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Dissemination and Implementation Science in Plastic and Reconstructive Surgery: Perfecting, Protecting, and Promoting the Innovation That Defines Our Specialty

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Summary: Plastic and reconstructive surgery has an illustrious history of innovation. The advancement, if not the survival, of the specialty depends on the continual development and improvement of procedures, practices, and technologies. It follows that the safe adoption of innovation into clinical practice is also paramount. Traditionally, adoption has relied on the diffusion of new knowledge, which is a consistent but slow and passive process. The emerging field of dissemination and implementation science promises to expedite the spread and adoption of evidence-based interventions into clinical practice. The field is increasingly recognized as an important function of academia and is a growing priority for major health-related funding institutions. The authors discuss the contemporary challenges of the safe implementation and dissemination of new innovations in plastic and reconstructive surgery, and call on their colleagues to engage in this growing field of dissemination and implementation science. (*Plast. Reconstr. Surg.* 147: 304e, 2021.)

Plastic and reconstructive surgery is characterized by its emphases on problem-solving, rich diversity of procedures, and collaborative role with several surgical specialties. Proficient in not only a singular anatomical system, the specialty fosters creativity, entrepreneurship, and a degree of surgeon autonomy.¹⁻⁴ Indeed, innovation has played a defining role in plastic and reconstructive surgery since its origins. Harold Gillies used staged reconstruction to restore the faces of veterans during World War I.^{5,6} Joseph Murray won a Nobel Prize for completing the

first successful human kidney transplant.^{6,7} The first microvascular anastomosis using an operating microscope was performed in 1960,⁸ soon followed by the first arm replantation in 1964.⁹ Of the 50 most cited plastic and reconstructive surgery articles, nearly half introduced or modified a surgical technique.¹⁰ It follows that continual and widespread adoption of innovations is necessary for the advancement and survival of the specialty.

Although research is considered a prerequisite for driving innovation,¹¹ the process from ideation to implementation typically takes many decades.¹² Our goals herein are three-fold: (1) to call attention to contemporary challenges for safe and ethical innovation in plastic and reconstructive surgery, (2) to discuss how the emerging field of dissemination and implementation science (D&I) can help to speed the spread and adoption of new ideas into clinical practice, and (3) to identify next steps toward incorporating D&I science into plastic and reconstructive surgery.

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EXISTING STRATEGIES TO PROMOTE INNOVATION IN PLASTIC AND RECONSTRUCTIVE SURGERY

Despite the ubiquity of the term, there is no consensus over what constitutes surgical innovation. Here, we define surgical innovation as (1) the introduction of an entirely new procedure or technology/product used for a procedure, (2) the development of a substantial modification to an existing procedure or technology/product for a procedure, or (3) the application of an existing procedure/technology/product to a new anatomical site or a new patient population.^{11,13}

Implicit in this definition is some uncertainty regarding the procedure's risks and/or benefits over other available treatments, and innovation does not necessarily imply improvement. Indeed, ethical innovation in any surgical discipline demands robust evaluation of safety, efficacy, and effectiveness.^{14,15} The decision to offer an innovative procedure should depend on the patient's goals and expectations, the surgeon's experiences and incentives, the operative risks and available alternatives, and impact on society. In effect, this decision should be difficult, and may often require expertise beyond an individual surgeon's training. These considerations are often particularly complex in plastic and reconstructive surgery, as both aesthetic and reconstructive surgeons routinely work with vulnerable patient populations. Adequate oversight of safe innovation in plastic and reconstructive surgery remains an unmet need.

In recent years, multiple studies and societal groups have proposed strategies to promote the ethical development and application of surgical innovations.^{10,14,16–20} In general, these strategies can be categorized as either surgeon-level or systems-level processes. Surgeon-level processes involve strategies to facilitate shared decision-making and informed consent, provide additional technical training, and improve education on surgical ethics. Proposed systems-level processes include oversight by ethics and/or specialized innovation committees, approval by institutional review boards, longitudinal evaluation by accreditation or regulatory groups, changes in incentive structures, and adherence to reporting guidelines in peer-reviewed publications. The IDEAL framework, for example, provides a five-stage pathway from preclinical studies to patient registries through which surgical procedures should be developed and assessed.^{16,17}

Unfortunately, implementing these strategies has proven difficult. A recent international survey of plastic surgeons found that half did not consider institutional review board approval to be

of high importance for surgical innovation, and respondents reported low familiarity with ethics of surgical innovation.¹³ Despite repeated calls in their support, oversight committees and regulatory bodies have not been widely implemented.¹⁰ Concerns have also been raised that such groups may stifle innovation, which could jeopardize rather than promote patient safety.¹⁸

In this context, it is unlikely that any strategy will be effective or sustainable in isolation. For realistic reform, an understanding of how innovations are spread and adopted, and how these processes may be improved, is needed.

