size is increasing (Fortunato et al., 2018; Wuchty, Jones, & Uzzi, 2007). Team authored manuscripts receive more citations, a common metric of scientific impact (Fortunato et al., 2018; Lauer, 2018). The advantages of team science to address complex health problems justify efforts to build successful teams. Team science can present many challenges. This *Western Journal of Nursing Research* Editorial Board special paper addresses pearls and pitfalls of team science. Strategies to address team science challenges are summarized in Table 1.

Ann Marie McCarthy

The University of Iowa

While solo science allows for total control of a project, it is limited by the expertise of a single researcher. The process and methods for conducting research are increasingly complex, as are the topics to be studied, often requiring interdisciplinary collaborations, team science. There are challenges that are unique to team science, such as the need to share control and the need, at times, to compromise. However, with careful planning, team science can be extremely rewarding, provide needed expertise, and improve scientific outcomes.

How do you find interdisciplinary collaborators? The first step is to identify the skills and expertise that are needed for the success of the proposed research. Some times what is needed is a colleague with similar expertise but who is interested in partnering on research projects. This might include multisite projects that require site investigators to manage data collection, or projects that require clinically based colleagues for the success of the project. Often a colleague with unique expertise is needed. For example, one study might need a geneticist while another needs an informaticist. While it is unrealistic to have the same depth of knowledge in these areas as the experts, it is essential to have

Table 1. Strategies for Successful Team Science.

Aim	Strategies

Form research teams	• Select members by identifying what kind and when new expertise is required
	  ○ Large comprehensive schools may have varied expertise but it may be difficult to locate the expertise
	  ○ Smaller schools may necessitate seeking expertise outside the organization
	  ○ May need to add members as projects are completed or the field of science moves forward
	• Carefully consider whether to invite a potential team member who has difficulty working with others. If they possess a rare commodity (e.g., unusual expertise, access to a scarce pool of subjects), some interpersonal difficulties may be a reasonable trade-off.
	• Recruit desirable team members:
	  ○ With a clear abstract of a proposed direction
	  ○ With some ideas about individual scientific contribution
	  ○ With some idea about other team members' roles and responsibilities
	• Articulate members individual scientific contributions
	• Articulate nursing's unique contribution if team members need the information
	• Start a team with a small project will allow time to develop common language and learn work styles while building relationships
	• Start development of shared goals
	• Welcome membership turnover as a means to increase new ideas
	• Consider when to terminate a team member (e.g., number of noncontributions to papers, inability/unwilling to work cooperatively, incompatible goals)

Develop and sustain research teams	• Create mutual expectations regarding scope of work and build mutual goals
	  ○ Develop and regularly assess operational activity links with goals
	  ○ Discuss scientific products (presentations, publications, grants) early in team formation
	  ○ Avoid nonproductive individual agendas
	• Establish new shared language—some misunderstandings are from language divergence
	  ○ Encourage team members to read other team members' articles to understand their perspectives and intellectual contribution

(continued)

Table 1. (continued)

Aim	Strategies

	• Build interpersonal relationships
	  ○ Include social time to build trust
	  ○ Accept that time and effort will be spent building team relationships
	  ○ Celebrate individual and team successes
	• Clarify the roles of team members—which is achieved when roles are negotiated, reviewed, revised, understood, and valued by all team members
	  ○ Foster communication among individuals
	  ○ Communicate among organizational units
	  ○ Ensure administrators know about team members' commitments to the team
	• Create incentives for team science
	  ○ Consider school rewards for productivity (e.g., distribution of indirects)
	  ○ Assist member to achieve tenure and promotion
	• Maintain open communication and consider designating individual for external communication
	• Challenge everyone to contribute
	• Maintain momentum
	  ○ Frequent attention to future plans (e.g., new grants)
	  ○ Continually assess and refine operational components in relationship to goals
	  ○ Frequent reassessment of individual and team incentives

Manage team meetings	• Meet in person as possible to foster relationships
	• Use consistent team meeting times and locations
	• Structure team meetings with agenda items for:
	  ○ Planning projects
	  ○ Reporting on and managing ongoing projects
	  ○ Trouble shooting project difficulties
	  ○ Developing manuscripts and new grants
	• If necessary, develop strategies to manage team members who dominate team discussions

