The Systems Analysis and Improvement Approach: Data-driven Quality Improvement

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Abstract

**Background:** Healthcare systems in low-resource settings need simple, low-cost interventions to improve services and address gaps in care. Though routine data provide opportunities to guide these efforts, frontline healthcare workers (HCW) are rarely engaged in analyzing them for facility-level decision making. The Systems Analysis and Improvement Approach (SAIA) is an evidence-based, multi-component implementation strategy that engages HCW in use of facility-level data to promote systems-level thinking and quality improvement (QI) efforts within multi-step care cascades. SAIA was originally developed to address HIV care in resource-limited settings, but has since been adapted to a variety of clinical care systems including cervical cancer screening, mental health treatment, and hypertension management, among others; and across a variety of settings in sub-Saharan Africa and the United States. We aimed to extend the growing body of SAIA research by defining the core elements of SAIA using established specification approaches, and thus improve reproducibility, guide future adaptations and lay the groundwork to define its mechanism of action.

**Methods:** Specification of the SAIA strategy was undertaken over 12 months by an expert panel of SAIA-researchers, implementing agents and stakeholders using a three-round, modified nominal group technique approach to match core SAIA components to the Expert Recommendations for Implementing Change (ERIC) list of distinct implementation strategies. Core implementation strategies were then specified according to Proctor's recommendation for specifying and reporting, followed by synthesis of data on related implementation outcomes linked to the SAIA strategy across projects.

**Results:** Based on this review and clarification of the operational definitions of the components of the SAIA, the four components of SAIA were mapped to 13 ERIC strategies. SAIA strategy meetings encompassed external facilitation, organization of provider implementation meetings, and provision of ongoing consultation. Cascade analysis mapped to three ERIC strategies; facilitating relay of clinical data to providers, use of audit and feedback of routine data with healthcare teams, and modelling and simulation of change. Process mapping tied to local needs assessment, local consensus discussions and assessment of readiness and identification of barriers and facilitators. Finally, continuous quality improvement encompassed tailoring strategies, developing a formal implementation blueprint, cyclical tests of change and purposefully re-examining the implementation process.

**Conclusions:** Specifying the components of SAIA provides improved conceptual clarity to enhance reproducibility for other researchers and practitioners interested in applying the SAIA across novel settings.

**Contributions To The Literature**

SAIA is broadly adaptable to QI efforts involving complex, multi-step processes within health systems, in resource-limited as well as higher-resourced settings. SAIA is well-suited to quality improvement efforts in systems containing a defined care cascade and routinely available data, especially when modifications to
workflows are within HCW control. Specification of the SAIA components provides improved conceptual clarity to enhance reproducibility for other researchers and practitioners interested in applying the SAIA across heterogenous settings.

**Background**

The field of implementation science (IS) focuses on improving the delivery of evidence-based interventions (EBI) to maximize their potential impact across heterogenous settings. Implementation strategies, defined as methods or techniques employed to improve adoption, implementation and sustainment of a clinical program or practice\(^1\) – are a major focus of the field. As the IS field has developed, generating evidence on effectiveness of implementation strategies to improve the delivery of EBIs across varied contexts has been a focus. Implementation strategies are key in guiding how to effectively realize EBIs in practice settings. In order to build the evidence-base on implementation strategies, including how well they work across varied contexts, it’s important for researchers to explicitly define and report on the core elements of implementation strategies.

Unclear terminology or inconsistent specification of implementation strategies has made replication of study findings in novel settings difficult.\(^2\)–\(^5\) Guidelines for naming, defining and operationalizing implementation strategies have been proposed by Proctor et al\(^2\), in order to further the science, disseminate more generalizable knowledge and add conceptual clarity. These guidelines established seven dimensions of nomenclature: actor, action, action targets, temporality, dose, implementation outcomes addressed and theoretical justification.

The Expert Recommendations for Implementing Change (ERIC) are another effort to create “a common nomenclature for implementation strategy terms, definitions and categories that can be used to guide implementation research and practice”\(^5\) across heterogenous health service settings. The ERIC expert panel reached consensus on 73 implementation strategies, whose use helps improve conceptual clarity, relevance and comprehensiveness when reporting on implementation strategies.

