Participatory system dynamics modeling for

expanding the timely reach of evidence-based practices in VA outpatient mental health:

A 24-month pre/post quasi-experimental evaluation with matched comparison sites

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**Abstract**

**Background:** In some health care systems, evidence-based practices (EBPs) may be adopted by providers, prioritized by leadership and supported by health system infrastructure, yet still not reach an adequate proportion of patients. In these systems, local staff expertise and operations data can be synthesized in a participatory system dynamics (PSD) model, developed for selecting strategies to improve EBP reach. PSD modeling simulation empowers stakeholders by enabling them see the potential yield of implementation plans prior to implementation.

**Methods:** This pre/post quasi-experimental evaluation will examine the effectiveness of PSD to improve implementation of evidence-based psychotherapies (and pharmacotherapies for depression, PTSD, alcohol use disorders, and opiate use disorders in VA outpatient mental health clinics. Retrospective 12-months pre-PSD vs. prospective 12-months post-PSD implementation measures will be evaluated in two low performing sites with two matched comparison sites (4 total sites). Statistical process control and Fischer’s exact test for inequality of proportions will be used to examine reach of EBP initiation, reach of adequate course/dose, and timeliness of EBPs.

**Discussion:** If PSD models that evaluate stakeholders’ theories of clinic operation and test explanatory mechanisms (i.e., local policies and procedures) improve EBP reach, the field will have a new strategy that a) facilitates timely patient access to EBPs even when no new system resources (e.g., new staff, new EBP trainings) are available; and b) increases general staff capacity for quality improvement by identifying implementation strategies tailored to local EBP-specific capacities and constraints.

**Keywords**

Implementation; Evidence-based practices; Mental Health; Psychotherapy; Pharmacotherapy; System Dynamics; Participatory Research; Simulation; Depression; PTSD; Alcohol Use Disorder; Opioid Use Disorder; Facilitation; Group Model Building

**Participatory system dynamics modeling for expanding the timely reach of evidence-based practices in VA outpatient mental health: A 24-month pre/post quasi-experimental evaluation with matched comparison sites**

**BACKGROUND**

VA is the largest provider of addiction and mental health services in the U.S. and demand for these services is increasing (by 70% from 2005-2014).Two-thirds of addiction and mental health patients in the VA outpatient system are treated for alcohol use disorder (AUD), opiate use disorder (OUD), PTSD, and/or depression.[1–4] VA must meet this demand with effective, evidence-based treatments. In 2008, VA implemented national dissemination activities to promote adoption ofevidence-based psychotherapy and pharmacotherapy (EBPs),[5–9] and developed corresponding performance measures and mandates. [10–14] Despite substantial investments, there is wide variability in patients *initiating* EBPs (ranging from 4-66%).[15,16] In addition, care is not timely and only 6-28% of patients complete the therapeutic *dose* recommended by providers and guidelines,[15,17,18] resulting in limited EBP reach.[19–21] Improving EBP timeliness and reach will reduce unmet patient needs and attendant risks for chronic impairment, relapse, overdose and suicide.[22–25]

The VA aims for system-wide reach of evidence-based psychotherapy (EBPsy) among patients diagnosed with PTSD, depression and substance use disorders (SUDs), and evidence-based pharmacology (EBPharm) for depression, alcohol use disorders (AUD) and opioid use disorders (OUD).[5–14]Meta-analyses of randomized controlled trials among thousands of patients indicate that the EBPsy and EBPharm selected for national implementation in VA (detail in *Methods*), have positive effect sizes as compared to alternative treatments, usual care or waitlist-control, and lead to positive outcomes for patients, including reduced PTSD [26–34]and depression symptoms, [35–52] reduced alcohol or opiate use [43,53–76]and thereby, reduced risk of death.[22–25]

Based on the weight of evidence in support of EBPs, EBPs are recommended in VA/DOD clinical practice guidelines, mandated in the VA Uniform Mental Health Services Handbook,and assessed with VA quality measures.[10–14]Resources dedicated to increasing EBP adoption among VA providersinclude national EBP trainings and EBP note templates in electronic record systems. [5–9] Use of EBPs led to significant improvements in the health and well-being of Veterans involved in national rollouts. Patients who received cognitive behavioral therapy (CPT) for depression experienced a 40% reduction in depression symptoms,[6] and over 60% of Veterans who received prolonged exposure (PE) experienced a clinically-significant improvement in PTSD. [8] However, more work is needed to increase EBP reach. [44] We define reach as the proportion of the outpatient population who *initiate* an EBP and complete a therapeutic *dose*. Too few VA patients receive EBPsy, even in specialty programs.[5] Nationally, less than half of patients diagnosed with depression or SUD initiate psychotherapy of *any kind* and 96% of AUD patients and 71% of OUD patients do not initiate EBPharm (). For these disorders, the proportion of patients who complete a therapeutic dose of EBPsy ranges from a mere 6% to 22% and only 28% of patients starting antidepressants receive an adequate dose (*CITE*).

**Deficits in reach and timeliness can be conceptualized as misalignedsystem capacity to supply EBPs.** [77] National dissemination programs and performance metrics are not effectively integrated into local management decision processes that coordinate local access to EBPs. [78] Almost all implementation science frameworks describe a setting’s capacity, structure, and local context as factors that impact implementation outcomes, but few implementation strategies quantify mobilization of these factors.[79–86]We propose a systems-based implementation strategy that will optimize capacity by *restructuring*[82] local procedures that govern the “supply” of EBPs to meet patient demand. This innovative process, participatory system dynamics modeling (PSD),identifies mechanisms to improve EBP implementation, even when no new resources are available.

**PSD blends quantitative, dynamic modeling techniques of systems engineering with participatory, stakeholder engagement, to facilitate local staff in optimizing processes that improve EBP implementation, while accounting for local system constraints.** Successful implementation must address *systemic* *complexity*, such as coordinating EBP referrals among outpatient providers and settings, and *dynamic complexity,* such as implementing timely, multi-session and continuous care. A major strength of PSD is the ability to mathematically model these factors with high precision, using electronic health records data available in any integrated healthcare system. [87–89]A high level of staff stakeholder engagement occurs throughout model building and testing, which serves to increase buy-in for changes and capacity for sustaining ongoing implementation. [84,90] Our use of highly-innovative PSD addresses national priorities to identify strategies that improve the timeliness and quality of health care, and at the same time, overcomes a critical barrier in the field of implementation science, which is the need to identify effective system-level implementation strategies.[79,84]

**Preliminary Studies**

The principal investigator (PI) and co-Investigator (co-I), Dr. Lounsbury, were invited by VA Palo Alto Healthcare System (VAPAHCS) Director of Outpatient Mental Health, Dr. Lindley (co-I), to help the outpatient system increase the number of patients who attend EBPs. In January 2015, staff began by agreeing to a goal that all new depression and PTSD patients would be scheduled for EBPsy, and set a goal for new patients to complete two EBPsy sessions within 30 days. This led to an increase in EBPsy scheduling, but time from intake to first EBPsy session still ranged from 7 to 73 days, with delays associated with significantly lower probability that the patient completed eight sessions *X2*(2, *N* = 375) = 14.82, *p* < .001. This highlighted how a service delivery problem (timing) was interacting with an implementation outcome (reach). [79] Although some progress was made, it was unclear *how* gains were achieved or would be sustained. Staff lacked explanations for ongoing variability and did not know what caused the discrepancy between scheduling and completing an EBPsy visit, which remained stubbornly at *8-10%, below the national average*. Performance measures highlighted the implementation problem, but not what stakeholders could do about it.