Embrace change	• Maintain an open system:
	  ○ Flexible and responsive to scientific developments, funding opportunities, institutional priorities, composition of the team
	  ○ Able to nimbly respond to changes while protecting goals
	  ○ Fusion of established and new ideas
	• Expect members to be changed by the team experience

(continued)

Table 1. (continued)

Aim	Strategies
Strategically build presentations, publications, and future grants	• Plan products early in team process • Openly discuss members willingness to commit resources to specific products • Negotiate authorship early with reassessments as products are developed • Accept not all members will participate in all manuscript and grants • Recognize disciplinary differences related to authorship order • Recognize disciplinary differences in value of the products of team science including manuscripts, revenue generation, community collaboration, industry links, etc. • Use transparency around expected performance outcomes of team members • Assess whether outputs justify investment of time and resources from the perspective of all stakeholders • Secure shared site for access to project materials • Celebrates successes
Thrive in the midst of differences	• Clarify individual team members' needs (e.g., publications to support grant submissions, promotion and tenure evidence) • Attend to advancing junior scientists • Recognize members may not share same work ethic • Manage conflicts • Expect disagreements and criticism of the science—this is how science progresses—keep them focused on the science not the scientists • Preserve individual creativity • Accept that team science requires shared control and sometime compromise • Recognize and plan for differences in work styles (such as preparation of grants far vs. immediately before deadlines) • Maintain transparent communication about disciplinary perspectives that may affect planning, implementing, or reporting projects
Build for future team science	• Include students and trainees • Recognize disciplinary differences in student engagement in projects • Address disciplinary variations in student authorship participation • Teach team science in PhD programs • Include team science experiences in PhD programs

a basic knowledge and vocabulary of the area to understand the contributions of our colleagues. Reaching out to other colleagues to help identify appropriate collaborators is a typical first step in team development. Some schools have hosted "speed dating" sessions or 3-min research presentations to facilitate identifying potential collaborators with similar interests.

Once a team has been identified, what can be done to facilitate the development of that team? Successful collaborative relationships can take time to develop and often begin with learning the working styles of each member. For example, an individual who prefers to have grant applications developed a week before they are due may find it difficult to work with someone who tends to submit an application at the last minute. Beginning with a small project will help identify differences in styles and provide an opportunity to develop strategies to compromise and ultimately collaborate. Communication among members is essential for successful team science. For each project, the effort commitment, role expectations, and financial allocations for each member need to be clear to all members. Regular team meetings are critical, and a secure site where all materials relevant to the study are accessible to all team members should be established. Some teams have used sites such as a drop box or a website to share their team meeting minutes, relevant articles, and other key materials. Early in the collaborative process, it is important to discuss contributions and recognition for each team member on presentations, publications, and future grant applications. The order of authorship should be discussed for presentations and publications early and revisited during the project, as it may change as the project progresses and individual contributions change. The academic expectations or clinical responsibilities of each team member should be acknowledged and addressed as appropriate. For example, a nontenured tenure track faculty member may benefit from first authorship more than a senior faculty member.

While team science requires additional leadership and organization, the rewards of developing interdisciplinary teams are often exceptional. Science is impacted in a more comprehensive way, benefiting from the additional resources. New scientific questions emerge, our understanding of a range of issues increases, and health care is improved. And for the researcher, the interdisciplinary collaborations and friendships established through team science are extremely rewarding.

Marlene Z. Cohen

VA Nebraska-Western Iowa Health Care System and University of Nebraska Medical Center

The study of complex problems often requires complex research strategies. These complex strategies frequently benefit from a large team of researchers,

often from different disciplines. One of the key values of team science is that each member of the team brings a unique perspective. It is essential to consider your role and what you "bring to the table." It is likely that you bring expertise as a nurse and perhaps proficiency in a particular method and topic. Understanding your unique skills helps clarify your role in the team. Having the confidence to share your perspective when it is different is important. Skill is needed to know when and how to share your ideas, and listening is always valuable.