Understanding How Innovations Are Spread

Thomas Kuhn described scientific development as “a succession of tradition-bound periods that are punctuated by sudden breaks and paradigm shifts.”²¹ However, a necessary stage between the development of an innovation and its eventual adoption is the process by which the innovation is spread. Everett Rogers proposed the diffusion of innovation paradigm in 1962 as a universal, general process of social change (Fig. 1).²² Diffusion, in this context, is the passive spread of an idea or innovation over time to members of a social system through existing channels. Diffusion of innovation seeks to describe why it routinely takes several years for an innovation to gain widespread adoption, and why an innovation that is superior to existing methods may actually never be adopted.

Rogers defined five types of adopters in his paradigm, each with distinct roles in the diffusion process and relations to the “circle of local peer networks” (Fig. 1). Innovators are outside the peer network, which frees them from constraints of a local system and allows them to generate new ideas. Early adopters, well respected within the local system, are the first to accept an innovation. They have the resources and risk tolerance to try new ideas. In health care, the early adopters are commonly elected leaders or representatives of clinical groups. Their status decreases the uncertainty of a new idea, which allows it to spread to the early majority, who tend to embrace innovation but seldom hold positions of leadership. If there are no early adopters to communicate a new idea, endorse it, and decrease its uncertainty, the innovation will be rejected and fail to achieve widespread adoption.

It is also important that early adopters modify the innovation (often, this means simplifying the innovation) to promote and teach the new idea.²² Once adoption has reached a critical level of 15 to 20 percent of members in the local system, the idea spreads rapidly to most of the rest of

Roger's Diffusion of Innovation

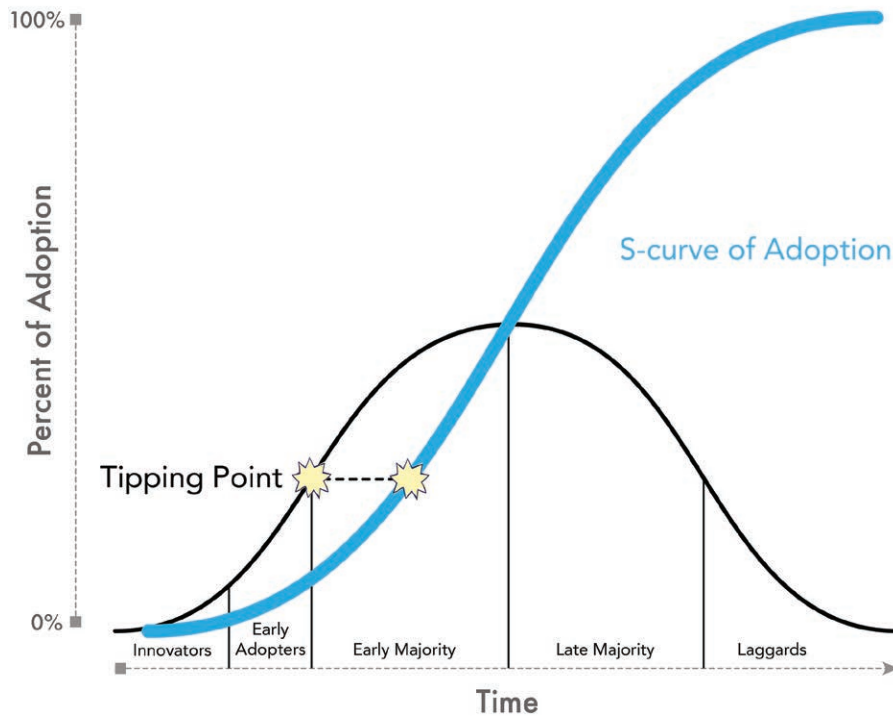


Fig. 1. Diffusion of innovation. The bell-shaped curve (*black*) describes the diffusion of innovation across the social groups of innovators, early adopters, early majority, late majority, and laggards. The S-curve (*blue*) describes the percentage of adoption across these social groups. The tipping point occurs when an idea reaches 15 to 20 percent of adoption in the local system, essentially transitioning into the early majority, after which there is rapid “unstoppable” adoption in the group. (Modified from Rogers EM. *Diffusion of Innovations*. 5th ed. New York: Simon & Schuster; 2003. Adaptations are themselves works protected by copyright. So in order to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.)

the system (i.e., “tipping point”), including to the late majority and the laggards, who are suspicious and/or resistant to change.²² This spontaneous, passive process takes time. Indeed, the treatment and prevention of scurvy with vitamin C, for example, took over two centuries to be accepted, and the more efficient Dvorak keyboard never replaced the less efficient QWERTY keyboard that is still used today.^{12,22} Another analogy is the time it takes in the rise (Roger’s diffusion of innovation) and then fall of a surgical technique, known together as Scott’s parabola (Fig. 2).²³

WHAT CONTROLS THE SPEED OF DIFFUSION?