**Participatory System Dynamics Modeling (PSD) Implementation Strategy.** We were invited in by a large, complex outpatient system to enlist a multi-dimensional EBP implementation strategy that could improve dynamic workflows and deliver *multiple* EBPs despite constant changes in staff. [84] We selected PSD as our implementation strategy and our approach. PSD has been used in government, industry and communities to optimize systems by uncovering how system structures that create delays (e.g., wait-times) and accumulations (e.g., patients in the system) “feedback” on one another. [91–94] System dynamics (SD) modeling was used to expand the reach of EBPs that reduced Veteran homelessness by 33% over four years, [95–97]and identify dynamics maintaining the backlog of Veteran benefits claims.[98,99] SD simulations also evaluated the population impacts of alternative system-wide EBP implementations. [100,101] A recent Institute of Medicine and Centers for Medicare and Medicaid Services report identified 1) misaligned demand and resources, 2) uneven processes, 3) non-integrated data tools and 4) lack of leader empowerment in VA, and recommended use of SD simulation modeling to improve patient access. [77] This is consistent with local staff views that system processes exert interdependent influence on EBP timing and reach *CITE*. These effective prior uses of SD modeling to a) reduce system delays, b) expand EBP reach, and c) evaluate alternative EBP implementations, highlights the promise of PSD for meeting the increasing patient demand for outpatient services with improved EBP implementation, as well as strengths for advancing implementation science with dynamic systems strategies. [84]

**PSD has unique utility for examining EBP reach as a function of system *capacity*.** Capacity is conceptualized as a key driver of implementation outcomes. [81,85]We propose that the PSD *process* (planning, engaging, executing, evaluating) can locally optimize the fit of EBP implementation via restructuring [82] – re-aligning roles, teams, procedures and data systems in the inner setting – to improve EBP delivery capacity consistent with the consolidated framework for implementation research (CFIR) [83]and dynamic sustainability framework. [84] To our knowledge, no other exemplars exist for empowering frontline healthcare providers to use data to make *forecasts* that better align existing resources with core EBP implementation processes. Other participatory strategies (e.g., external facilitation) [102–104] or systems strategies (e.g., lean)[105–107] involve more trial and error. PSD helps frontline staff evaluate competing implementation plans via simulation and assess likely impacts on multiple outcomes (CITE). Best practices in PSD call for an iterative process involving problem identification, system conceptualization, model formulation, model simulation, and model evaluation.[91–94,108] PSD comprises the theoretical framework and methodological basis for a “learning organization,” [109,110] and a central value is a participatory process for learning from model building. Despite 50 years of scholarship and application,[111] PSD is underutilized by implementation scientists. We aim to contribute a significant innovation to advance the field of implementation science by evaluating the effectiveness of PSD for improving EBP timing and reach.

**PSD Acceptability: Formative Evaluation (Step 1).** System dynamics model development and validation requires implementation of a multi-stepped, iterative procedure. Weinvoked *Steps 1-3* of the PSD procedure during our feasibility period. Staff formalized the outpatient system in a model and tested potential EBP restructuring plans via simulation. Staff feedback on the perceived utility of PSD indicated good acceptability and described many relative advantages of PSD (*CITE*).

**STUDY FOCUS AND AIMS**

**Using participatory system dynamics modeling we will achieve the following** **specific aims**:

We propose to use PSD to improve implementation of seven evidence-based psychotherapies (EBPsy) for depression, PTSD and alcohol use disorders (AUD) and seven evidence-based pharmacotherapies (EBPharm) for depression, AUD and OUD. EBPs have established efficacy and are part of VA dissemination programs.[26–76] We propose a quasi-experimental, pre/post evaluation of PSD (retrospective 12-months pre-PSD vs. prospective 12-months post-PSD) in two low performing sites with two matched comparison sites.

***1a. Increase the reach of EBP initiation***. In the PSD sites, the proportion of patients initiating EBPsy or EBPharm (an omnibus test averaging across all EBPs) will exhibit a statistically significant increase relative to the year prior to PSD. We aim to increase EBP reach measures to match or exceed national averages. The increase in EBP reach will be greater in PSD sites than in matched comparison sites over this period.

***1b. Increase the reach of an adequate course/dose of EBPs.*** In PSD sites, the proportion of patients receiving an adequate number of sessions of EBPsy or adequate dosage of EBPharm (averaging across all EBPs) will be significantly higher post-PSD than in the year prior to PSD restructuring, and the increase over time will be greater in intervention sites than in matched comparison sites over this period.

***2. Increase timeliness of EBPs.*** In PSD sites, the number of days from intake (first clinic contact) to initiation of EBPsy or EBPharm in the 12-months post-restructuring period will be significantly lower than in the prior year, and the decrease over time will be greater than in matched comparison sites over this period.

**METHODS**

**Study Design**

We propose a quasi-experimental, pre/post evaluation of PSD with matched comparison sites (4 total sites) for a 24-month evaluation of PSD.

**Pre/Post Operationalization.** Our “pre-” condition will be 12 months of EBP timing and reach before our PSD feasibility pilot, to avoid contamination effects. Our “post-test” condition is operationalized as 12 months of EBP timing and reach after outpatient system restructuring plans are implemented. We will compare against the same 12-month period (e.g., Jan-Dec) for our pre- and post-observations to reduce bias from seasonal effects.

**Study Sites.** We will complete the PSD process at the Menlo Park/Palo Alto outpatient system and spread to the Stockton community-based outpatient clinic (CBOC), implementing PSD in two settings that differ in complexity and resources (Menlo Park = high; Stockton = low). Some of the scheduling and staffing differences between these settings include: 1) the typical caseload per provider, 2) the number of days until new patients see a provider, 3) the ratio of EBPsy and EBPharm providers,4) onsite training programs (Menlo Park = yes; Stockton = no), 5) onsite specialty programs (Menlo Park = yes; Stockton = no), and 6) reliance on telehealth for EBP access (Menlo Park = yes; Stockton = no) (CITE). We will spend the first six months facilitating the participatory model building, data calibration and simulation tests (PSD steps 1-3) in the new site, and will implement PSD steps 4-6 to evaluate effectiveness in both sites.

**Matched Comparison.** In addition to within-setting pre/post tests, we will compare changes in EBP timing and reach in our two study sites against two matched comparison sites with concurrent observation. Comparison sites will match PSD pilot sites on key variables likely to influence EBP timing and reach: patient panel size, staffing configuration, complexity of programs, urban/rural location,[112] and past-year performance on VA measures of EBP timing and reach. We will stagger start dates across pilot sites (tethered to matched sites) to help mitigate cohort effects. To guard against threats from secular trends [8,20,113] (overall patient demand or VA EBP adoption may be increasing), and regression to the mean (given these are lower performing sites), we will also track national trends in EBP reach and estimate the percentage of regression towards the mean.

**Stakeholders** include leadership, a core modeling group comprised of one “champion” from each service delivery team, Veteran patients and VA national program offices. Feasibility is enhanced by our established partnerships with outpatient stakeholders, such as Dr. Lindley (co-I), Veterans in the Veteran Advisory Partnership for Operations and Research (see *letter of support*) and partnership with the VA Program Evaluation Resource Center (PERC), directed by Dr. Trafton (co-I). We will build our data algorithms on to existing daily PERC data pulls, re-purposing existing data infrastructure (servers and code), which is efficient and cost-effective.