The diverse perspectives that team members bring can be a key challenge. It is likely that members will be from different disciplines, and disciplines have unique languages. It is useful to speak many languages, or at least to be bilingual! When preparing to be a good team member, reading what other team members have written on the topic may be useful. Clarifying what is said is always important, even when it seems on the surface to be clear. When different disciplinary terms are used, the meaning to one outside the discipline may not be clear. One of the values (and challenges) of language is that words have nuanced meanings that can be difficult to translate easily or with one word.

In addition, members of different disciplines likely have different expectations, and it is always important to explicitly clarify expectations. The expectation of whether one will be an author, the order of authorship, and journals in which it is appropriate to publish are all important to discuss very early in the team building process. It is always important to clarify your needs in relation to grants and publications. Team members at different career stages have different needs to be principal investigator, first author, and to present at conferences. Talking about these roles and expectations at the beginning is vital to ensure that expectations are met.

Authorship is an important and good example of an issue in team science. Katz (2015) questioned how a large number of authors could contribute sufficiently to warrant authorship. In contrast, Hammer and Miaskowski (2017) argued that each member of a large group could make unique intellectual contributions to advance the science, and to warrant authorship on a paper. Deliberation about the aspects of working with a large team is important.

Cindy Anderson

The Ohio State University

Active engagement with the right team is essential to catalyze scientific advances and solve the complex problems required to advance the field. The combined and sometimes disparate expertise needed to address pressing problems often requires different perspectives derived from inter- and

intradisciplinary teams. A strategic approach to establishment of effective and efficient teams can serve as the framework by which cohesive, collaborative, and productive teams are established and maintained.

A first step is to identify the expertise necessary to advance scientific ideas and approaches related to investigation of the phenomena of interest. As science advances, new methods and approaches are often needed to address new gaps in knowledge. Identification of partners with the necessary expertise is central and often requires the need for intensive inquiry through review of the authors publishing in the area of interest, grantees conducting related research, and colleagues both within and external to the local area. In large universities, it is often difficult to navigate through the complexity and size though there is a broad scope of expertise and number of potential researcher partners. Conversely, in smaller settings, it is sometimes difficult to identify local partners due to more narrowed scope of expertise characteristic of smaller institutions. The faculty with the expertise needed may often be within the discipline, perhaps in the same department or unit, and are prepared to make significant contributions to the team with a different nursing lens.

Establishing mutual expectations regarding scope of work, commitment, and scholarly outcomes is imperative when forming and maintaining efficient and effective scientific teams. Interdisciplinary teams often have expectations specific to their fields, requiring an understanding of disciplinary approaches and thinking unique from nursing. There may also be the opportunity to learn new ways to communicate, including the use of different language and terms and the interpretation of phenomena. Maintaining open communication and trust advance the longevity of the team through streamlined resolution of challenges and a spirit of cooperation that motivates team members for continued collaboration. Clarity in scholarly outcomes is central to assuring that all team members have an understanding of expectations and roles within each project, including grant submissions and publications. Leveraging interdisciplinary expertise provides a wide range of opportunities for funding and publication beyond any single individual's specialized focus, provides opportunities to alternate leadership, and increases critical outcomes for each member of the team.

Nursing has a unique opportunity for intradisciplinary partnerships due to the breadth of knowledge and clinical expertise in the profession. Nurse scientists' programs of research may be complementary while simultaneously providing a unique approach that is needed for the team. The opportunity to engage in rich partnerships between nurse scientists and practice experts through PhD-DNP collaborations allows for advancement of science through generation of evidence and facilitates translation to practice through implementation of evidence, improving health outcomes. Factors leading to the

development and maintenance of effective and efficient teams include mutual respect, clear communication, and commitment to the team mutual objectives. Efficient and effective teams working together all "float the boat," providing opportunities for advancing science and professional goals.

