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SHEA

SHEA White Paper

Leveraging de-implementation science to promote infection prevention and stewardship: a roadmap and practical examples (Part II of II)

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Abstract

De-implementation of established practices is a common challenge in infection prevention and antimicrobial stewardship and a necessary part of the life cycle of healthcare quality improvement programs. Promoting de-implementation of ineffective antimicrobial use and increasingly of low-value diagnostic testing are cornerstones of stewardship practice. Principles of de-implementation science and the interplay of implementation and de-implementation are discussed in part I of this Society for Healthcare Epidemiology of America White Paper Series. In this second part of the series, we discuss a process for applying principles of de-implementation science in infection prevention and stewardship and then review some real-world examples and case studies, including a national blood culture shortage, contact precautions, and surgical and dental prophylaxis. We use these examples to demonstrate how barriers and facilitators can be mapped to evidence-informed implementation/de-implementation strategies to promote efforts to reduce low-value, ineffective, or out-of-date practices. These real-world examples highlight the need for infection prevention and stewardship programs to adapt to changing evidence, contexts, and conditions. Although barriers to practice change are often a bit different, de-implementation can sometimes be thought of as the implementation of a new program—but the new program aims to stop rather than start doing something.

As the saying goes, sometimes less really is more. Medicine and public health have a strong action bias and a strong aversion to risk and uncertainty. Although our best intentions may point us to implementing more interventions, often, the best medicine instead dictates that we do less, or nothing at all. Leveraging principles of de-implementation science can help move healthcare in the right direction when interventions are low-value, ineffective, or no longer needed.

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Introduction

De-implementation of established practices is a common challenge in infection prevention and antimicrobial stewardship and a necessary part of the life cycle of healthcare quality improvement programs. Promoting de-implementation of ineffective antimicrobial use practices, and increasingly of low-value diagnostic testing, are cornerstones of stewardship practice. Principles of de-implementation science and the interplay of implementation and de-implementation are discussed in Part I of this Society for Healthcare Epidemiology of America (SHEA) White Paper Series.[1] In this second part of the series, we discuss a process for applying principles of de-implementation science in infection prevention and stewardship and then review several real-world examples and case studies.

An evidence-based process for de-implementation

De-implementation efforts typically focus on interventions that fall into one of several categories of evience basis: those that are ineffective and wasteful but not harmful, those that are harmful and actively contraindicated, often with associated "medical reversals," those with a mixed or conflicting evidence base, and those that are untested and/or have limited evidence to support use.[2] Norton and Chambers highlight that distinguishing the evidence underpinning the intervention being targeted as part of the de-implementation process is important because each has different barriers to de-implementation and different actions to remediate negative outcomes. These barriers and actions are best addressed through different types of tailored implementation/de-implementation strategies.[2]

De-implementation of programs can involve removing, replacing, reducing, or restricting the delivery of a low-value or untested interventions; examples of each one of these different types of de-implementation approaches exist within infection prevention and stewardship.[2,3] For example, and discussed in more detail below, contact-based precautions have been *replaced* in many settings with newer, more effective strategies, such as decolonization protocols. Many antimicrobial stewardship and diagnostic stewardship interventions do not aim to stop the use of antibiotics or testing entirely, but rather to *restrict* or *reduce* their use to improve yield and minimize harms. Different programmatic aims (eg, complete removal, replacement, or reduction/restriction) imply different implementation strategies and approaches.[4–7]

Prior to initiating a de-implementation project, formative work, often manifested as qualitative interviews combined with the collection of quantitative data, may be helpful to guide the process of designing the de-implementation plan. First, data about existing practices, including volume and patterns of use, should be collected. This may include a combination of qualitative input as well as quantitative data from healthcare data systems to establish baseline use and ultimately to provide a benchmark for evaluating the impact of the de-implementation effort. Quantification of the degree and scope of the practice that requires de-implementation efforts can also be used to guide the implementation/de-implementation strategies deployed as well as the targets of these strategies (eg, is this a systemwide problem? A single provider problem? A unit problem?). Answers to these questions will guide overall de-implementation initiative efforts.

After gathering some information about the scope of the problem and establishing baseline use, collecting input from those impacted by the change about implementation outcomes, particularly about existing processes and embedded workflows that facilitate an ongoing low-value practice and the reasons why providers continue to pursue that low-value practice, may be helpful for identifying facilitators and barriers to discontinuation. These formative evaluations can also shed light on how deeply engrained a practice is, which has implications for how difficult a de-implementation initative is likely to be. This, in turn, can be used to guide the complexity and design of the bundle of de-implementation strategies. Engagement of facility stakeholders and leadership to learn about institutional priorities and how these can be leveraged to support the de-implementation project is also an important strategy for success. As discussed in more detail in Part I of this series,[1] when considering de-implementation, particular attention should be given to liability concerns, action bias, and embedded processes that continue to support a given practice.[2] Uncertainty can also be a major barrier to de-implementation that needs to be considered prior to embarking upon a program focused on discontinuing or reducing low-value care.[8]