**Steps of PSD**: PSD is inherently ‘mixed methods,’ proceeding from developing a qualitative understanding of the system, to use of rigorous mathematical modeling to evaluate the system. The six iterative steps are:

1. **Participate**: PSD is highly participatory valuing stakeholder expertise and building consensus. Modeling begins by eliciting stakeholders’ experiential knowledge to generate a set of elements (i.e., constructs, variables) that are considered to be related to the topic of interest. Participating stakeholders are asked to describe behavior patterns can often be plotted over time, to show trends in key elements of the system (i.e., ‘reference modes’ shown as simple ‘behavior-over-time’ graphs).

2. **Calibrate**: Through synthesis of administrative data and stakeholder estimates, a model of system behavior is developed. Simulations of system behavior are calibrated against historical data and other sources of evidence.

3. **Simulate**: Stakeholders test system impacts of potential changes (e.g., restructuring staffing, procedures, etc.) in the “virtual world” of the model prior to implementation, saving time and effort. Simulation is generated per a set of algebraic and differential equations, each verified to be dimensionally correct and conceptually meaningful (i.e., consistent with available evidence), assessed over a given period, or time horizon.

4. **Translate**: Various scenarios are run to test the utility of particular policies, or interventions of interest, hypothetically implemented over a given time horizon. The change strategy most likely to reduce delays and increase EBP reach is agreed upon and subsequently implemented by designated stakeholders.

5. **Evaluate**: The model is updated with data regarding the impact of system restructuring providing detailed *where* and *why* feedback that describe how the restructured clinic processes are influencing EBP delivery.

6. **Iterate**: Based upon implementation outcomes, the model’s design and behavior is assessed and re-assessed to accommodate new insights or to correct key assumptions guiding the project. The system dynamics model and growing system thinking/modeling skills among participating staff serve to sustain ongoing implementation.[84,90]

**PSD Feasibility: Validation and Calibration of our Preliminary Model (Step 2).** Model building and simulation tests are performed with the aid of computer simulation software [114] with a graphical user interface that enables representation of variable relationships that are difficult to visualize or impossible to model easily with other approaches, such as 1) stochastic or deterministic, 2) continuous or discrete, 3) linear or non-linear, and 4) simultaneous or lagged.[115,116]We constructed a preliminary model with provider (and patient?) stakeholders and calibrated the model with parameter values obtained from administrative data sets documenting patient (diagnostic codes) and appointment information (common procedural terminology codes) and the EBP ‘supply’ available in each team (by number of staff, discipline/license and hours). Model equations were formulated in collaboration with provider stakeholders, and the mathematical model is expressed as a stock-and-flow diagram. The model excerpt in *Figure 1* represents the patient panel structure for illustration, which shows how new patients referred to a given ‘clinic’ must first complete an intake evaluation appointment before officially joining the clinic’s patient panel. Other structures included in the full model represent how patients start and complete a mix of services (per their diagnostic profile and approved treatment plan).

Once a member of a clinic’s patient panel, other model structures capture the dynamics of service delivery. The goal is that most or all patients referred to a given service receive the ‘adequate’ dosage or exposure. For example, *Figure 2* represents the delivery of 60 minute psychotherapy, which captures the dynamics of three levels of service delivery: Initial, adequate, and extended. For 60 minute psychotherapy, an ‘adequate’ dosage is operationalized as 6 to 8 sessions delivered within 6 to 10 weeks. We developed structures to conceptualize service delivery dynamics at the level of a given ‘clinic,’ which is comprised of ‘teams of providers,’ who deliver EBP mental health services to ‘panels of patients.’ Six clinics and offering a mix of seven different mental health services were represented initially.

Data inputs, such as “*% missed intake*,” are in italics. Stakeholders generated new insights during step 2, *before* simulation, which is common in PSD.[117] For example, despite concerns about attrition from trauma-focused therapy, [118,119] staff were surprised that outpatient EBPsy and EBPharm sessions for all disorders had consistently lower ‘no-show’ rates than case management. Note that these model parameters are generic inputs available in any health system. No new data collection was required. PSD gives stakeholders new integrated data views they can direct toward *locally* identified problems. The uniqueness in PSD is triangulation of local data, local expertise in defining flows (e.g., policies/procedures) and allocations (e.g., staffing), and evaluation of restructuring alternatives via simulation.

**PSD Feasibility: Simulation of Alternative EBP Implementations via Restructuring (Step 3).**

The model can be understood as a ‘dynamic hypothesis’ of system capacity to provide EBPs as a function of patient demand and initial system conditions. Stocks (depicted by a rectangle) represent the level (prevalence) of a variable at any given time, such as the number of patients on any given day pending any service. Flows (double-lined arrow with ‘faucet’ icon) increase or decrease a stock over time (incidence). On their own, stocks provide a snapshot of the clinic; many clinic managers have data snapshots like these. By specifying rates or flows, PSD also estimates whether levels are increasing/decreasing and what system factors are driving specific increases or decreases. Managers can ‘zoom in’ on any part of the process, up or downstream, such as to differentiate referrals from scheduling. The direction of patient flow is determined by local programs, procedures and policies and *can be redesigned* to explore a wide variety of scenarios.

In *Figure 1*, the desired patient ‘flow’ is through the stocks in the center. The rate at which patients move through this sub-system is a function of the available service supply at the bottom and the percent of patients who ‘no show’ out of flows at the top. By formulating these health system characteristics, the model displays and compares simulated trends for every variable, showing changes in service dynamics per day, within any section of the clinic system, over any time horizon, making data systems newly actionable for EBP implementation planning.

For example, within the Medication Management (MM) Model, one important loop is the *return visit interval (RVI),* which refers to the time interval between patients’ consecutive appointments. Providers have the capacity to adjust the RVI for each patient independently and observe the effects on the system. The RVI is a critical lever for change available to providers as they seek to balance meeting the needs of existing patients while also doing their best to get new patients scheduled into the clinic. The MM appointment booking rate contributes to MM appointments and finally to the completed MM appointments rate, and is influenced by factors including the RVI, desired appointment completion rate, appointments used for existing patients, appointments available for new patients, and stock of patients in MM, as well as the MM starting rate. Within this complex balancing loop, providers may choose to adjust the RVI based on model simulations using their clinic’s data.

We formally defined system EBP capacity with a set of differential and algebraic equations of hypothesized system structures, or *mechanisms*, driving EBP implementation. We calibrated the model to ensure that it replicated historical system behaviors in retrospective data. Staff provided *thirty* hypotheses for testing, ranked by priority. The large number of hypotheses highlights the importance of modeling. Stakeholders needed an empirical means for resolving their lack of consensus about proposed plans. For example, we evaluated three strategies of interest to stakeholders regarding the proportion of time allocated to delivery of two high demand services: 60 minute psychotherapy and case management. Staff found that splitting providers allocated time 50% psychotherapy/50% case management was essentially equivalent to 75% psychotherapy/25% case management, simulated over a 20 quarter (5 year) time horizon (see *Figure 3*). Knowing how this allocation of time played out helps stakeholders explore the possibility of someone counterintuitive notions about how to achieve and sustain desired service performance goals.

**Key Implementation Outcomes and Analysis**

**EBP definitions.** We propose to use PSD to improve implementation of 14 EBPs in the outpatient system. We selected EBPs for highly prevalent AUD, OUD, PTSD and depression [1–4]based on demonstrated clinical efficacy[26–76]and local difficulty with implementation (). We will study *seven* **EBPsy** for *depression* (Cognitive Behavior Therapy [CBT-D], Acceptance and Commitment Therapy [ACT], Interpersonal Psychotherapy [IPT]), *PTSD* (Prolonged Exposure [PE], Cognitive Processing Therapy [CPT]), and *AUD* (Cognitive Behavior Therapy-Relapse Prevention [CBT-RP], Motivational Enhancement Therapy [MET]). We will also study *seven* **EBPharm** for *depression* (therapeutic continuity at new antidepressant start), *AUD* (naltrexone, vivitrol, acamprosate, disulfiram) and *OUD* (methadone and buprenorphine).