Cheryl Killion

Case Western Reserve University

With the heightened complexity of health conditions and related health care delivery challenges, team science has become pivotal in addressing some of these issues. Increasingly, nurse scientists are collaborating on research teams comprised of investigators from other disciplines. Also, nurse researchers are beginning to lead, develop, and participate in centers, consortia, and institutes, though nursing's contributions in these areas have been relatively limited. Until recently, nurses' research efforts have been dominated primarily by individual, single-investigator approaches (Meneses, 2007). Nursing's involvement in resolving health related issues, with sustainable outcomes, by whatever means, is critical for advancing optimal quality of life, promoting the profession, and elevating the nurse scientist. Partnering with researchers from multiple disciplines has great potential for all members of the team.

Because, in team science, models of scientific collaboration differ by the level of theoretical and methodological integration, it matters how nurse scientists are positioned and participate on the teams. Although each research team is different, the ease and efficacy by which nurse scholars can incorporate a nurse science perspective, making its uniqueness visible and understandable, is critical. Establishing legitimacy of the nursing perspective by revealing facets of nursing knowledge is key. Furthermore, the ability to articulate and translate the essence of nursing, for a focal issue, is essential. This is not to suggest that nurse scientists should maintain unilateral or irreconcilable positions. Rather, the goal is that known theoretical, philosophical, and methodological approaches can be presented with confidence while maintaining openness to alternative approaches and opportunities for transformation. The hope is that other involved disciplines do the same and have similar standards. This fusion of established and new ideas, for all team members, represents a paradigm shift in research. Although there is evidence that the nursing perspective is welcomed and valued, some nurse scholars have expressed concerns about the loss of distinct nursing knowledge that could result from nurse scientists focusing on transdisciplinary research (Kneipp et al., 2014). The notion of perceived bias against the nursing profession by other team members has been identified as an issue, as well (Bartunek,

2011). Others have questioned whether nurse scientists sometimes relinquish their stance in interprofessional collaborative research and allow approaches reflecting solely a medical model to be advanced through team science (Kneipp et al., 2014).

To optimize the contribution of nursing in team science, strategic engagement by the nurse scientist is required. In clinical settings teamwork is strong and has laid the foundation for engaging in team science. However, team science extends far beyond teamwork. According to Bennett and Gadlin (2012), critical elements for team science must include self-awareness and the preservation of individual creativity, effective leadership, integrity, mutual trust, and respect.

To achieve these principles, sharing and mutual learning should be encouraged for all team members. Every team member should have the opportunity to articulate his or her own research goals and how these goals relate to the "big picture" (Bennett, Gadlin, & Levine-Finley, 2010). Given that team science membership is relatively new for nurse scientists, one's expertise and achievements, as they may contribute to the success of the study, should be readily assessed and conveyed to the team.

For optimal functioning, all team members should engage in "authentic communication" (Sandberg, 2013). A paradox of research is that "Science thrives on disagreements; it is the motivator for scientific progress" (Bennett et al., 2010). Interpersonal dissension is an inevitable part of human interaction, and in team science a plan for resolving conflict is critical. Growth and progress are facilitated when team members believe there is no one "absolute truth" and understand that multiple perspectives can coexist. Being aware of power dynamics allows for being mindful that differing opinions may provide a vessel for creativity and important new ideas. Finally, team accountability is important. Each team member should share ownership of the project and articulate personal and team contributions to the success or failure of the study.

Holli A. DeVon

University of Illinois at Chicago

One day in January 2008, I opened my email to find a message from Dr. Anne Rosenfeld, a prominent nurse researcher in heart disease. Anne asked whether I would be interested in collaborating on a grant application. I immediately replied that I would be delighted to meet with her and discuss the possibility. That marked the beginning of a very collegial and productive interprofessional relationship that grew to include other scientists and students. Working alone or only with other nurse researchers is no longer a good strategy for

advancing nursing science. Human health problems are complex and are best addressed through interdisciplinary collaborations (Börner et al., 2010). A valuable philosophy is to embrace teamwork as a high value concept. There are many benefits including professional validation, increased innovation, and improved patient care (Disis & Slattery, 2010).