The speed of diffusion is governed by (1) characteristics of the adopters, (2) characteristics of

the innovation itself, and (3) contextual factors.²⁴ Surgeon adopters may be wary of a new intervention if what he or she has been doing “works well in his/her hands.” Studies on the neuroscience of learning suggest that, as a species, we are hardwired to resist change and innovation, and instead seek safety in constancy and predictability.²⁵ Moreover, our emotions affect learning. In his book *Descartes’ Error*,²⁶ Antonio Damasio describes how emotions “create an enduring or nontransient memory, unique in its intensity”²⁷ that does not require the usual repetition to ensure a memory is sustained. A single patient, or a single surgical encounter, can be so powerful that it imprints an indelible learning moment. Innovation-specific factors include its complexity (simple ideas spread more quickly), trialability (or the ability to test it on a small scale), and observability (whether its effects

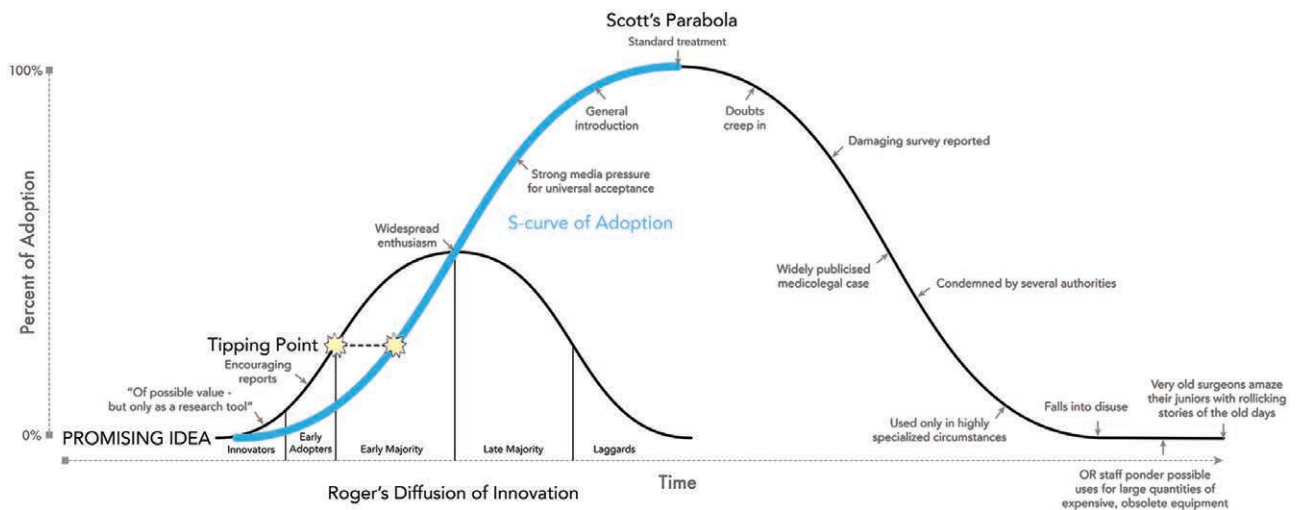


Fig. 2. Scott's parabola. If the S-curve of adoption is extended to represent when an idea falls into disuse, the curve becomes what is known in surgery as Scott's parabola—the rise and fall of a surgical technique. Roger's diffusion of innovation is considered the first half of Scott's parabola. (Modified from Scott JW. Scott's parabola: The rise and fall of a surgical technique. *BMJ* 2001;323:1447. Adaptations are themselves works protected by copyright. So in order to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.)

are easily apparent). Important contextual factors include an organization's culture, leadership, communication and incentive structure, history, and current needs. For example, health care organizations that foster social exchanges between innovators and early adopters, and between early adopters and the early majority, will see faster diffusion than organizations that discourage it or are simply indifferent.