After barriers (eg, knowledge gaps, existing order sets with out-of-date recommendations, posters or other educational materials present in the medical center that are no longer relevant) and facilitators (eg, engaged and respected opinion leaders supporting the project, facility leadership support, desire to improve efficiency and reduce costs, desire to improve outcomes, policy change) are identified, these barriers and facilitators can be mapped to implementation strategies to create an evidence-informed de-implementation bundle to support the effort to discontinue the low-value practice. After the de-implementation initiative has been launched, ongoing evaluations should focus on the degree to which practices have changed in response to these efforts. Ongoing adaptations based on lessons learned during the de-implementation initiative may be needed to achieve the desired level of success. A process map for considering de-implementation is presented in Figure 1, and several case studies of leveraging de-implementation in stewardship and infection prevention follow.

Diagnostic stewardship

Diagnostic stewardship aims to optimize testing utilization with the downstream impacts of reducing unnecessary testing, improving diagnostic accuracy, and reducing unnecessary treatments; in other words, the field focuses on the *reduction* or *restriction* of low-value testing. Diagnostic stewardship iniatives face several barriers: (1) many providers are driven to order tests due to concerns about medical liability; (2) once a test result is available, even if the test was not indicated, it is difficult for providers to dismiss the result and not act upon it; and (3) many providers do not have a strong intuitive sense of pretest probability prior to a test, positive and negative predictive value, or how much a clinical test should move posttest probability of disease.[9,10] Existing order sets and bundles embedded into electronic health records (EHRs) may also create obstacles to de-implementation. Knowledge gaps about indications for treatment given a test can also drive inappropriate testing practices. Facilitators supporting de-implementation can be more difficult to identify but can include supply challenges and other external pressures to support change or changes in the availability of testing.

Changing the culture of culturing

Leveraging the blood culture bottle shortage as part of a bundle to improve use

Although indicated in many clinical scenarios, blood cultures to rule out bacteremia are well known to be overutilized, with up to

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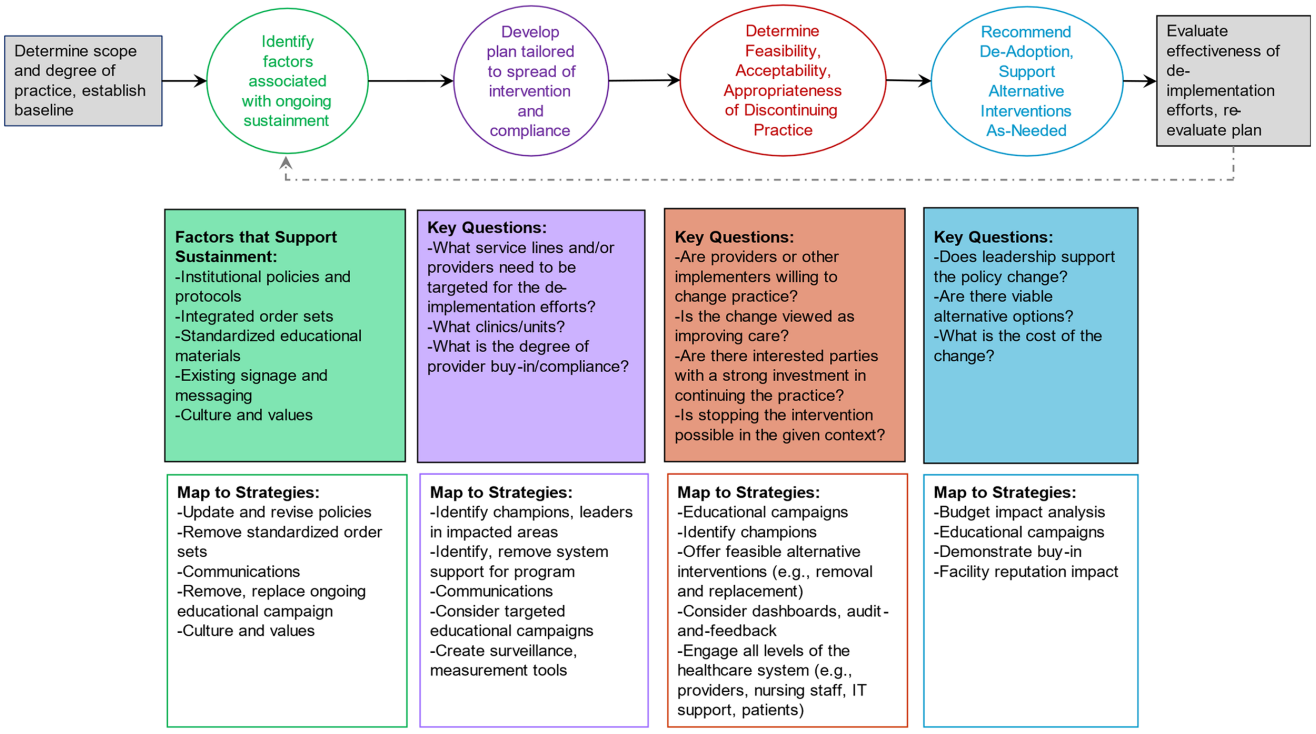

Figure 1. Practical application of de-implementation science principles to support effective removal of low-value care.