**EBP Measurement.** Our **EBPsy** measure is completion of EBP templates during sessions with a relevant CPT code delivered by an EBP trained provider.[120,121]Data review indicated that EBP templates were present for >80% of 60 or 90 minute psychotherapy sessions in our two sites. For **EBPharm** will use a combination of prescriptions placed with the VA pharmacy and sessions with a relevant CPT code delivered by a prescriber. *Initiation* of an EBP is indicated by EBPsy template or EBPharm prescription after intake. Adequate *dose* is based on receiving an adequate number of EBPsy sessions to be a “completer” (typically 8 sessions; fewer for MET) or enough refills for a guideline-recommend adequate trial of each medication (varies by medication).

**Analysis plan.** We will determine whether Aim 1 and Aim 2 are achieved using **statistical process control** (SPC) and **Fisher’s exact test** for inequality of proportions (aim 1a and 1b – reach only). We describe steps to balance type 1 error (alpha), type 2 error (beta) and power below. **SPC** is a standard, healthcare quality tool [122–124] robust for non-normal data and small, unbalanced samples. Aims 1 and 2 will be successful if serial observation (average run line = 8 data points) of a new mean after restructuring is outside initial control limits indicating improvement beyond 3 SD ( = .0027). [124] When 80% of data points fall within 1 SD of this new mean, improvement is stable.[125] We will follow SQUIRE reporting standards for SPC.[126]

***Aim 1*.** **Increase reach of EBPs in the outpatient population.** We define reach as the proportion of patients diagnosed with AUD, OUD, PTSD, or depression (ICD-9 codes) who meet EBPsy and EBPharm *1a) initiation* and *1b) dose* measures (numerator) divided by the total number of patients with these diagnoses (denominator) at that location. **SPC p-charts** will display the pre/post proportions of patients who receive each EBP. The p-chart centerline corresponds to the mean proportion of patients who meet EBP criteria, controlling for the number of patients in each observation. [127] To avoid inflating type I error rates, we will conduct an omnibus test for improved reach using **Fisher’s exact test**. But, we will also check for heterogeneity of impact across diagnoses and EBPs. We seek to improve EBP reach for each diagnostic cohort (PTSD, depression, AUD and OUD) *to meet or exceed the national average* and we will be powered to assess for this. Opiate agonist therapy (OAT) for OUD is the limiting analysis for power calculations to test aim 1 (current reach 15.7%; *N* = 213). In *Figure 2*, power is on the y-axis, sample size on the x-axis. The four simulation curves labeled “p2” indicate that we will have 80% likelihood of detecting an 10% pre/post increase in reach (p2 = .25) and adequate power to detect improving OAT reach to the national average (29%).[128]

***Aim 2*. Reduce time from intake to EBP.** Xbar r-charts will display calculations of moving average and operational range of EBP appointment timing across our two 12-month cohorts (prior year and post-restructuring). The centerline in the xbar r-chart corresponds to the mean intake-to-EBP timing.[124,125]

**DISCUSSION**

**We propose to move through the full PSD model building procedures to evaluate the effectiveness of PSD as an implementation strategy**. Study sites are below VA national averages on five reach measures, with the greatest discrepancy for OUD (13% below national average). To move from *provider adoption* to *system-wide reach*, EBP implementation plans must address *systemic* *complexity*, such as coordinating staffing and EBP referrals among outpatient providers and settings, and *dynamic complexity,* such as scheduling to insure timely, continuous care. This is critical to prevent chronic symptomology, substance misuse and deaths. [22–25] [26–76]

**Our overarching, long-range goal is to develop rigorous, scalable, “user-friendly” and effective tools that empower front-line staff to improve EBP implementation in healthcare.** Our short-term objective is to evaluate the effectiveness of PSD as a strategy to improve EBP reach and timing in outpatient mental health and addiction services. This pilot will test PSD in two outpatient facilities, one high in complexity and resources, and the other low. Both facilities exhibit poor EBP reach, with *local reach ranging from 4 to 13% below* the already low national VA averages. VA is ideal for innovating with PSD modeling, allowing leveraging of partnerships with the national VA quality assurance office, patients, and frontline staff. At the same time, the PSD approach can be translated to data systems and stakeholders in any integrated health network.

**PSD is novel for meeting critical national priorities for improving timely access to high-quality health care**. This study is innovative in identifying new uses for existing data that empower frontline staff to reach greater consensus and specificity regarding system organization to implement EBPs. Without methods to improve system procedures, health systems will make ineffective use of their resources to provide evidence-based addiction and mental health care, and fall short of national goals to provide timely, patient-centered care [77]; [129,130] that reduces health risks and death, andincreases patient well-being and quality of life. [26–76]

**PSD is innovative in meeting several needs for advancing the field of implementation science**.

1. **Generalizability**.A primary innovation of the SD modeling methodology is the generalizability of one systems approach to tailor EBP implementation to any local healthcare setting. PSD can be applied to any EBP that requires coordination among multidisciplinary providers and multiple appointments. It is also responsive to the need to improve implementation of *multiple* evidence-based practices in one system.
2. **Stakeholder Engaged**.Participatory by-design, PSD responds to calls for practice-based research and pragmatic implementation knowledge.[131] Embedding high levels of stakeholder engagement in developing implementation strategies also improves buy-in among staff. PSD is consistent with a learning health care organization, promoting leadership and systems thinking among staff.[110–112,114–130,132–139]Modeling to adapt or make ongoing improvements increases sustainability of EBP implementation efforts amid ongoing change.[84]
3. ‘**Fit’ and system ‘capacity’ formally specified.** Eliciting stakeholders’ ‘mental models’ is necessary, but not sufficiently precise for improved alignment of EBP implementation to meet patients’ needs.[85,20,140]
4. **Empirically quantified mechanisms or implementation ‘barriers and facilitators.**’ Stakeholders make causal attributions about the system that are structured in the model, but validated with calibrated parameters from health system data.[108,109] This is a significant advance beyond self-report measures alone.
5. **Simulation versus trial-and-error.** Rather than guesswork, wasted resources or unintended consequences, stakeholders’ ‘dynamic hypotheses’ about system impacts are tested before changes. Without simulation, implementation strategies can only be improved via trial-and-error in the real world.
6. **Dynamic (time) and missing data.** Traditional statistical evaluations omit important variables when data are unavailable. PSD models estimate these ‘missing parameters’ formally in real-time from other data. Unlike linear statistics, PSD addresses non-linearities, such patient accumulations and service delays.

**LIMITATIONS**

Our pilot procedures are limited to existing data and formative evaluation. Other patient or provider measures will be outside of our scope. *Formative evaluation.* Our mixed methods approach elicits information to inform/improve the PSD process (see 15-item pre-, mid-, and post-evaluation in *supplementary materials*). We are documenting CFIR implementation constructs discussed in modeling group and staff meetings to inform measure selection in a future R01.[134,135] We are also tracking staff participationas an initial estimate of cost (defined by number of hours and provider discipline/ role). We will complement primary tests of aims 1 and 2 using exploratory alternatives that mitigate potential limitations of the other strategies**.** *Bayesian Growth Curve Modeling (BCGM)*.[136,137] We will quantify the degree of uncertainty in key parameter estimates, obtaining probabilities for parameters that would benefit from additional exploration as we seek to scale PSD to other settings. *Autoregressive integrated moving average (ARIMA).*[138]We will evaluate ARIMA models to detect and correct for autocorrelation-biased residuals in time-series observations. *Models of the dynamics of EBP delivery*. We will evaluate the interdependent causal processes that drive EBP timeliness and reach using our PSD model and report findings using SIMULATE.[139]

**CONCLUSION**

**The VA is the ideal system to innovate with PSD modeling**. Identifying the best ways to allocate limited resources is critical in VA and all healthcare systems. Learning from investments to promote EBP adoption and infrastructure, VA is at the vanguard of implementation science, recognizing the need for generalizable implementation strategies, applied at the local, setting-level. If PSD is effective, our partnership with national offices can facilitate multi-site evaluation and system-wide scaling. Health care data systems are ubiquitous,[87–89] and lessons learned in VA can be translated to many other integrated health networks.