The factors may explain differences in the uptake of practices in plastic and reconstructive surgery. For example, nerve transfer, now a standard technique for the management of peripheral nerve injuries, has had poor adoption in the tetraplegic population despite its first successful application over 10 years ago.²⁸ In contrast, the use of allograft for the treatment of bony hand and wrist defects had very rapid uptake, despite good evidence suggesting its inferiority to autograft.²⁹

THE BEGINNINGS OF D&I SCIENCE

With the accelerated pace of scientific advancements, the gap between evidence-based medicine, or the care that could be provided, and actual clinical practice continues to widen.³⁰ Indeed, it is estimated that it takes 17 years for just 14 percent of medical research to influence patient care.¹² In the years since the introduction of the diffusion of innovations paradigm, focus has shifted toward means of improving and operationalizing the spread and adoption of ideas.³¹ Collectively,

these investigations constitute a new area of study, D&I science.

The field of D&I science has been described in multiple terms, including “research translation,”³² “knowledge translation,”³³ “knowledge to action,”³⁴ “evidence-based policy and practice,”³⁵ and “research implementation,” among others. Although this inconsistency of terminology may create confusion,^{32,36} each term emphasizes the active, directed, and planned spread of knowledge. D&I science promises to speed the safe translation of medical research knowledge into widespread clinical practice by moving Scott's parabola to the left (Fig. 3), and to narrow the quality gap in health care.³⁷ The two interrelated components of D&I research are dissemination science, the study of how knowledge and interventions can best be actively communicated to potential adopters, and implementation science, the study of how an intervention is actually put into practice.³⁷

The field of D&I science has grown exponentially over the past decade. It is increasingly recognized as an important function of academia, and is a growing priority for major health-related funders, including the National Institutes of Health.³⁸ Several peer-reviewed journals have devoted special issues or sections to the topic of implementation of evidence-based practices.^{39–48} For example, the impact factor for the open-access peer-reviewed journal *Implementation Science*, dedicated entirely to D&I science research, rose