I would not consider working in isolation as an option. While you have knowledge in a specific area, it is not sufficient. You need the expertise of others whether it is conceptual, biological, behavioral, content, methodological, policy, or political. Teamwork that capitalizes on the expertise of each member is more likely to lead to success. Always be open to requests for collaboration and consider the many benefits of being part of a collaborative team who shares leadership and responsibilities. You may be the principal investigator or first author on one project and be a co-investigator or co-author on another project. According to Rose and Anderson (2016), a well-functioning research team has shared goals, clarifies the roles of team members, meets in person as much as possible, negotiates authorship early in the process, includes students and trainees, and celebrates successes.

Working in teams is not without challenges. Rose and Anderson (2016) also noted barriers to the success of team science including misunderstandings, making faulty assumptions, and personality conflicts. I would add "values conflicts" meaning all members of the team may not share the same work ethic or vision for the research. There is always a risk that someone may appropriate your ideas when you collaborate. This may be intentional or unintentional. In my experience, the biggest challenge in team science is getting everyone to contribute. It is a useful skill to be able to recognize the person who says yes to making a contribution to the work when they mean no. Unlike baseball's "three strikes and you are out" rule, I try to abide by a "two strikes and you are out" rule for team science. If a team member fails to deliver on an agreed-upon task or they miss deadlines twice, it is best to consider terminating the relationship.

Conflicts will arise and must be resolved expeditiously to meet goals. Steven Covey, the noted author, best known for his book *The 7 Habits of Highly Effective People*, said "we judge ourselves by our intentions and others by their behavior" (Covey & Merrill, 2008, p. 13). Building on that thought, we might acknowledge that we often judge ourselves by our *best* intentions and others by their *worst* behavior. A wise colleague once pondered over why we seem to assume the worst rather than the best in a person or situation. There is probably a biological and/or social explanation for these thoughts but whatever the reason; when it comes to collaboration, we might work harder to assume the best in others but clarify and verify.

Effective team building is a relational process and requires good communication, organizational skills, and management as well as patience, persistence, trust and respect (Mâsse et al., 2008). Investing time and energy into building a strong research team is well worth the effort and will result in higher quality research, education, and ultimately better health care.

Robert Topp

University of San Diego

"It is amazing what you can accomplish if you do not care who gets the credit."—Harry S Truman

The benefits of nurse scholars engaging in team science or interdisciplinary teams far outweigh the challenges (Henly et al., 2015). The challenges of participating on an interdisciplinary team can be formidable and if not addressed can extinguish the productivity of the most promising interdisciplinary team. I am going to describe three strategies I have employed that have contributed to successful interdisciplinary teams. The earlier you employ these strategies in the process of conducting team science, the greater the rewards of the collaboration. First I'll describe some strategies to building a successful interdisciplinary team. Next, I'll discuss the importance of respecting and appreciating interdisciplinary differences. Finally, I'll explore an approach I've used to distribute the products resulting from participating on an interdisciplinary team.

When building an interdisciplinary team, there are a number of considerations when deciding who to invite to join the team. The first consideration is "Does the individual possess some critical content expertise or access to resources that are essential to achieving the team's objectives?" If the expertise and resources the individual control are widely available, then more emphasis can be placed on the remaining three considerations. If they control exceptionally rare resources, the team may need to weigh the advantages of the access to these resources with any challenges that may accompany inviting the individual to participate on the team. The second consideration is, "Can the potential team member be a team player who can 'share, play fair, and doesn't hit?'" Not everyone learned these rules in kindergarten (Fulghum, 1986) and troublesome individuals who don't respect *all* other members of the team or share the objectives of the team are best not invited to participate on the team. An important consideration when deciding to invite a team member is to understand their motivation for participating on the team. I try not to subscribe to Napoleon Bonaparte's narrow view of human motivation, "there are only two forces that unite men—fear and

self-interest" (Taras, 2012, p. 5), but asking someone why they are willing to venture out of their scientific discipline to work as part of an interdisciplinary team can be enlightening. Being transparent in disclosing what you and other members of the team expect to achieve because of their investment on the team minimizes hidden agendas and helps align the individual's goals with the team's objectives.