**List of abbreviations**

If abbreviations are used in the text they should be defined in the text at first use, and a list of abbreviations should be provided.

**Declarations**

This study protocol was approved by the Stanford University Institutional Review Board panel on medical human subjects (IRB #6208, Panel 8).

**Consent for publication**

Not applicable.

**Availability of data and materials**

Raw operations data synthesized in system dynamics models were generated during routine clinical care at the Veterans Health Administration, and restrictions apply to this protected health information. The de-identified aggregate data, system dynamics model and synthetic data generated via simulation necessary to interpret, replicate and build upon the findings generated by this study will be available from the corresponding author upon request.  
**Competing interests**

The authors declare that they have no competing interests" in this section.

**Funding**

This research protocol was reviewed by the Dissemination and Implementation Research in health study section at the National Institutes of health and funded by the National Institute of Drug Abuse (R21DA04219801). The National Institute of Drug Abuse had no role in the design of the study and collection, analysis, and interpretation of data and in writing the manuscript.

**Authors' contributions**

LZ, DL and SL collected and synthesized patient data in the system dynamics model. LZ, DL, and SL developed the system dynamics model with input from VA mental health stakeholders. LZ, CR, RK and JT developed the data-based definitions and measures of the evidence-based practices consistent with VA national guidelines. LZ was a major contributor in writing the manuscript. All authors contributed to the protocol design and specific aims. All authors read and approved the final manuscript.

**Acknowledgements**

We acknowledge project support contributions from McKenzie Javorka, B.A., Alexandra Ballinger, B.A., Swapandeep Mushiana, M.A., Cora Bernard, M.S., Tom Rust, Ph.D. and Dan Wang, Ph.D. This project is a collaboration among local and national mental health stakeholders in the Veterans Health Administration (VA). We would also like to acknowledge the contributions of the Veterans Advisory Partnership for Operations and Research (VAPOR), an advisory council of Veterans with lived experience in recovery as VA mental health patients who now work as patient advocates and health care navigators. We would like to acknowledge the hard work and dedication of the mental health staff in outpatient services who are working to provide Veterans high-quality care. We also acknowledge the expertise of two national program offices, the Office of Mental Health Operations, Program Evaluation Resource Center (PERC) and the National Center for PTSD, Dissemination and Training Division. The views and opinions of authors expressed in this manuscript do not necessarily state or reflect those of the United States Government or the Department of Veterans Affairs.

1. Williams EC, Rubinsky AD, Lapham GT, Chavez LJ, Rittmueller SE, Hawkins EJ, et al. Prevalence of clinically recognized alcohol and other substance use disorders among VA outpatients with unhealthy alcohol use identified by routine alcohol screening. Drug Alcohol Depend. 2014;135:95–103.

2. Hankin CS, Spiro III A, Miller DR, Kazis L. Mental disorders and mental health treatment among US Department of Veterans Affairs outpatients: The Veterans Health Study. Am. J. Psychiatry [Internet]. 2014 [cited 2016 Jan 7]; Available from: http://ajp.psychiatryonline.org/doi/10.1176/ajp.156.12.1924

3. Hoggatt KJ, Williams EC, Der-Martirosian C, Yano EM, Washington DL. National prevalence and correlates of alcohol misuse in women Veterans. J. Subst. Abuse Treat. 2015;52:10–6.

4. Fulton JJ, Calhoun PS, Wagner HR, Schry AR, Hair LP, Feeling N, et al. The prevalence of posttraumatic stress disorder in Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) Veterans: A meta-analysis. J. Anxiety Disord. 2015;31:98–107.

5. Watts BV, Shiner B, Zubkoff L, Carpenter-Song E, Ronconi JM, Coldwell CM. Implementation of evidence-based psychotherapies for posttraumatic stress disorder in VA specialty clinics. Psychiatr. Serv. 2014;65:648–653.

6. Karlin BE, Cross G. From the laboratory to the therapy room: National dissemination and implementation of evidence-based psychotherapies in the U.S. Department of Veterans Affairs Health Care System. Am. Psychol. 2014;69:19–33.

7. Karlin BE, Brown GK, Trockel M, Cunning D, Zeiss AM, Taylor CB. National dissemination of cognitive behavioral therapy for depression in the department of veterans affairs health care system: Therapist and patient-level outcomes. J. Consult. Clin. Psychol. 2012;80:707–18.

8. Ruzek JI, Karlin BE, Zeiss AM. Implementation of Evidence-Based Psychological Treatments in the Veterans Health Administration. In: McHugh RK, Barlow DH, editors. Dissem. Evid.-Based Psychol. Treat. N. Y. NY Oxf. Univ. Press. 2012.

9. Eftekhari A, Ruzek JI, Crowley JJ, Rosen CS, Greenbaum MA, Karlin BE. Effectiveness of National Implementation of Prolonged Exposure Therapy in Veterans Affairs Care. JAMA Psychiatry. 2013;70:949.

10. Department of Defense, Department of Veterans Affairs. The management of MDD Working Group. VA/DOD clinical practice guideline for management of major depressive disorder (MDD) [Internet]. 2009. Available from: http://www.healthquality.va.gov/guidelines/MH/mdd/MDDFULL053013.pdf

11. Department of Veterans Affairs, Department of Defense. VA/DoD Clinical practice guideline for the management of post-traumatic stress. [Internet]. 2010. Available from: http://www.healthquality.va.gov/guidelines/MH/ptsd/cpgPTSDFULL201011612c.pdf

12. Department of Veterans Affairs, Department of Defense. VA/DoD Clinical practice guideline for the management of substance use disorders. [Internet]. 2009. Available from: http://www.healthquality.va.gov/guidelines/MH/sud/sud\_full\_601f.pdf

13. Department of Veterans Affairs. Uniform mental health services in VA medical centers and clinics. Washington DC: Veterans Health Administration; 2008. Report No.: VHA Handbook 260.1.

14. Harris AHS, Humphreys K, Bowe T, Kivlahan DR, Finney JW. Measuring the quality of substance use disorder treatment: Evaluating the validity of the Department of Veterans Affairs continuity of care performance measure. J. Subst. Abuse Treat. 2009;36:294–305.

15. Department of Veterans Affairs, Veterans Health Administration, Office of Mental Health Operations. Mental Health Evaluation Center Information System [Internet]. 2014. Available from: https://spsites.dev.cdw.va.gov/sites/OMHO\_PEC/Pages/MHIS.aspx

16. Seal KH, Maguen S, Cohen B, Gima KS, Metzler TJ, Ren L, et al. VA mental health services utilization in Iraq and Afghanistan Veterans in the first year of receiving new mental health diagnoses. J. Trauma. Stress. 2010;n/a-n/a.