90% of blood cultures in hospitalized patients yielding no growth.[11,12] This creates a need for implementation/de-implementation strategies that promote *reduction* in use, rather than complete *elimination* of use. A major challenge in promoting improvement is that, in order to catch true positive cases, we are willing to tolerate *some* overuse; the relevant question lies in what the optimal threshold is and where overuse becomes actionable. Adding to de-implementation challenges, that threshold may be different for different providers and in different situations—an "always right answer" likely does not exist. This challenge of balance and differences in risk tolerance can be a major challenge in de-implementation in general and for initatives focused on reducing clinical testing in particular. A second major challenge with blood culture collection and the downstream impacts on utilization and care is the high rate of false positives (eg, contamination) relative to true cases. Nearly 50% of positive blood cultures represent contaminants. Isolation of contaminants on blood cultures leads to increased length of stay, additional testing, and unnecessary antibiotic exposure and is also an independent target for improvement.[13]

External factors, including national policy changes and supply chain challenges, can provide an opportunity to garner institutional support for diagnostic stewardship interventions. In July 2024, the FDA announced a shortage of BD BACTEC blood culture media bottles.[14] This shortage forced hospitals around the country to rapidly develop systems for improving their blood culture ordering practices, leading to successful reductions in inappropriate use that do not appear to have negatively impacted patient care. Following a rapid institutional multifaceted de-implementation intervention that leveraged this shortage and combined it with education and order restrictions, Humphries *et al* were able to decrease blood culture orders by 49%.[15]

The external pressure from the shortage can be combined with other implementation/de-implementation strategies to create a bundle to support the de-implementation of excessive blood culture ordering and subsequent costly but unnecessary care (Figure 2). Political pressure leading to buy-in and prioritization for the project by facility leadership can be combined with provider education, including audit and feedback about practice patterns and recently developed guidelines for determining when blood cultures are indicated, and clinical decision support algorithms embedded into the EHR; this bundle of strategies has been found to successfully reduce the frequency of blood culture orders. Due to the general fear of litigation as a driver of both diagnostic testing and a barrier to de-implementation efforts, creation of standardized protocols by guideline-issuing bodies can also be a useful strategy to support change, as it provides a layer of protection for providers concerned that they are not providing the accepted standard of medical care. The general framework developed by Fabre *et al* in *Clinical Infectious Diseases*[16] provided a useful reference for providers concerned about limiting blood culture ordering; official endorsement and support from professional societies would provide an additional boost to de-implementation efforts in the direction of ordering less. Other effective strategies for de-implementing blood culture ordering include creation of local guidelines and policies, such as halting automatic blood culture orders prior to the insertion of a peripherally inserted central catheter in asymptomatic patients, and audit and feedback (with or without benchmarking).[17]

Another focus to reduce the downstream consequences of unnecessary blood culture collection has been on optimizing the blood culture collection process, often through the use of diversion devices, to minimize contamination.[18] Although contamination devices do not reduce unnecessary blood culture ordering, by reducing contamination, they have the potential to reduce some of

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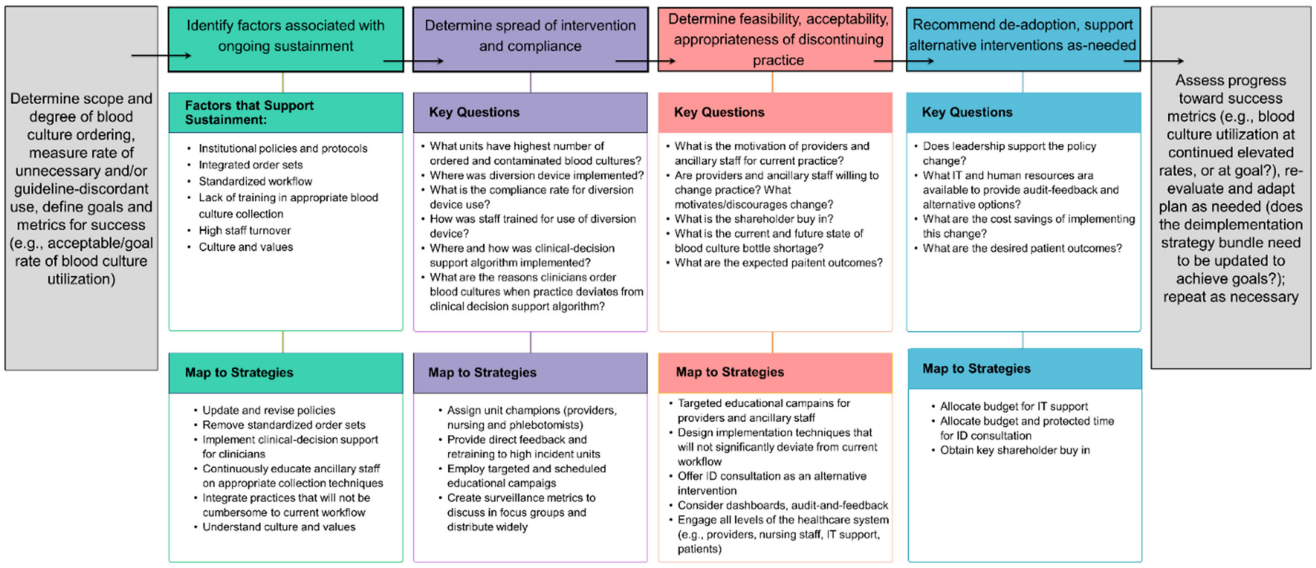