The Systems Analysis and Improvement Approach (SAIA) is a multi-component implementation strategy focused on optimizing service delivery cascades. SAIA combines systems engineering tools into an iterative process to guide service delivery staff and managers to visualize treatment cascade drop-offs and prioritize areas for system improvements, identify modifiable organization/facility-level bottlenecks, identify and implement modifications to improve system performance and assess their impact.\(^6\) The core systems tools that the SAIA harnesses are cascade analysis\(^7\) (whereby routine data is used to assess how the client population passes through specific sequential steps, identify drop off among the clients and prioritize steps for quality improvement efforts), process mapping (where frontline service providers and managers collaboratively outline the steps that clients currently go through to achieve care in their specific organization/facility) and continuous quality improvement (CQI), to guide service provider-led,
data-driven quality improvement. This work is conducted through organization/facility-level learning meetings supported by external facilitators and conducted at set intervals, typically monthly, for a minimum of six months, to allow service providers to gain expertise in implementing SAIA to improve outcomes of their specific service.

While care cascades have gained increasing traction as a useful way to organize data to inform actions, there are few implementation strategies using and optimizing care cascades that are tailored for LMIC and low-resourced settings. Most strategies target a single step in a system, whereas SAIA focuses on the system as a whole. In addition, the use of CQI ensures the contextual relevance of the proposed solutions to identified bottlenecks. Over the last decade, there has been a steady rise in funded research to adapt SAIA to novel clinical areas and geographic settings, and a growing demonstration of its broader effectiveness across a range of public health settings. To extend on this previously published research and ensure SAIA's success, its adaptation and implementation should be guided by conceptually clear implementation strategies. In this short report we comprehensively map the core components of the SAIA implementation strategy to the distinct strategies of the ERIC typology, specify each resultant ERIC implementation strategy according to Proctor's guidelines for specifying and reporting implementation strategies, and describe implementation outcomes that link to the multi-component SAIA strategy.

**Methods**

Soliciting collective input to specify implementation strategies has been called for by leaders in the field of implementation science, in particular as the evidence-base on strategies like SAIA is rapidly emerging. To capture structured feedback and support consensus building, the investigators convened a panel of 23 implementation scientists, researchers, implementing team members and organizational stakeholders, all with direct experience implementing and/or evaluating SAIA. This panel included those experienced with SAIA's adaptation and application across a range of clinical areas (including PMTCT, mental health, hypertension, family planning, pediatric HIV, cervical cancer, community-based naloxone distribution, juvenile justice health care services, and malaria), and countries (Mozambique, Kenya, USA, Democratic Republic of the Congo), whose direct implementation experience made them well-suited to synthesize best practices and priorities for further adaptation and spread.

**Process**

As pre-work, a smaller group of IS experts, engaged in the initial SAIA studies targeting the optimization of prevention of mother-to-child transmission of HIV (PMTCT) programs, convened to specify the components of the SAIA strategy (SAIA strategy meetings, cascade analysis, process mapping, CQI) and discuss the process by which a broader SAIA panel would be engaged. Subsequently, over 12 months, a modified nominal group technique approach was employed to name, define, and operationalize SAIA core components using Proctor's recommendations, and match them to ERIC implementation strategies.
Three in-person meetings were held and multiple drafts reviewed to specify the actors, action, action targets, temporality, dose, implementation outcomes and theoretical justification for each of the SAIA intervention components. Each component was presented independently followed by interactive debate, to gain consensus on the most appropriate mapping to ERIC strategies. Broader conversation across clinical areas highlighted commonalities and differences, clarifying the essential SAIA components, as well as broader linkages of this multi-component strategy to Proctor’s implementation outcomes. Through consensus, the broader SAIA panel determined which Proctor implementation outcomes are effectively addressed through the use of the SAIA implementation strategy, a process that was informed by the published results of the various studies in peer reviewed journals and conferences as well as feedback from field-based research teams. Implementation outcomes were considered for SAIA as a whole (not its individual components), as it is a multi-component strategy designed to be implemented holistically. The SRQR reporting guideline checklist was deemed appropriate for this short report and is available as an additional file.