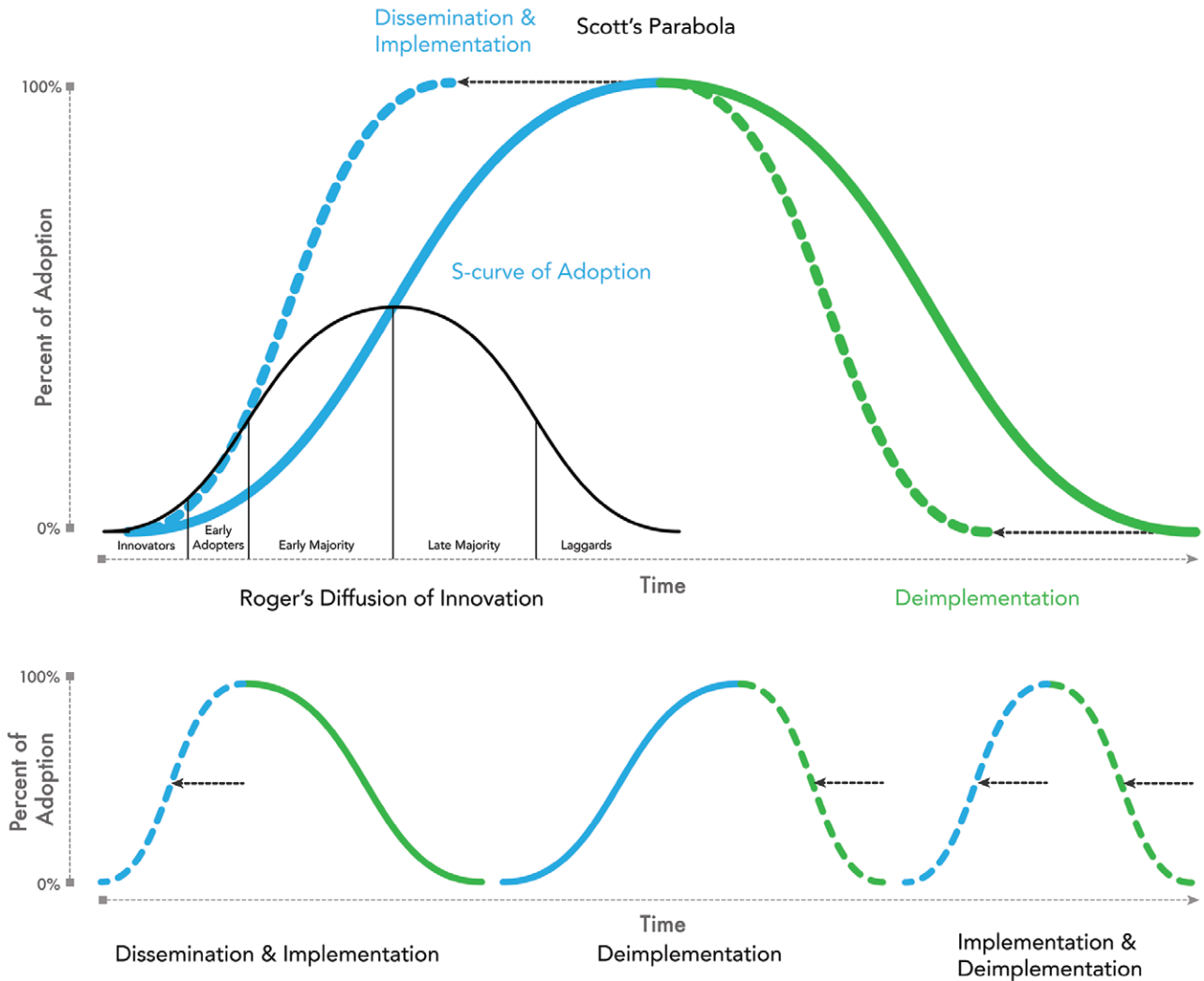


Fig. 3. Implementation and deimplementation. The field of dissemination and implementation (*blue*) promises to speed the adoption of innovation, essentially reducing the time for surgeons to adopt a new technique. This aims to truncate the timeline of Roger's parabola for diffusion of innovation and the first half of Scott's parabola with the rise of a surgical technique. Deimplementation (*green*), a new subfield within dissemination and implementation science, studies the process of when innovation falls into disuse, promising its quick and safe exit, and thereby making room for the next innovation. This aims to truncate the timeline of the second half of Scott's parabola with the fall of a surgical technique. *OR*, operating room.

quickly from 2.93 after its first year of publication in 2006 to 5.65 by 2014. The uptake of D&I science in surgery, however, has been comparatively slow. In fact, it could be said that early adopters of D&I research, specifically in the surgical specialties, have yet to be identified.

A D&I APPROACH TO INNOVATION IN PLASTIC AND RECONSTRUCTIVE SURGERY

A D&I science approach involves (1) an evidence-based intervention (the issue of what constitutes evidence-based practices in plastic and reconstructive surgery is addressed below; see

Contemporary Challenges in D&I Science) to be scaled-up or introduced to a new patient population; (2) planned strategies to promote the dissemination, implementation, and sustainability of the intervention; and (3) validated approaches to evaluate whether the strategies were effective.⁴⁹ Rather than relying on intuition or trial-and-error, D&I uses validated models, often referred to as frameworks or theories, to achieve these aims.

Popular models used in D&I research include the Consolidated Framework for Implementation Research, knowledge-to-action, promoting action on research implementation in health services, RE-AIM, and translation research continuum or

T models.³² Choice of model depends on the purpose of the D&I study and on investigator preference. For example, RE-AIM was created as a five-step framework (reach, efficacy, adoption, implementation, and maintenance) to conceptualize the public health impact of an intervention.⁵⁰ Whereas RE-AIM outlines criteria for the successful implementation of an intervention, the T models depict a general pathway in medical research from ideation to implementation.⁵¹ The steps in this pathway include T0 (description and discovery),⁵² T1 (basic science to clinical research), T2 (clinical research to clinical practice),³⁸ T3 (clinical practice to large-scale dissemination),⁴⁹ and T4 (large-scale dissemination to population health outcomes).⁵³

Irrespective of the selected model, the foundation of any D&I project is an understanding of context. An understanding of context can help to explain why surgical innovations are taken up in some areas but not in others, such as geographic variation in endoscopic versus open carpal tunnel release,⁵⁴ or the use of custom computer-assisted design and manufactured implants in North America but less so in resource-restricted countries. The Consolidated Framework for Implementation Research model recommends examining the inner setting, outer setting, and characteristics of individuals for contextual assessment.⁵¹ The inner setting may involve an understanding of a hospital's resources; an organization's culture to accept or prioritize change; or the relationships between physicians, patients, and hospital administrators. The outer setting may refer to how a plastic and reconstructive surgery department interacts with the greater surgical, regulatory, or patient community. Assessing the outer setting may, for example, involve describing what external financial incentives or disincentives influence surgeons' behaviors. Lastly, characteristics of individuals may refer to how surgeons view their own responsibility to follow ethical practices and what they consider to be ethical practice. These constructs may be evaluated through interviews, surveys, or consensus conferences, but they remain poorly described in plastic and reconstructive surgery. An understanding of context can help to explain why surgical innovations are taken up in some geographic areas but not in others.