The final consideration when deciding to invite someone to join the team is, "Do they clearly understand their role on the team and are they committed to fulfilling that role?" Early on in developing an interdisciplinary team, each member needs to disclose to everyone else on the team what benefit(s) they expect from their participation and what they envision as their contribution to the team. Of course, the more clearly communicated and quantitative the anticipated benefits and contributions are, the less chance for misinterpretation by members of the team.

Team science leverages the strengths and expertise of professionals trained in different fields. This advantage of team science is accompanied by discipline-specific values, terminology, methods, theoretical perspectives, and work styles. These differences between disciplines in conducting scientific inquiry present a challenge, can germinate conflict within the team, but also have the potential to improve the quality of the science. An interdisciplinary team is more productive when all members of team recognize, appreciate, and have the opportunity to learn from the differences among disciplines. Learning new values, terminology, methods, theoretical perspectives and work styles and the rationale commonly results in the individual reexamining the efficacy of their own discipline-specific approaches. Comparing and integrating different discipline-specific approaches may lead to improved scientific methods and wider application of the findings. One of the best examples of this is when I was teaching a measurement class that included students from a variety of health care disciplines. An in-class assignment required the students, as an interdisciplinary group, to develop a novel approach to pain measurement to facilitate patient recovery. The nurses in the group wanted to measure a patient-centered level of acceptable pain, while the physical therapy students wanted to measure pain as a metric of physical functioning. An open respectful discussion of the discipline-specific definitions of pain, along with an explanation of the rationale for the definition allowed an exchange of values, terminology, methods, and theoretical perspectives among the students. This exchange resulted in a unique definition of pain to assess patient recovery. An important characteristic of successful interdisciplinary teams is the ability of the members to recognize and appreciate each other's discipline-specific values, terminology, methods, and theoretical perspectives and work styles to achieve an individual and team goals.

Distributing the products of team science can also be challenging for a number of reasons. First, traditional incentive and reward systems within the academe are only beginning to reward faculty for participating on interdisciplinary teams. As well, the products of team science are not equally valued in all disciplines. Different disciplines assign a different value to the products of team science including patents, peer review manuscripts, being listed as first or last author, student training, policy or practice changes, revenue generation, community engagement, industry collaboration, and so forth. A final challenge recognized by anyone who has led an interdisciplinary team is that each discipline participating on the team commonly believes theirs is the only critical irreplaceable contribution. Hence, they believe they are contributing the majority of the resources and therefore should receive the majority of the products. I have found that discussing what each member anticipates as a valued product and what resources they anticipate committing to the collaboration is a fruitful conversation to have early on in the development of the team and when a member joins or leaves the team. This conversation allows all of the members to understand what products other members value and what resources they are willing to invest to achieve those products. This conversation also allows all members to measure their relative contribution to the team and to negotiate openly for the products of the collaboration. Finally, this conversation of the entire team is a forum where ground rules for distributing unanticipated future products or conflict resolution can be established.

Nancy Fahrenwald

South Dakota State University

A highly functioning team is essential for team science. What holds a team together is a focus on the team's vision and strategic goals as they relate to the overall impact of the collaborative research. In reality, the operational components of achieving strategic team science goals must be finely tuned and revisited regularly. A major success strategy is role clarity, which is achieved when roles are negotiated, reviewed, revised, understood, and valued by all team members. Approaches to role review and negotiations must be built into the operating plans to maintain momentum and grow. Transparency around expected performance outcomes of team members is essential. Celebrate outcomes achieved by all team members.

One of the greatest challenges of team science is communication among the members of the team and between the institutions or organizational units represented by the team. This communication within and beyond the team requires consistent and expected messaging about processes and outcomes. A

designated communications leader is valuable. The team should consider who constructs the messages about the team and their work. How are the messages disseminated and to whom? A plan for communication prevents the unfortunate breach of trust that can occur when messages are unexpected and sometimes made with a myopic view of the team.

It is important to maintain the momentum of the team and to advance junior scientists. Mentorship by senior team members is a vital component of team science. A plan for mentorship is helpful, specifying the length of time for the mentorship, expected outcomes, roles of the mentee and mentor, as well as evaluation of the experience. A team is an open system that must be flexible and responsive to input from the environment, such as scientific developments, funding opportunities, institutional priorities, composition of the team, and other factors. The ability to nimbly respond to environmental changes while protecting the valued and productive work of the team is critical. Output from the team must be worth the investment of time and resources from the perspective of all stakeholders.