Results

The components of the SAIA implementation strategy components were named and operationally defined to guide further specification.

**Component 1: SAIA Strategy Meeting** is defined as an assembly convened of frontline service providers by an external facilitator with expertise in SAIA, to facilitate the process of implementing SAIA. These meetings usually occur monthly and the aforementioned external facilitators provide ongoing support and/or feedback on SAIA implementation to the service delivery team.

**Component 2: Cascade Analysis** is defined as use of a Cascade Analysis Tool (CAT) to analyze the implementing unit’s data, assess current performance of a multi-step care cascade, identify gaps, and quantify potential improvement to the system if a given step were optimized.

**Component 3: Process Mapping** is when frontline service providers visualize, on paper, the service they are providing from the perspective of the target client population and identify bottlenecks and inefficiencies. Through the resulting process map, service providers discuss modifiable system challenges and then pair the results with the CAT optimization, to identify the step and/or target of future improvement efforts.

**Component 4: CQI** is defined as using the results of the CAT and process mapping to propose and prioritize potential micro-interventions, targeting the specific cascade step and/or service bottleneck identified. The micro-intervention is operationalized in terms of its goal, scope, timeframe, specific tasks, and responsible party. Once micro-interventions are identified for testing, their impact is assessed through the plan-do-study-act cycle. At each SAIA strategy meeting, the fidelity and impact of the micro-intervention implementation are assessed and the decision is made to adopt, adapt, or abandon it.
Each of these four SAIA components was mapped to distinct ERIC implementation strategies by the broader research team, followed by specification of their strategy-specific actor(s), action(s), action target(s), temporality, dose and intended implementation outcome(s). All results are presented in Additional File 2.

**SAIA Strategy Meetings**

The action taken through SAIA strategy meetings is the creation of a discussion space of current processes, enabling engagement with data driven problem solving by the frontline service providers with support from external facilitators. The targets of this action are the frontline service providers implementing SAIA. The SAIA strategy meetings sync together the three remaining components of the SAIA implementation strategy. Meetings are held monthly but frequency can be adjusted to match the timing of supervision visits, availability of routine data, or other driving considerations at the site level.

**Cascade Analysis**

Cascade Analysis is accomplished in SAIA through the CAT. Sequentially linked, summarized outcome data from the site over a previous period (typically 1–3 months) is fed into the CAT and provides the team with a snapshot of current performance, including drop offs across steps. The optimization function simulates the overall improvement to the system if a particular step were fully optimized (assuming other steps remain constant), thereby identifying the steps with the greatest potential for cascade gain. The action targets of the cascade work are the frontline providers whose improved use of data to diagnose problems within the system bolsters their sense of ownership and accountability for overall performance. Cascade analysis is seen as the initial step of SAIA and is typically revisited monthly to assess the impact of CQI's cyclical tests of change; however, frequency can be adjusted to match the frequency of data aggregation within the unit or systems' health management information system (HMIS).

**Process Mapping**

Process mapping facilitates the discussion and drawing of a physical map of how clients pass through services within the implementing unit, highlighting steps that are redundant, represent barriers or otherwise do not add value to the individual. Through reviewing these maps, teams discuss and achieve consensus on current service organization across all components of the system, while identifying target areas for improvement. The target is to improve problem identification and prioritization that is tailored to the specific implementing organization or unit. Process mapping, like cascade analysis, also reinforces ownership and accountability for system performance amongst the frontline team. Process mapping is the second step of SAIA and can be understood as a two-part step, whereby the first is the physical mapping and the second is local consensus discussions conducted after the CAT and process maps are completed. At a minimum, process mapping is conducted once, at the first SAIA strategy meeting, but may be revisited and reworked as often as monthly throughout the implementation period.
CQI

The specific actions for this component are four-fold. First, health care teams use data on systems performance and current processes to select a target step and propose a micro-intervention with potential to improve service delivery and outcomes. Once the broader goal and scope are agreed upon, the micro-intervention itself is delineated into discrete tasks, each clearly assigned to a specific team member or members for implementation and reporting at the subsequent meeting. Once the micro-intervention has been implemented for the aggregated data period, the CAT is repeated to determine whether to integrate the micro-intervention into routine processes. After assessment of the intervention's impact on cascade performance, the team decides together whether to adopt it as part of routine performance, adapt it and test it for a second cycle, or abandon it. The action targets of CQI include current processes and service provision as well as communication amongst the health care team. All actions are repeated at every SAIA meeting, with the exception of review of micro-interventions to adopt, adapt, or abandon, which only occurs after the initial SAIA strategy meeting.