The next step in a D&I study is to formulate strategies to address barriers identified during contextual assessment. Several validated strategies have been developed to overcome common implementation barriers.⁴⁹ As described by Proctor et al.,⁴⁹ a D&I project should use multiple strategies

to facilitate change at multiple levels, including the systems and individual levels. Many previously suggested methods for promoting ethical innovation, such as ethics training for surgeons or oversight committees, are potential implementation strategies. Choice of strategy depends on the purpose of the study and on the contextual assessment. After all, an oversight committee instituted at a hospital with little funding or surgeon interest would be unlikely to achieve its intended purpose.

The last component of a D&I study is to assess whether its implementation strategies are successful. Commonly evaluated outcomes are acceptability, adoption, feasibility, fidelity, and sustainability (Table 1).^{49,55,56} An important distinction between traditional D&I research and clinical research is that success is defined by how well the intervention is disseminated or implemented rather than by improvements in clinical outcomes^{57,58} (or "effectiveness research"⁵⁹). The traditional assumption for D&I research is that the evidence-based intervention will work as published, provided that it is appropriately implemented. However, this assumption is not always realistic, particularly when the evidence for an intervention is relatively modest or when the intervention's generalizability has not yet been established. Hybrid designs have been developed that combine D&I and effectiveness research; they are defined by how much emphasis is placed on testing the implementation strategies versus gathering clinical information on the intervention.⁵⁸

DEIMPLEMENTATION OF HARMFUL OR INEFFECTIVE INTERVENTIONS

In addition to promoting the uptake of evidence-based interventions, there is also a need to replace or abandon existing interventions that are harmful or ineffective. This process of deimplementation (the right half of Scott's parabola) (Fig. 3) has intuitive implications for surgical innovation, and it is a fledgling area of study within D&I science.⁶⁰ Speeding the discontinuation of less effective alternatives makes room for new innovations and interventions, and deimplementation may also help curtail the inappropriate spread of new yet harmful practices. The development of distal nerve transfers for proximal nerve injuries highlights the importance of deimplementation in the innovation process. Traditionally, these injuries have been managed with nerve grafting. However, the introduction of nerve transfer surgery takes advantage of nearby expendable nerves to convert a more proximal

Table 1. Common Implementation Outcomes and Definitions Proposed by Proctor et al.*

Outcome	Definition	Example Measure
Acceptability	How agreeable an innovation or set of implementation strategies is to stakeholders	EBPAS†
Adoption	The uptake of an innovation among stakeholders	Survey assessing the fraction of surgeons who have offered the innovative procedure when indicated
Feasibility	The degree to which an innovation can be used in actual practice; it is distinct from acceptability, in that an innovation may be agreeable but impractical for a setting because of resource or training limitations	Semistructured interviews with surgeons and/or hospital administrators
Fidelity	Adherence to the implementation protocol; it describes the match between how an innovation was meant to be implemented and how it was actually implemented	SDM-Q-9 questionnaire‡
Sustainability	The degree to which an innovation or a set of implementation strategies is maintained over time; it reflects the stable integration of the practice within an organization	A follow-up survey assessing long-term fidelity and adoption

EBPAS, Evidence-Based Practice Attitude Scale; SDM-Q-9, nine-item Shared Decision-Making Questionnaire.

*Proctor E, Silmere H, Raghavan R, et al. Outcomes for implementation research: Conceptual distinctions, measurement challenges, and research agenda. *Adm Policy Ment Health* 2011;38:65–76.

†Aarons GA. Mental health provider attitudes toward adoption of evidence-based practice: The Evidence-Based Practice Attitude Scale (EBPAS). *Ment Health Serv Res*. 2004;6:61–74.

‡Kriston L, Scholl I, Hölzel L, Simon D, Loh A, Härter M. The 9-item Shared Decision Making Questionnaire (SDM-Q-9): Development and psychometric properties in a primary care sample. *Patient Educ Couns*. 2010;80:94–99.

injury to a distal injury, thereby shortening reinnervation time and leading to superior functional outcomes.^{61,62} Unfortunately, even nerve repair with tension and joint flexion are still used to repair nerve gaps by some surgeons. Other examples in plastic and reconstructive surgery include the deimplementation of Allergan Biocell (Allergan Medical Corporation, Santa Barbara, Calif.) textured breast implants^{63,64} and titanium mesh cranioplasties.^{65,66} D&I models to guide deimplementation efforts are active areas of study.

Of course, not all innovations undergo deimplementation. Some innovations ride the crest of adoption for a very long time before an improvement or new innovation replaces the existing innovation (Fig. 4). The goal of D&I science is to retain adoption until a new innovation becomes the standard of care.