Linda Herrick

University of Nebraska Medical Center

Research teams made up of multiple disciplines can be extremely rewarding and productive but also pose some challenges. Teams that have been formed through clinical relationships with common clinical and research interests often have established relationships, a degree of trust, and a common patient-oriented language. These teams have included different mixes of nurses, physicians, dieticians, social workers, biostatisticians, and economists. Effective clinical practice translated to effective research teams though challenges existed such as who to include in which study, keeping all team members involved despite competing demands, authorship, and recognizing contributions. Good team communication in which individuals are open to new ideas, respectful of all contributions, and able to negotiate not only the project but roles within the project has been key. A consistent time for team meetings has provided time for needed communication and discussion of projects, participation, and consensus building related to everything from study aims to data interpretation and decisions regarding presentation and publication opportunities.

Other study teams resulted from collaborations among various institutions for the purpose of research. In this case, relationships and knowledge of the discipline and contributions need to be established quickly. Working with basic scientists in medical adhesives proved to be problematic until we

realized we were operating on different definitions for what we each thought were common terms and research methods. We had multiple meetings at which we explored the common terms, research goals, clinical research methodologies, and considerations and formed trusting relationships. This is not different than other research teams, but we found it took longer and more perseverance to come to common understanding and goals. A neutral location outside both institutions with ample time for uninterrupted conversations was needed to move the project forward.

There are a number of benefits working with multiple disciplines, especially some of the basic scientists. While I appreciate the expertise each discipline brings, one of the challenges is learning enough about what they know and study to see how that can contribute to the team and possible studies. Understanding their science and role may mean studying the literature and asking knowledgeable questions. Another benefit has been the ability to combine data sets or to take advantage of existing data sets for new studies. The challenge is understanding the data sets and negotiating use to answering the scientific questions that may not be answered in other ways or without more expense. Another advantage is the number of connections each of the scientist has within the field that expands the possible collaborations and expertise that the team can bring to a study. This has led to international collaborations and use of existing data sets that combined enable the team to answer questions that would otherwise be cost prohibitive to answer.

Occasionally, I have been asked to join a team for the "nursing perspective" but more likely just to have a nurse on the protocol. I have had several colleagues who were asked to participate but only because they had access to nurses as subjects for someone's study or the principal investigator thought the nurse could coordinate the conduct of the study. Roles and contributions need to be discussed early, and it is sometimes necessary to decline and walk away. However, having worked in clinical research teams with multiple disciplines for most of my research, the challenges and time are worth the rewards and opportunities. While I have learned more than I could have ever imagined through the multiple perspectives and knowledge at the table, we have also been able to contribute to our patient populations and move science forward. Another reward is working and having fun with a lot of great people.

Lazelle E. Benefield

University of Oklahoma Health Sciences Center

Many years ago, I launched a research project to encourage team investigation and invited a group together around a topic I presumed was of interest to

all. In addition, I presumed each invitee would bring purposeful intention to use their expertise in some aspect of the research process. Unfortunately, nonproductive individual agendas prevailed and valuable time was lost with misdirected team building goals. After the initiative was completed with limited success, my cursory assessment was that members devalued each other's disciplinary sophistication and were unwilling to fully participate due to a lack of skill in working together. I had attributed the problem only to an unwillingness to engage, when the deeper issues included a lack of knowledge of how, when, and why to engage. Even with dedicated funding for the collaborative project, individuals used overt and covert methods to protect and sustain their silos of disciplinary funding. Of course, these actions compromised forward movement.

Since that time, the national imperative has progressed and scientists working together reflect the national emphasis on building interdisciplinary research teams to address the complex problems of health and well-being. Team science is considered a specialty with strategies to address effective and efficient team science evolving at an accelerated pace (National Research Council, 2015; U.S. Department of Health and Human Services, NIH, National Cancer Institute, 2018).