17. Mott JM, Mondragon S, Hundt NE, Beason-Smith M, Grady RH, Teng EJ. Characteristics of U.S. Veterans Who Begin and Complete Prolonged Exposure and Cognitive Processing Therapy for PTSD: Veterans in Evidence-Based Therapy for PTSD. J. Trauma. Stress. 2014;27:265–73.

18. Harpaz-Rotem I, Rosenheck RA. Serving those who served: Retention of newly returning Veterans from Iraq and Afghanistan in mental health treatment. Psychiatr. Serv. [Internet]. 2014 [cited 2016 Jan 7]; Available from: http://ps.psychiatryonline.org/doi/10.1176/ps.62.1.pss6201\_0022

19. Rubinsky AD, Chen C, Batki SL, Williams EC, Harris AHS. Comparative utilization of pharmacotherapy for alcohol use disorder and other psychiatric disorders among U.S. Veterans Health Administration patients with dual diagnoses. J. Psychiatr. Res. 2015;69:150–7.

20. Oliva EM, Trafton JA, Harris AHS, Gordon AJ. Trends in Opioid Agonist Therapy in the Veterans Health Administration: Is Supply Keeping up with Demand? Am. J. Drug Alcohol Abuse. 2013;39:103–7.

21. Shiner B, D’Avolio LW, Nguyen TM, Zayed MH, Young-Xu Y, Desai RA, et al. Measuring Use of Evidence Based Psychotherapy for Posttraumatic Stress Disorder. Adm. Policy Ment. Health Ment. Health Serv. Res. 2013;40:311–8.

22. Lin LA, Bohnert AS, Ilgen MA, Pfeiffer PN, Ganoczy D, Blow FC. Outpatient provider contact prior to unintentional opioid overdose among VHA service users. Psychiatr. Serv. [Internet]. 2015 [cited 2016 Jan 7]; Available from: http://ps.psychiatryonline.org/doi/abs/10.1176/appi.ps.201400194

23. Harris AHS, Bowe T, Del Re AC, Finlay AK, Oliva E, Myrick HL, et al. Extended Release Naltrexone for Alcohol Use Disorders: Quasi-Experimental Effects on Mortality and Subsequent Detoxification Episodes. Alcohol. Clin. Exp. Res. 2015;39:79–83.

24. Kaplan MS, Huguet N, McFarland BH, Newsom JT. Suicide among male veterans: a prospective population-based study. J. Epidemiol. Community Health. 2007;61:619–24.

25. Desai RA, Dausey DJ, Rosenheck RA. Mental health service delivery and suicide risk: The role of individual patient and facility factors. Am. J. Psychiatry [Internet]. 2014 [cited 2016 Jan 7]; Available from: http://ajp.psychiatryonline.org/doi/10.1176/appi.ajp.162.2.311

26. Steenkamp MM, Litz BT. Psychotherapy for military-related posttraumatic stress disorder: Review of the evidence. Clin. Psychol. Rev. 2013;33:45–53.

27. Bradley R, Greene J, Russ E, Dutra L, Westen D. A Multidimensional Meta-Analysis of Psychotherapy for PTSD. Am. J. Psychiatry. 2005;162:214–27.

28. Bisson JI, Roberts NP, Andrew M, Cooper R, Lewis C. Psychological therapies for chronic post-traumatic stress disorder (PTSD) in adults. In: The Cochrane Collaboration, editor. Cochrane Database Syst. Rev. [Internet]. Chichester, UK: John Wiley & Sons, Ltd; 2013 [cited 2016 Oct 3]. Available from: http://doi.wiley.com/10.1002/14651858.CD003388.pub4

29. Barrera TL, Mott JM, Hofstein RF, Teng EJ. A meta-analytic review of exposure in group cognitive behavioral therapy for posttraumatic stress disorder. Clin. Psychol. Rev. 2013;33:24–32.

30. Tuerk PW, Yoder M, Grubaugh A, Myrick H, Hamner M, Acierno R. Prolonged exposure therapy for combat-related posttraumatic stress disorder: An examination of treatment effectiveness for Veterans of the wars in Afghanistan and Iraq. J. Anxiety Disord. 2011;25:397–403.

31. Powers MB, Halpern JM, Ferenschak MP, Gillihan SJ, Foa EB. A meta-analytic review of prolonged exposure for posttraumatic stress disorder. Clin. Psychol. Rev. 2010;30:635–641.

32. Schnurr PP, Friedman MJ, Engel CC, Foa EB. Cognitive behavioral therapy for posttraumatic stress disorder in women: A randomized controlled trial. JAMA [Internet]. 2007; Available from: http://archneur.jamanetwork.com/article.aspx?articleid=205769

33. Forbes D, Lloyd D, Nixon RDV, Elliott P, Varker T, Perry D, et al. A multisite randomized controlled effectiveness trial of cognitive processing therapy for military-related posttraumatic stress disorder. J. Anxiety Disord. 2012;26:442–452.

34. Monson CM, Schnurr PP, Resick PA, Friedman MJ, Young-Xu Y, Stevens SP. Cognitive processing therapy for veterans with military-related posttraumatic stress disorder. J. Consult. Clin. Psychol. 2006;74:898–907.

35. Gloaguen V, Cottraux J, Cucherat M. A meta-analysis of the effects of cognitive therapy in depressed patients. J. Affect. Disord. 1998;49:59–72.

36. Butler A, Chapman J, Forman E, Beck A. The empirical status of cognitive-behavioral therapy: A review of meta-analyses. Clin. Psychol. Rev. 2006;26:17–31.

37. Tolin DF. Is cognitive–behavioral therapy more effective than other therapies? Clin. Psychol. Rev. 2010;30:710–720.

38. Wampold BE, Minami T, Baskin TW. A meta-(re) analysis of the effects of cognitive therapy versus “other therapies” for depression. J. Affect. Disord. 2002;68:159–165.

39. Minami T, Wampold BE, Serlin RC, Hamilton EG, Brown GSJ, Kircher JC. Benchmarking the effectiveness of psychotherapy treatment for adult depression in a managed care environment: A preliminary study. J. Consult. Clin. Psychol. 2008;76:116–124.

40. Merrill KA, Tolbert VE, Wade WA. Effectiveness of cognitive therapy for depression in a community mental health center: A benchmarking study. J. Consult. Clin. Psychol. 2003;71:404–409.

41. Feng C-Y, Chu H, Chen C-H, Chang Y-S, Chen T-H, Chou Y-H, et al. The effect of cognitive behavioral group therapy for depression: A meta-analysis 2000-2010. Worldviews Evid. Based Nurs. 2011;9:2–17.

42. McDermut W, Miller IW, Brown RA. The efficacy of group psychotherapy for depression: A meta-analysis and review of the empirical research. Clin. Psychol. Sci. Pract. 2006;8:98–116.

43. Hofmann SG, Asnaani A, Vonk IJJ, Sawyer AT, Fang A. The efficacy of cognitive behavioral therapy: A review of meta-analyses. Cogn. Ther. Res. 2012;36:427–440.

44. Powers MB, Zum V ouml rde Sive V ouml rding MB, Emmelkamp PMG. Acceptance and Commitment Therapy: A meta-analytic review. Psychother. Psychosom. 2009;78:73–80.

45. Forman EM, Herbert JD, Moitra E, Yeomans PD, Geller PA. A randomized controlled effectiveness trial of Acceptance and Commitment Therapy and cognitive therapy for anxiety and depression. Behav. Modif. 2007;31:772–799.

46. Walser RD, Karlin BE, Trockel M, Mazina B, Taylor CB. Training in and implementation of Acceptance and Commitment Therapy for depression in the Veterans Health Administration: Therapist and patient outcomes. Behav. Res. Ther. 2013;51:555–563.