CONTEMPORARY CHALLENGES IN D&I SCIENCE

Although the goal of D&I science is to promote implementation of an evidence-based intervention, the amount and level of evidence required before an innovation is considered ready for dissemination in surgery remains an unanswered question.⁶⁷ Indeed, the majority of published studies in plastic and reconstructive surgery journals offer relatively low-quality evidence.^{68–70} As such, hybrid designs,⁵⁸ which gather clinical information while also testing implementation strategies, rather than traditional D&I studies may be most applicable in plastic and reconstructive surgery (Fig. 5).

Furthermore, because of restrictive inclusion criteria, high-level evidence from randomized trials is often not directly applicable to the majority of patients seen in everyday clinical practice. Recently, practice-based research networks have been developed to better understand issues arising in daily practice and the gap between recommended and actual care.⁷¹ Academic institutions may play an important role in collaborating with community clinicians through practice-based research networks to encourage the uptake of new interventions and practices; this includes those in private and hybrid practices.

Finally, the use of new media and emerging technologies also accelerates the rate at which information is disseminated.⁷² They allow for the creation of large, online communities³⁷ and have been shown to expand reach in health promotion,⁷³ disease prevention,⁷⁴ telehealth,^{75,76} and cybermedicine.⁷⁷ However, these modalities may also lead to the spreading of misinformation, as exemplified by the rise in the modern antivaccine campaign.⁷⁸ The safe and ethical use of media and technology to disseminate new information is a necessary but unmet need.

A CALL TO ACTION

Ensuring the widespread adoption of necessary practices in plastic and reconstructive surgery requires a realignment of academic and financial incentives. Although considerable emphasis, time, and funding is placed on developing innovations, there is comparatively little focus on sharing

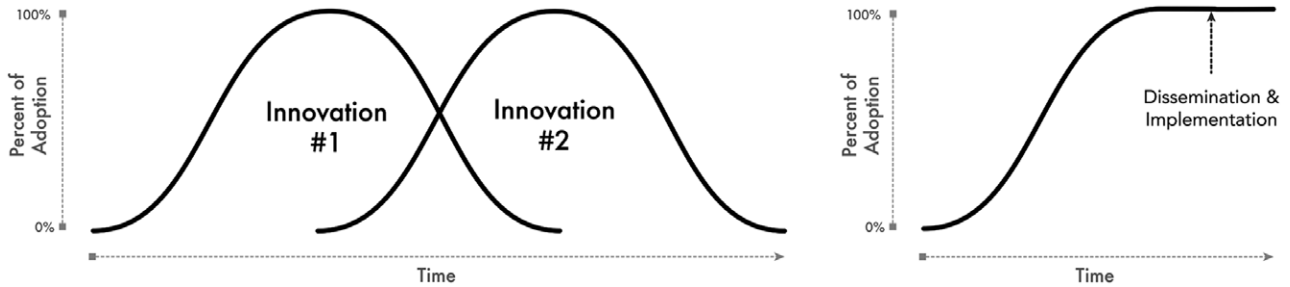


Fig. 4. Sustainability of an innovation. Adoption of a new innovation (*innovation #2*) necessarily leads to deimplementation of an existing innovation (*innovation #1*). The goal of dissemination and implementation science is to retain adoption until a new innovation becomes the standard of care, termed “sustainability.”