Figure 2. De-implementation mapping process applied to reducing unnecessary blood culture orders.

the downstream consequences of the practice that lead to subsequent low-value medical interventions and, in some cases, patient harm. Of note, both strategies can be combined to improve clinical care quality; one facility first implemented a diversion device and, in the setting of the national shortage, added a clinical decision support algorithm aimed at reducing the number of blood cultures ordered. Analysis is ongoing to see if this two-pronged approach was able to improve the yield of blood cultures while simultaneously reducing unnecessary treatment and follow-up testing stemming from a combination of excess use of blood cultures and subsequent identification of contaminants.

Asymptomatic bacteriuria

Asymptomatic bacteriuria has been a major stewardship target for the de-implementation of a low-value test (the urine culture) and preventing the administration of inappropriate antimicrobials. Common implementation/de-implementation strategies employed to reduce inappropriate urine culture collection and subsequent unnecessary treatment in asymptomatic patients include replacing urine culture orders with urinalysis with reflex to culture (eg, updating order sets and processes), removing urine culture orders from order sets, and reducing/restricting cultures performed by changing urinalysis with reflex to culture criteria. Ongoing audit and feedback via surveillance and reporting is another tool that can be employed to promote discontinuation, particularly if the review is occurring in near real-time. These de-implementation interventions, coupled with active implementation of other catheter-associated urinary tract infection (CAUTI) prevention measures, such as the "ABCs of ASB," have resulted in significant reductions in urine culturing rates, antimicrobial use, and CAUTI rates.[19,20] Additional interventions to reduce overuse of urine cultures (and resulting CAUTI diagnoses) include integration of soft (allowing clinician override) and hard stops (not allowing override) in the electronic medical record to prevent ordering. Demonstrating the positive impact of these de-implementation strategies, a quasi-experimental observational study involving 5 hospitals in Southeast Michigan found that the use of a hard stop to prevent inappropriate urine culturing led to a significant reduction in CAUTI rate and SIR.[21]

Clostridioides difficile diagnostics

Clostridioides difficile diagnostics, particularly PCR-based tests, are another important target for de-implementation, highlighted in the 2017 Update of the IDSA-SHEA Clinical Practice Guidelines for *C. difficile* infection (CDI).[22] Initially, these assays offered improved turnaround time and reduced laboratory labor compared to culture and cytotoxicity assays, while reportedly maintaining high sensitivity.[23] However, the high sensitivity of these assays resulted in increased diagnosis of CDI and raised concern that positive results may represent colonization rather than active infection requiring treatment; furthermore, there were concerns that inappropriate treatment may be associated with unnecessary risk to patients.[24,25] Given these challenges, alternative strategies that mostly rely on multi-stepped processes (eg, confirmation of antigen testing, changing standard laboratory testing and contracts, changing hospital procedures to only allow samples with certain standards to be processed) have been employed to reduce reliance on PCR diagnostics. Additional effective efforts have focused on informational strategies, including educating providers about the use of laxatives if diarrhea develops and providing information about recent negative testing.[27,28]

De-implementation in infection prevention

A common de-implementation intervention in infection prevention is the discontinuation of contact-based precautions for the prevention of methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant *Enterococcus* (VRE) transmission within a healthcare facility. Contact precautions were widely implemented as control measures to reduce transmission of VRE and MRSA and were considered a basic practice in the SHEA 2014 Update.[28] During the period since the 2014 guidance was published, alternative strategies for preventing these healthcare-associated infections (HAIs), such as decolonization protocols for MRSA, have emerged as more effective alternatives.[29] Simultaneously, other studies have demonstrated patient harms and medical and industrial waste impacts associated with the widespread use of contact precautions and transmission of these

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Table 1. Practical examples of de-implementation science in infection prevention