47. Stewart MO, Raffa SD, Steele JL, Miller SA, Clougherty KF, Hinrichsen GA, et al. National dissemination of interpersonal psychotherapy for depression in veterans: Therapist and patient-level outcomes. J. Consult. Clin. Psychol. 2014;82:1201–1206.

48. Cuijpers P, Geraedts AS, van Oppen P, Andersson G, Markowitz JC, van Straten A. Interpersonal psychotherapy for depression: A meta-analysis. Am. J. Psychiatry. 2011;

49. Cuijpers P, van Straten A, Andersson G, van Oppen P. Psychotherapy for depression in adults: A meta-analysis of comparative outcome studies. J. Consult. Clin. Psychol. 2008;76:909–922.

50. Fournier JC, DeRubeis RJ, Hollon SD. Antidepressant drug effects and depression severity: A patient-level meta-analysis. JAMA [Internet]. 2010; Available from: http://archfaci.jamanetwork.com/article.aspx?articleid=185157

51. Cipriani A, Furukawa TA, Salanti G, Geddes JR, Higgins JP, Churchill R, et al. Comparative efficacy and acceptability of 12 new-generation antidepressants: A multiple-treatments meta-analysis. The Lancet. 2009;373:746–758.

52. Barrett B, Byford S, Knapp M. Evidence of cost-effective treatments for depression: A systematic review. J. Affect. Disord. 2005;84:1–13.

53. Miller WR, Wilbourne PL. Mesa Grande: A methodological analysis of clinical trials of treatments for alcohol use disorders. Addiction. 2002;97:265–277.

54. Morgenstern J, Blanchard KA, Morgan TJ, Labouvie E, Hayaki J. Testing the effectiveness of cognitive-behavioral treatment for substance abuse in a community setting: Within treatment and posttreatment findings. J. Consult. Clin. Psychol. 2001;69:1007–1017.

55. Irvin JE, Bowers CA, Dunn ME, Wang MC. Efficacy of relapse prevention: A meta-analytic review. J. Consult. Clin. Psychol. 1999;67:563–570.

56. Witkiewitz K, Marlatt GA. Relapse prevention for alcohol and drug problems: That was Zen, this is Tao. Am. Psychol. 2004;59:224–235.

57. Magill M, Ray LA. Cognitive-behavioral treatment with adult alcohol and illicit drug users: A meta-analysis of randomized controlled trials. J. Stud. Alcohol Drugs [Internet]. 2009; Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/pmc2696292/

58. Ball SA, Martino S, Nich C, Frankforter TL, Van Horn D, Crits-Christoph P, et al. Site matters: Multisite randomized trial of motivational enhancement therapy in community drug abuse clinics. J. Consult. Clin. Psychol. 2007;75:556–567.

59. Lundahl B, Burke BL. The effectiveness and applicability of motivational interviewing: A practice-friendly review of four meta-analyses. J. Clin. Psychol. 2009;65:1232–1245.

60. Burke BL, Arkowitz H, Menchola M. The efficacy of motivational interviewing: A meta-analysis of controlled clinical trials. J. Consult. Clin. Psychol. 2003;71:843–861.

61. Rubak S, Sandbæk A, Lauritzen T, Christensen B. Motivational interviewing: a systematic review and meta-analysis. Br. J. Gen. Pract. 2005;55:305–12.

62. Nunes EV, Levin FR. Treatment of depression in patients with alcohol or other drug dependence: A meta-analysis. JAMA. 2004;291:1887–1896.

63. Jonas DE, Amick HR, Feltner C, Bobashev G, Thomas K, Wines R, et al. Pharmacotherapy for adults with alcohol use disorders in outpatient settings. JAMA. 2014;311:1889–12.

64. Anton RF, O’Malley SS, Ciraulo DA, Cisler RA. Combined pharmacotherapies and behavioral interventions for alcohol dependence: The COMBINE study: A randomized controlled trial. JAMA [Internet]. 2006; Available from: http://jama.jamanetwork.com/article.aspx?articleid=202789

65. Streeton C, Whelan G. Naltrexone, a relapse prevention maintenance treatment of alcohol dependence: A meta-analysis of randomized controlled trials. Alcohol Alcohol. 2001;36:544–552.

66. Anton RF, Moak DH, Latham P, Waid LR, Myrick H, Voronin K, et al. Naltrexone Combined With Either Cognitive Behavioral or Motivational Enhancement Therapy for Alcohol Dependence: J. Clin. Psychopharmacol. 2005;25:349–57.

67. Pettinati HM, O’Brien CP, Rabinowitz AR, Wortman SP, Oslin DW, Kampman KM, et al. The Status of Naltrexone in the Treatment of Alcohol Dependence: Specific Effects on Heavy Drinking. J. Clin. Psychopharmacol. 2006;26:610–25.

68. Rösner S, Hackl-Herrwerth A, Leucht S, Vecchi S, Srisurapanont M, Soyka M. Opioid antagonists for alcohol dependence. Cochrane Database Syst. Rev. 2010;12.

69. Mason BJ, Lehert P. Acamprosate for alcohol dependence: A sex-specific meta-analysis based on individual patient data. Alcohol. Clin. Exp. Res. 2011;36:497–508.

70. Rosner S, Leucht S, Lehert P, Soyka M. Acamprosate supports abstinence, Naltrexone prevents excessive drinking: Evidence from a meta-analysis with unreported outcomes. J. Psychopharmacol. (Oxf.). 2007;22:11–23.

71. Franck J, Jayaram-Lindström N. Pharmacotherapy for alcohol dependence: status of current treatments. Curr. Opin. Neurobiol. 2013;23:692–699.

72. Hser Y-I, Saxon AJ, Huang D, Hasson A, Thomas C, Hillhouse M, et al. Treatment retention among patients randomized to buprenorphine/naloxone compared to methadone in a multi-site trial: Treatment retention on buprenorphine/methadone. Addiction. 2014;109:79–87.

73. West SL, O’Neal KK, Graham CW. A meta-analysis comparing the effectiveness of buprenorphine and methadone. J. Subst. Abuse. 2001;12:405–414.

74. Barnett PG, Rodgers JH, Bloch DA. A meta-analysis comparing buprenorphine to methadone for treatment of opiate dependence. Addiction [Internet]. 2001; Available from: http://onlinelibrary.wiley.com/doi/10.1046/j.1360-0443.2001.9656834.x/full

75. Marsch LA. The efficacy of methadone maintenance interventions in reducing illicit opiate use, HIV risk behavior and criminality: A meta-analysis. Addiction [Internet]. 1998; Available from: http://onlinelibrary.wiley.com/doi/10.1046/j.1360-0443.1998.9345157.x/full

76. Degenhardt L, Bucello C, Mathers B, Briegleb C, Ali H, Hickman M, et al. Mortality among regular or dependent users of heroin and other opioids: A systematic review and meta-analysis of cohort studies. Addiction. 2010;106:32–51.

77. Centers for Medicare & Medicaid Services Alliance to Modernize Healthcare (CAMH). Independent Assessment of the Health Care Delivery Systems and Management Processes of the Department of Veterans Affairs (Volume 1: Integrated Report) [Internet]. Available from: http://www.va.gov/opa/choiceact/documents/assessments/Integrated\_Report.pdf

78. Rosenheck RA. Organizational process: A missing link between research and practice. Psychiatr. Serv. [Internet]. 2014 [cited 2016 Jan 7]; Available from: http://focus.psychiatryonline.org/doi/10.1176/appi.ps.52.12.1607

79. Proctor E, Silmere H, Raghavan R, Hovmand P, Aarons G, Bunger A, et al. Outcomes for implementation research: Conceptual distinctions, measurement challenges, and research agenda. Adm. Policy Ment. Health Ment. Health Serv. Res. 2011;38:65–76.