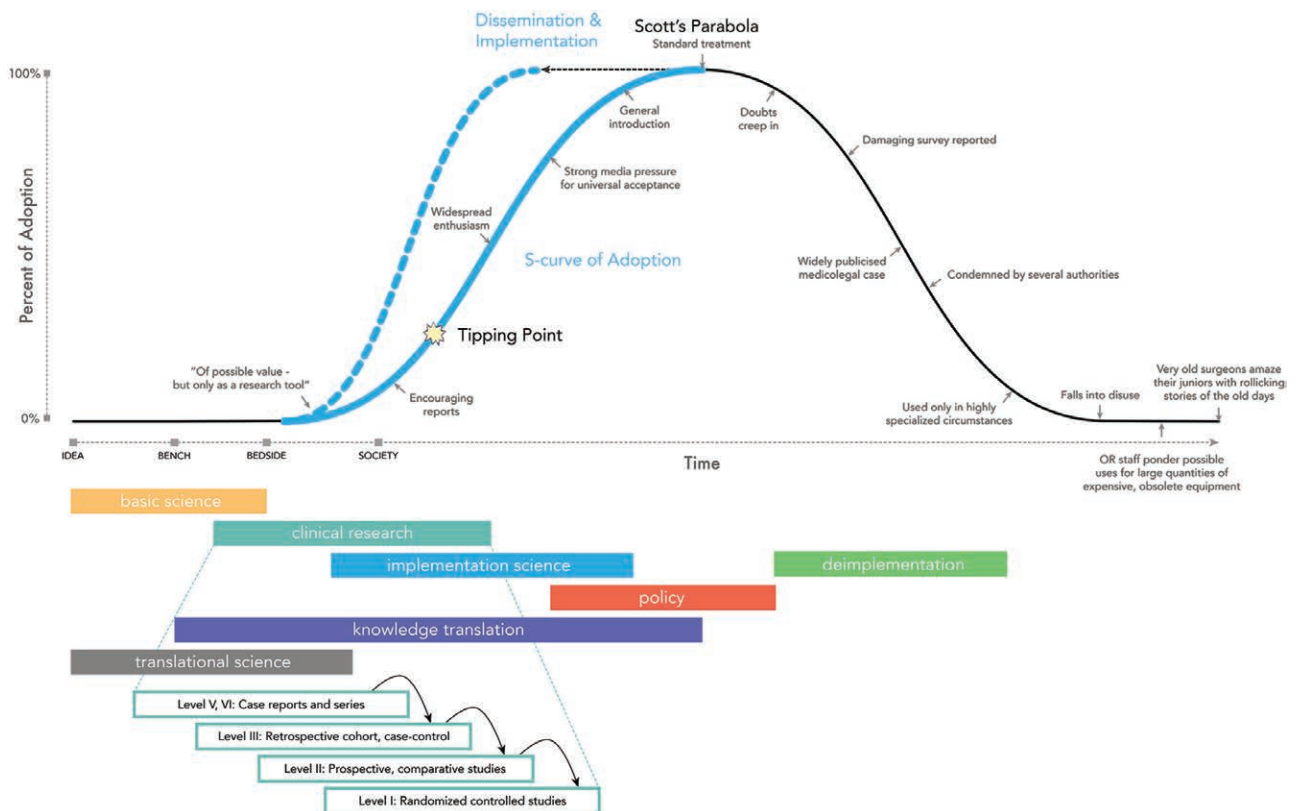


Fig. 5. Translating an innovation from idea to society. The fields of basic science, translational science, clinical research, knowledge translation, implementation science, and policy change all play an important role in bringing an innovation from idea to society. Plotted over time, these fields overlap and occur concurrently. Hybrid designs (Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: The RE-AIM framework. *Am J Public Health* 1999;89:1322–1327), which gather clinical information (levels V through I evidence) while also testing implementation strategies, rather than traditional dissemination and implementation science studies, may be most applicable in plastic and reconstructive surgery. (Modified from 2018 Translational Research Program, University of Toronto. Adaptations are themselves works protected by copyright. So in order to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.)

innovations once developed. In the present system, an innovating surgeon may be rewarded for developing and hoarding a new intervention, becoming the expert on that procedure and collecting referrals. However, establishing a culture and

system to facilitate the sharing of ideas is essential for advancement of plastic and reconstructive surgery, and demands new perspectives in health care policy, health care delivery, and reimbursement.⁷⁹ The current business model of reimbursing for

high–relative value unit procedures in many academic departments stifles both scholarship and innovation, and D&I science emphasizes collaboration over competition. This cultural shift will require input from all stakeholders, including the plastic surgery community-at-large, governing organizations, policy makers, even patients themselves. The role that each of these stakeholders will play remains to be determined. A potential starting point could be increased funding by plastic and reconstructive surgery organizations (e.g., Plastic Surgery Foundation, American Association of Plastic Surgeons) for CME activities and research in D&I science. This could be a single strategy in a multifaceted plan to bring about larger, systemic change. Although these issues are shared across surgical disciplines, plastic surgeons are perhaps uniquely situated to lead such reforms, given the fundamental importance of innovation to the specialty.

The emerging field of D&I science provides strategies to study and facilitate the safe spread and adoption of surgical innovations. It is imperative that, as a group, we become involved in this growing field, and address the contemporary issues facing our specialty. These next steps include the following:

- Defining evidence in plastic and reconstructive surgery: what level of evidence is required to disseminate a new innovation?
- Advocating for culture change and financial support to foster the spread of innovations.
- Applying D&I models to new innovations to ensure their adoption.
- Actively deimplementing harmful or ineffective interventions.
- Using media responsibly to spread innovation.
- Developing and participating in practice-based research networks.
- Developing and maintaining an awareness of our own personal resistance to change.
- Engaging with meetings and journals that focus on D&I science.

Through such efforts, we will continue to accelerate improvements in the safety and quality of surgical care in plastic and reconstructive surgery.

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