Study	Description	(De-)Implementation framework, strategies, and outcomes	Key points
Dekker M, Jongerden IP, Caris MG, de Bruijne MC, Vandenbroucke-Grauls CMJE, van Mansfeld R. Evaluation of an infection control link nurse program: an analysis using the RE-AIM framework.[45]	Single site study at a large university hospital to evaluate the implementation of a nurse link program for infection prevention	TMFs:	
		• RE-AIM	Mixed method approach to evaluation including surveillance data, meeting minutes and attendance logs for engagement, surveys, direct observations, and interviews
		Strategies:	
		• Stakeholder engagement • Leadership support • Ongoing quality improvement cycles	The results in each domain of RE-AIM were used for specific adaptation of the program and to support sustainability for greatest impact
		Outcomes:	
		• Reach • Effectiveness • Adoption • Implementation • Maintenance	
Schneider A, Coope C, Michie S, Puleston R, Hopkins S, Oliver I. Implementing a toolkit for the prevention, management and control of carbapenemase-producing Enterobacteriaceae in English acute hospitals trusts: a qualitative evaluation.[43]	Qualitative evaluation of the implementation of a toolkit to prevent carbapenem-producing *Enterobacteriaceae* infections at 12 acute hospital trusts in England	TMFs:	
		• Behavior change wheel • COM-B • Theoretical Domains Framework	The authors found that frontline staff knowledge and skills (capability) and their opportunities to use the toolkit impacted their motivation to perform the behaviors recommended in the toolkit
		Strategies:	
		• To be determined from study	Resource availability, the physical environment, and social influences were also widely indicative of implementation
		Outcomes:	
		• Awareness and reach • Implementation and impact of the toolkit • Facilitators and barriers	Adaptation based on results from the study can enhance uptake and utilization of the toolkit
Kallam B, Pettitt-Schieber C, Owen M, Agyare Asante R, Darko E, Ramaswamy R. Implementation science in low-resource settings: using the interactive systems framework to improve hand hygiene in a tertiary hospital in Ghana.[46] Int J Qual Health Care. 2018 Nov 1;30(9):724-730. doi: https://doi.org/10.1093/intqhc/mzy111. PMID: 29788245; PM	Quality improvement initiative to increase hand hygiene in the neonatal intensive care unit of a hospital in a low-resource country	TMFs:	
		• Interactive Systems Framework for Dissemination and Implementation (ISF)	Authors adapted training materials to the local context and engaged "familiar faces" for cues to action
		Strategies:	
		• Synthesis and translation • Support • Delivery	To support the evidence-based guideline, they produced visual demonstration of hand contamination and shared progress with hand hygiene compliance transparently Training was flexible and integrated into routine staff meetings
		Outcomes:	
		• Knowledge • Hand hygiene compliance	Authors did not document implementation specific outcomes

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Table 1. (*Continued*)

Study	Description	(De-)Implementation framework, strategies, and outcomes	Key points
Hall L, White NM, Allen M, Farrington A, Mitchell BG, Page K, Halton K, Riley TV, Gericke CA, Graves N, Gardner A. Effectiveness of a structured, framework-based approach to implementation: the Researching Effective Approaches to Cleaning in Hospitals (REACH) Trial.[47]	Pragmatic, stepped wedge randomized trial of an environmental cleaning bundle among 11 hospitals of differing sizes to study the effectiveness the implementation strategy	TMFs:	
		• i-PARiHS	The bundle included audit, communication, product, training, and technique
		Strategies:	
		• Intervention characteristics • Intervention recipients • Context	The authors found the implementation plan was successful with increases in integration and adherence to the bundle increased from baseline and cleaning improvement
		Outcomes:	
		• Integration and adherence to bundle • Cleaning effectiveness	
Balbale SN, Hill JN, Guihan M, Hogan TP, Cameron KA, Goldstein B, Evans CT. Evaluating implementation of methicillin-resistant Staphylococcus aureus (MRSA) prevention guidelines in spinal cord injury centers using the PARIHS framework: a mixed methods study.[48]	Mixed method evaluation of the implementation of an MRSA prevention guideline in 24 spinal cord injury centers of the Veterans Affairs system using an implementation science framework	TMFs:	
		• PARiHS	Used the PARiHS framework to inform survey and semi-structured interview questions for the evaluation
		Strategies:	
		• Evidence • Context • Facilitation	The intervention achieved approximately 90% reach (either full or partial) and nurses were the position that demonstrated the most awareness
		Outcomes:	
		• Awareness • Adoption • Barriers and facilitators	Resources, including support, training, and funding, were important for implementation. Perceived strength of evidence was also a strong determinant of implementation

Note. TMFs, theories, models, and frameworks; RE-AIM, reach, effectiveness, adoption, implementation, maintenance; COM-B, capabilities, opportunities, and motivation to perform a behavior; i-PARiHS, integrated promoting action on research implementation in health services.

pathogens has moved from being primarily hospital-focused to occurring in other settings, including household and community settings.[30,31] As noted in the first part of this series, clinical medicine is practiced in the setting of constant change.[1] This change drives the implementation and de-implementation life cycle of infection prevention initiatives,[1] which must adapt as evidence, context, and environments change.