Strategies for efficient and effective team science must systematically incorporate the institution, college or discipline, community, and individual research faculty. Selected strategies for early-career researchers include the following:

- Build your own capacity in understanding team science and the associated resources (National Research Council, 2015; *SciTS and Team Science Resources*, n.d.; U.S. Department of Health and Human Services, NIH, National Cancer Institute, 2018). Consider conferences and other intensive learning formats to quickly become fluent.
- As you lead or assist others in bringing a team together, maintain clarity on the scientific problem to be solved. Seek ways to establish team members' expertise and their view of the problem. Listen and lead or secure a facilitator skilled in the "science of team science" who can manage this team building aspect.
- Move away from traditionally viewed research silos and embrace the newer incentives for team science that may include the language of published requests for proposals that connect team science with high potential for funding, institutional team science priorities endorsed by Vice Presidents of Research and tenure and promotion criteria, and the distribution of research incentive funds or grant F and A to colleges/researchers when research leaders cross colleges and departments.

- Engage with champions of team science in your institution to understand when and how senior administrators and scientists are addressing your institution's research strategic plan and the associated rewards and incentives for team science. Translate, customize, and teach this model as part of PhD training.
- As your disciplinary preparation and research skill increases, be prepared to establish and articulate your scientific contributions as a member of a specific team. When asked to participate, be clear on the project aims and where you may contribute. Team responsibilities should be discussed and clearly documented. And as the project aims will surely evolve, be ready to pivot and adjust your contributions with integrity and focus.

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Having had the good fortune to be an NIH PI for 3 decades, I can verify that funding often is awarded to multidisciplinary research teams due to the strengths that varied backgrounds bring to the science. Although I have found numerous challenges, there are effective team methods I can recommend. First, write an abstract of the research to be conducted or quality assurance project to be undertaken (with citations of your prior work). This is an important document to be shared initially with all you approach. This abstract should clearly identify the content under study, intervention or procedures to be tested, and your expertise in the area (from the citations). At the bottom, have a list of those you are inviting to participate in this research. This includes giving their involvement a title (i.e., co-investigator, lab or technology specialist, measurement or programming specialist, interventionist, subject recruiter, etc.). With each title, provide an estimate of the time commitment you are asking for—including institutional review board (IRB) or NIH required training and regular team meetings.

This abstract will function to keep the team grant or policy development work on track. The original abstract verifies contributions of your initial ideas to be tested or approaches to be used and claims for "ownership" or first authorship. Make sure the abstract is dated and that the many changes that occur across time (i.e., sample inclusion/exclusion criteria, team members) are noted and given out at team meetings. In addition, attaching the initial abstract to the first invite allows each member to better understand the overall project prior to their committing to this specific grant team.

During the conduct of the research, I also have found it important to have regular team meetings with consistent and specific agenda items including

expected reports of progress from team members. It is important to also discuss members informing their administrators about their time commitment to the project, each member's role and expected responsibilities with deadlines, your own role as PI and future authorship, and continuing research opportunities.

Challenges do occur between disciplines and even among those in the same profession. These can be differing: (a) desired patient outcomes, (b) views of patient/family problems, and (c) language used related to research. Some may want questionnaire outcomes while others believe only biomedical data are valid measures. Conflicts also occur regarding "how to define patient compliance" or "why is it necessary" to enroll family members or friends in the research. Moreover, issues about what is meant by research terms such as "arms vs. groups," "random vs. cohort design," and "procedures vs. protocols" often cause confusion. Being aware of these differences, identifying and discussing each as these occur, does lead to consensus. Such discussions enrich the research and the colleagueship. The open respectful team meetings and recognition of the value of each point of view also results in long-term teamwork and research opportunities.

Conclusion

Team science is a powerful strategy to build the complex knowledge essential to address difficult health care problems. The very diversity of expertise that makes team science valuable also leads to challenges. Difficulties in managing team science can be addressed by intricate planning, frequent reassessment and realignment of team strategies with goals, and copious transparent communication. The opportunities inherent in team science justify the effort required to build and maintain successful functioning research teams.

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