Implementation outcomes linked to SAIA

Implementation outcomes, defined as the effects of deliberate and purposive actions to implement new treatments, practices or services have three key functions: 1) they serve as indicators of implementation success, 2) they are proximal indicators of implementation processes, and 3) they are important intermediate outcomes. According to the broader SAIA research team whose perspective was informed by the published evidence of the existing SAIA studies, the multi-component implementation strategy of SAIA mapped to six of Proctor's implementation outcomes as they relate to supporting the application of EBIs: acceptability, adoption, feasibility, fidelity, penetration and sustainability. The team also noted that these outcomes can apply both to the EBI under study and to SAIA itself (particularly in ongoing and planned research testing approaches to spread and sustain SAIA). Operational definitions within the context of SAIA, as well as tools and approaches to measure each outcome are available in Additional File 3.

Discussion

Based on this review and clarification of the operational definitions of the components of SAIA, the panel of experts mapped the ERIC strategies to each of the four SAIA components. SAIA mapped to 13 distinct ERIC strategies and as a multi-component implementation strategy aimed to impact six implementation outcomes: acceptability, adoption, appropriateness, feasibility and penetration.

Frontline service providers are actors in the context of some SAIA component and action targets in others. As implemented to date, SAIA relies on an external facilitator to convene meetings and guide teams through SAIA implementation. Sustainability may require the external facilitator to eventually be phased out, and a facilitator to instead be assigned directly from existing management structures, such as sub-national agencies, already tasked with organization/facility oversight and support; or transition to
facilitation by a champion among the frontline service providers themselves. SAIA is adaptable to a variety of care cascades and contexts. Our current work aims to facilitate future adaptations while maintaining reproducibility. Specific work exploring mechanisms of action (and the relative contributions of individual components of SAIA) is underway and will build upon the generalizability of the SAIA.

Of note, existing data on the service implementing the target EBI, which are key to data-driven systems-level thinking on current performance, varied across settings in its availability or accessibility. This required some study teams to work with key stakeholders (Ministry of Health, others) to introduce or add to data collection forms, or to develop creative ways to collate data across multiple data sources. This is particularly critical for the cascade analysis component. Given that many settings in which SAIA is being implemented are transitioning from acute to chronic care systems, this is hardly surprising. Service providers are being tasked to not just generate and supply data ‘up the chain of command’ but use it to identify bottlenecks and generate solutions for their systems. Thus, the initial work of SAIA often addresses the perennial challenge of data use by frontline service providers for decision-making.\textsuperscript{28}

**Conclusions**

SAIA represents a promising approach to harness systems-level knowledge of service providers and managers at the frontline of care, both in clinical and community settings. In order to ensure its successful and accurate translation to other clinical areas and geographic regions, the authors have built upon a growing body of SAIA research by detailing its core components and implementation strategies, through use of established specification approaches. This work provides clear definitions of the SAIA components using established taxonomy, and maps the SAIA strategy to implementation outcomes they may activate, in order to facilitate future adaptations and additionally lay the groundwork for future work to define its mechanisms of action.

**Abbreviations**

\textbf{CAT}: Cascade Analysis Tool

\textbf{EBI}: Evidence-based Intervention

\textbf{ERIC}: Expert Recommendations for Implementing Change

\textbf{HCW}: Health Care Worker

\textbf{HMIS}: Health Management and Information System

\textbf{IS}: Implementation Science

\textbf{PMTCT}: Prevention of Mother-to-Child Transmission of HIV

\textbf{QI}: Quality Improvement
Declarations

Ethics Approval and consent to participate: Not applicable.

Consent for publication: Not applicable

Availability of data and materials: Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

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**Supplementary Files**

This is a list of supplementary files associated with this preprint. Click to download.

- AdditionalFile1.pdf
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