Given these ongoing changes and advancements, many facilities opted to move forward with de-implementing contact precautions, often leveraging a removal-and-replacement approach (eg, stopping contact precautions and implementing decolonization programs or enhanced hand hygiene programs).[32–34] Barriers to discontinuation of contact precautions can include provider perceptions about personal risk (eg, concern for personal safety and safety of the healthcare personnel's family members), concern about liability (eg, concern about transmitting MRSA to another patient), existing order sets and facility protocols that reenforce and encourage the practice, and lack of knowledge about new, more effective interventions, among others. As evidence of the role risk and uncertainty play as major barriers to de-implementation initatives, special populations, among which perceived risks of stopping contact precautions are higher (eg, immunocompromised and pediatric populations), are slower to adopt change in the direction of doing less, with providers caring for these groups waiting for additional data to emerge about the "safety" of discontinuation of the practice. The slower change toward discontinuation in these higher-risk populations also highlights another perennial challenge in de-implementation efforts: once a baseline is established, it is quite hard in practice to take something away —even if the evidence supporting that baseline is weak, out of date, or non-existent. Evidence advancements and presentation of that evidence and education are implementation/deimplementation strategies that can be leveraged to support discontinuation but are almost never sufficient as stand-alone strategies to effect real practice change. Several of these identified barriers to discontinuation can be mapped to strategies (eg, ongoing evidence review and dissemination, education about risk, replacement with another more effective intervention,

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Table 2. Practical examples of de-implementation science in antimicrobial stewardship

Study	Description	(De-)Implementation framework, strategies, and outcomes	Key points
Malone S, McKay VR, Krucylak C, *et al*. A cluster randomized stepped-wedge trial to de-implement unnecessary post-operative antibiotics in children: the optimizing perioperative antibiotic in children (OPerAtiC) trial.[60]	3-year stepped-wedge cluster randomized trial in 9 hospitals to evaluate two de-implementation strategies for discontinuing use of post-operative antibiotics in low-risk pediatric surgeries	TMFs: • i-PARiHS • COM-B • ERIC • Implementation Outcomes Framework (Proctor) Strategies: • Order-set change • Facilitation training Outcomes: • Penetration • Acceptability • Appropriateness • Feasibility	Determinants of implementation included inner and outer context, recipients, and health beliefs Facilitation training as implementation strategy previously effective in antimicrobial stewardship Evaluation of outcomes via mixed methods including surveys, process interviews, and clinical data
McDaniel CE, Kerns E, Jennings B, *et al*.; AAP REVISE II QI Collaborative. Improving Guideline-Concordant Care for Febrile Infants Through a Quality Improvement Initiative.[61]	Quality improvement initiative among 103 general and children's hospitals in the United States and Canada to increase adherence to American Academy of Pediatrics Clinical Practice Guideline for treatment of "well-appearing" infants with fever	TMFs: • Psychological framing for de-implementation developed by Helfrich *et al* • Framework based on large-scale QI projects Strategies: • Intentional unlearning • Substitution • Facilitation (eg, stakeholder engagement, audit/feedback) • Mitigation to address psychological barriers (eg, normalizing, reframing) Outcomes: • Clinical activities related to the guidelines	Quantitative data for effectiveness of implementation was evaluated via process control charts Authors provided limited information about implementation outcomes but perceived normalization and audit/feedback as successfully influencing clinical activities
(Theory) Haskell L, Tavender EJ, Wilson CL, O'Brien S, Babl FE, Borland ML, Cotterell E, Sheridan N, Oakley E, Dalziel SR; Paediatric Research in Emergency Departments International Collaborative (PREDICT) network, Australasia. Development of targeted, theory-informed interventions to improve bronchiolitis management.[62] (Outcomes) Haskell L, Tavender EJ, Wilson CL, et al.; PREDICT Network. Effectiveness of Targeted Interventions on Treatment of Infants With Bronchiolitis: A Randomized Clinical Trial.[63]	Cluster randomized trial of 26 facilities to test an intervention to de-implement 5 ineffective practices in the management of pediatric bronchiolitis, one of which is prescribing antibiotics; informed by principles of implementation science	TMFs: • Theoretical Domains Framework • Behavior change techniques Strategies: • Clinical leads • Stakeholder meeting • Train the trainer workshop • Educational intervention delivery (Power Point) • Additional educational tools and materials • Audit and feedback Outcomes: • Feasibility • Local relevance • Acceptability • Clinical outcomes	Used a stepped theory-informed process to develop intervention in the context of TMFs and evidence-based behavior change techniques Assessed implementation outcomes via discussion with the study's advisory panel and members of the research group The intervention group demonstrated significantly higher compliance with bronchiolitis treatment than control group Fidelity to the intervention was variable; audit-feedback component most widely implemented
Branch-Elliman W, Lamkin R, Shin M, Mull HJ, Epshtein I, Golenbock S, Schweizer ML, Colborn K, Rove J, Strymish JM, Drekonja D, Rodriguez-Barradas MC, Xu TH, Elwy AR. Promoting de-implementation of inappropriate antimicrobial use in cardiac device procedures by expanding audit and feedback: protocol for hybrid III type effectiveness/ implementation quasi-experimental study.[59]	Hybrid stepped-wedge intervention trial to de-implement antibiotic use following surgery for cardiovascular implantable electronic devices at 3 large, complex Veterans Affairs hospitals	TMFs: • Learning/unlearning theory • i-PARiHS Strategies: • Informatics-based audit-and-feedback tool • Stakeholder engagement • Patient and provider education • Local champions • Blended facilitation Outcomes: • Acceptability • Adoption • Feasibility • Fidelity • Clinical outcomes	Authors used theory of de-implementation to design the intervention that leverages the strength of underlying evidence and addresses anxiety or fear of changing practice patterns The intervention included numerous constructs from the i-PARiHS framework including innovation, recipients, context and facilitation The study was designed to evaluate the multifaceted intervention using mixed methods, though it has not concluded at time of publication

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Table 2. (*Continued*)

Study	Description	(De-)Implementation framework, strategies, and outcomes	Key points
Livorsi DJ, Sherlock SH, Cunningham Goedken C. The use of telehealth-supported stewardship activities in acute-care and long-term care settings: An implementation effectiveness trial. Infect Control Hosp Epidemiol.[64]	Quasi-experimental study of antimicrobial stewardship activities delivered via a telehealth modality in 3 Veterans Affairs hospitals	TMFs: • RE-AIM Strategies: • Stakeholder engagement • Prospective audit-and-feedback • Education and training • Quality monitoring Outcomes: • Reach • Effectiveness • Adoption • Implementation • Maintenance	Authors used mixed methods to assess implementation outcomes including antibiotic days of therapy as key effectiveness outcome Implementation outcomes measured at the individual and organizational level The intervention reached all primary prescribers but missed off-hours physicians and nurses. Antibiotic days of therapy decreased immediately, then stabilized for the remainder of the implementation period The project was adopted by all invited hospitals (n = 3) and had high fidelity with appropriate tailoring to provider schedules. The intervention was not sustained after the study period ended. However numerous stakeholders spoke to the acceptability of continuing with remote antimicrobial stewardship

Note. TMFs, theories, models, and frameworks; RE-AIM, reach, effectiveness, adoption, implementation, maintenance; COM-B, capabilities, opportunities, and motivation to perform a behavior; i-PARiHS, integrated promoting action on research implementation in health services.

encouraging standard precautions, identification of champions, engagement and pressure from thought leaders) to support de-implementation efforts.

HAI surveillance activities are another example of an infection prevention program that can undergo substantial evolution and lead to positive change. One facility moved from local management of surveillance activities to a centralized program; in other words, this hospital network *removed* local reporting and *replaced* it with centralized reporting.[35] Removing surveillance activities from local control freed up local infection prevention practitioners to spend more time on patient-facing activities, leading to perceived improvements in care delivery.[35] In this case, although the surveillance program itself was sustained, the process and mechanism by which it was provided changed, and local surveillance activities were de-implemented in favor of other quality improvement activities.[35]

A final, and controversial, example in infection prevention and control is the use of universal masking policies in healthcare settings.[36] Universal masking was implemented early in the pandemic when limited other options were able to prevent spread and to reduce disease severity.[37] However, after other tools became available, the downsides of the approach (interpersonal communication and connections, environmental waste, morale, difficulty with effective use and application) were increasingly apparent.[38,39] Given these changes, facilities across the country variably opted to change their policies about universal masking. Barriers to practice change included perceptions about risk both among patients and providers, political environment and beliefs creating external pressure both in favor of and opposing the policy, conflicting and uncertain evidence, and medical-legal concerns. Thought leaders and influencers in infection prevention also expressed different opinions about the policy, further complicating facility-level decisions about maintaining or de-implementing universal masking requirements.[39,40] In the setting of these major barriers to de-implementation, some of the Expert Recommendations for Implementing Change (ERIC) implementation/de-implementation strategies, described in more detail in Part I,[1,41] were used to support de-implementation efforts. These included communication with the public through editorials, op-eds, and television interviews, ongoing evidence reviews, educational sessions and listening sessions with colleagues, legal consultations, creations of communities of practice to share experiences and express views, and ongoing surveillance reporting to ensure stable outcomes after discontinuation of the practice. Some of these barriers and challenges may have been avoided had de-implementation plans been integrated into facility and public health responses upfront as part of a dynamic and adaptive process.[42] Integration of de-implementation and de-escalation should be considered an essential element of any future emergency response planning. In their piece on dynamic public health policy responses, Branch-Elliman *et al.* include a practical toolkit for dynamic policy responses that can be applied to support ongoing assessments of specific recommendations and if deimplementation is indicated.[42]

As noted in an earlier example, and part of a recurring theme in de-implementation science, once a new baseline is established, resetting that baseline is extremely difficult—humans do not like having things taken away from them, no matter what the context. In healthcare settings—which inherently involve high-risk and high-emotion decisions—this tendency is amplified. Experience and data suggest that the burden of proof shifts toward demonstrating that a practice is ineffective or harmful, rather than the burden of proof resting on establishing that it is effective.

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Perhaps reflective of the ongoing controversies and disagreements about the evidence among thought leaders, not to mention the background political environment, many healthcare facilities follow local viral disease burden and risk stratification of patient populations (eg, neonates, bone marrow transplant) on when to initiate and de-implement masking during the respiratory season. Although the practice is common, as of this writing, an evidence-based risk threshold above which inpatient masking policies are effective has not been established.

In addition to the examples presented here, a summary of studies that have leveraged implementation and de-implementation principles in infection prevention is presented in Table 1. Though most reflect implementation, they are good examples of how the same theories, models, and frameworks can be used to support de-implementation efforts. For example, Schneider *et al* studied the implementation of a toolkit for prevention and control of carbapenem-resistant *Enterobacteriaceae* (CRE).[43] The purpose of the UK CRE toolkit was to empower frontline staff and leadership with information and to recommend process changes.[44] The CRE toolkit was designed to have strategies to support rapid implementation efforts, but many of the strategies, such as communications strategies, could also be leveraged to support de-implementation efforts once the perceived risk period has elapsed. Ironically, Schneider *et al* reported that a major limitation of the toolkit was that potential users found that the recommendations and strategies included in the toolkit were impractical (failing the feasibility test) and a lack of trust in the level of evidence included in the recommendations (failing the acceptability test).[43] Additional concerns included uncertainty about risk as well as receiving too much and overly detailed information.[43]

Antimicrobial stewardship

Discontinuation of low-value interventions is a core responsibility of stewardship programs; in fact, a systematic review found that reducing unnecessary antimicrobial use is one of the most frequently studied applications of de-implementation investigations.[49] Diagnostic stewardship interventions, as discussed above, are increasingly emerging as an effective strategy for promoting antimicrobial stewardship goals and de-implementing ineffective antimicrobial use in patients with colonization rather than active infection.[50–52]

Surgical prophylaxis: times change

The Surgical Care Improvement Project (SCIP) was a national quality improvement campaign designed to promote improvements in perioperative care; among the original elements of the SCIP was a recommendation associated with mandated public reporting to discontinue antimicrobials within 24 hours of surgery and within 48 hours for cardiac surgery.[53,54] To achieve compliance with these reporting requirements, facilities adopted a variety of strategies, including order sets, educational programs, and audit and feedback, among others. The antimicrobial use reporting requirement was sunsetted in 2015. During the period since the program ended, guidelines evolved to recommend immediate discontinuation of antimicrobials after surgery rather than permitting post-operative administration.[55] However, processes and physician educational interventions from the original SCIP program, such as order sets embedded into the EHR, remain.[53,56] Thus, there is a need for additional de-implementation efforts to support the adoption of the new recommendations. Factors that may continue to support the ongoing application of older guidelines include provider concerns about providing sub-standard care (eg, medical-legal concerns), embedded processes that support ongoing use (eg, standardized order sets), and knowledge and understanding about current recommendations.[56] These barriers to change suggest several strategies for promoting de-implementation initiatives, including engagement of IT services to update order sets, educational campaigns, and audit and feedback with benchmarking to demonstrate to providers that discontinuation is within the acceptable standard of care. Support from key, trusted opinion leaders and local experts about the safety of the practice change can also help to provide reassurance to those who are uncomfortable with the immediate discontinuation of prophylaxis.

Dental prophylaxis

Estimates suggest that up to 10% of all antimicrobial use occurs in dental offices; the vast majority of this use is either inappropriate or frankly contraindicated.[57,58] Reasons for high rates of use in dental settings include lack of knowledge about guidelines, concerns about severe adverse events and medical liability (eg, failure to provide prophylaxis will cause endocarditis), and limited feedback about harms of the treatment. These drivers of practice imply several strategies to support de-implementation initiatives: provider education, improved engagement and linkage to key thought leaders and experts, and better systems of providing feedback about use, current standards of care, and harms of the treatment. Unlike the inpatient setting where these strategies may be more easily deployed, a major challenge in the dental setting is the disconnected, diffuse nature of dental practices and limited linkage to experts who can support the de-implementation efforts. Ongoing studies seek to identify ways to overcome these challenges to improve care.[59]

Additional examples of implementation and de-implementation science leading to changes in behaviors and processes in antimicrobial stewardship are presented in Table 2.

Conclusions

De-implementation is an inherent part of a program's life cycle. As evidence evolves and conditions and context change, infection prevention and stewardship programs need to adapt to the new environment. Barriers to practice change in the direction doing less can differ from those for implementation initatives. They tend to be more influenced by risk aversion, uncertainty, and a general bias toward supporting the status quo relative to "do more" barriers. Medicine and public health have a strong action bias—but sometimes, the best medicine dictates we do less, not more. Leveraging principles of de-implementation science can help move us in the right direction.

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