80. Proctor EK, Powell BJ, McMillen JC. Implementation strategies: Recommendations for specifying and reporting. Implement. Sci. 2013;8:139.

81. Flaspohler P, Duffy J, Wandersman A, Stillman L, Maras MA. Unpacking prevention capacity: An intersection of research-to-practice models and community-centered models. Am. J. Community Psychol. 2008;41:182–96.

82. Powell BJ, McMillen JC, Proctor EK, Carpenter CR, Griffey RT, Bunger AC, et al. A compilation of strategies for implementing clinical innovations in health and mental health. Med. Care Res. Rev. 2012;69:123–157.

83. Damschroder LJ, Aron DC, Keith RE, Kirsh SR, Alexander JA, Lowery JC, et al. Fostering implementation of health services research findings into practice: A consolidated framework for advancing implementation science. Implement. Sci. 2009;4:50.

84. Chambers D, R Glasgow, K Strange. The dynamic sustainability framework: Addressing the paradox of sustainment amid ongoing change. Implement. Sci. 2013;117.

85. Scaccia JP, Cook BS, Lamont A, Wandersman A, Castellow J, Katz J, et al. A practical implementation science heuristic for organizational readiness: R = MC. J. Community Psychol. 2015;43:484–501.

86. Glasgow RE, Lichtenstein E, Marcus AC. Why don’t we see more translation of health promotion research to practice? Rethinking the efficacy-to-effectiveness transition. Am. J. Public Health. 2003;93:1261–1267.

87. Bates DW, Saria S, Ohno-Machado L, Shah A, Escobar G. Big data in health care: Using analytics to identify and manage high-risk and high-cost patients. Health Aff. (Millwood). 2014;33:1123–31.

88. Buntin MB, Burke MF, Hoaglin MC, Blumenthal D. The benefits of health information technology: A review of the recent literature shows predominantly positive results. Health Aff. (Millwood). 2011;30:464–71.

89. Heitmueller A, Henderson S, Warburton W, Elmagarmid A, Pentland AS, Darzi A. Developing public policy to advance the use of big data in health care. Health Aff. (Millwood). 2014;33:1523–30.

90. Charns M. The sustainability of new programs and innovations: A review of the empirical literature and recommendations for future research. [cited 2016 Sep 30]; Available from: http://www.implementationscience.com/imedia/1135790039679889\_manuscript.pdf

91. Forrester, J.W. The model versus a modeling process. Syst. Dyn. Rev. 1985;133–4.

92. Morecroft J, Sherman J. Modeling for learning organizations. Portland OR: Productivity Press; 1994.

93. Rahmandad H, Repenning N, Sterman J. Effects of feedback delay on learning. Syst. Dyn. Rev. 2009;25:309–38.

94. Sterman JD. Learning from evidence in a complex world. Am. J. Public Health. 2006;96:505–514.

95. S Glasser, W Ellis, J Chin, C Glazner, V Kane. A Model For Eliminating Veteran Homelessness in the USA. Delft, Netherlands; 2014.

96. Zeilinger LG, Director UE. United States Interagency Council on Homelessness United States Interagency Council on Homelessness. [cited 2016 Jan 7]; Available from: http://usich.gov/resources/uploads/asset\_library/USICH\_Ending\_Homelessness\_Among\_Veterans\_Rpt\_February\_2013\_FINAL.pdf

97. U.S. Department of Housing and Urban Development. The 2014 Annual Homeless Assessment Report (AHAR) to Congress: PART 1 Point-in-Time Estimates of Homelessness. [Internet]. 1996. Available from: https://www.hudexchange.info/resources/documents/2014-AHAR-Part1.pdf

98. T Rust, K Saeed, Bar-On, O Pavlov. Re-designing policy and process in health care service delivery: a system dynamics case study. Delft, Netherlands.;

99. Department of Veterans Affairs. Veterans Benefits Administration Reports, Detailed claims data [Internet]. 2015. Available from: http://benefits.va.gov/REPORTS/detailed\_claims\_data.asp

100. Lich KH, Tian Y, Beadles CA, Williams LS, Bravata DM, Cheng EM, et al. Strategic Planning to Reduce the Burden of Stroke Among Veterans: Using Simulation Modeling to Inform Decision Making. Stroke. 2014;45:2078–84.

101. Lyon AR, Maras MA, Pate CM, Igusa T, Vander Stoep A. Modeling the impact of school-based universal depression screening on additional service capacity needs: A system dynamics approach. Adm. Policy Ment. Health Ment. Health Serv. Res. [Internet]. 2015 [cited 2016 Jan 7]; Available from: http://link.springer.com/10.1007/s10488-015-0628-y

102. Stetler CB, Legro MW, Rycroft-Malone J, Bowman C, Curran G, Guihan M, et al. Role of “external facilitation” in implementation of research findings: A qualitative evaluation of facilitation experiences in the Veterans Health Administration. Implement. Sci. 2006;1:23.

103. Rycroft-Malone J, Kitson A, Harvey G, McCormack B, Seers K, Titchen A, et al. Ingredients for change: Revisiting a conceptual framework. Qual. Saf. Health Care. 2002;11:174–180.

104. Rycroft-Malone J. The PARIHS framework—A framework for guiding the implementation of evidence-based practice. J. Nurs. Care Qual. 2004;19:297–304.

105. Vest JR, Gamm LD. A critical review of the research literature on Six Sigma, Lean and StuderGroup’s Hardwiring Excellence in the United States: The need to demonstrate and communicate the effectiveness of transformation strategies in healthcare. Implement. Sci. 2009;4:35.

106. Mazzocato P, Savage C, Brommels M, Aronsson H, Thor J. Lean thinking in healthcare: A realist review of the literature. BMJ Qual. Saf. 2010;19:376–82.

107. DelliFraine JL, Langabeer JR, Nembhard IM, others. Assessing the evidence of Six Sigma and Lean in the health care industry. Qual. Manag. Healthc. 2010;19:211–225.

108. Martinez-Moyana IJ, Richardson GP. Best practices in system dynamics modeling. Syst. Dyn. Rev. 2013;12–123.

109. Sterman JD. Learning in and about complex systems. Syst. Dyn. Rev. 1994;10:291–330.

110. Senge, P.M. The fifth discipline: The art and practice of the learning organization. Broadway Business; 2006.

111. System Dynamics Review [Internet]. Available from: http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1099-1727

112. Mott JM, Grubbs KM, Sansgiry S, Fortney JC, Cully JA. Psychotherapy utilization among rural and urban Veterans from 2007 to 2010. J. Rural Health. 2015;31:235–43.

113. Mott JM, Hundt NE, Sansgiry S, Mignogna J, Cully JA. Changes in psychotherapy utilization among veterans with depression, anxiety, and PTSD. Psychiatr. Serv. [Internet]. 2014 [cited 2016 Jan 7]; Available from: http://ps.psychiatryonline.org/doi/10.1176/appi.ps.201300056

114. Ventana Systems Inc. Vensim@ Version 6.3. 2014.

115. Roberts, N, Anderson, D, Deal, R, Shaffer, W. Introduction to computer simulation: A system dynamics modeling approach. Reading, MA: Addison Wesley; 1983.

116. Meadows, D.H, Robinson, J.M. The Electronic Oracle: Computer models and social decisions. New York: John Wiley; 1985.

117. Sterman, J.D. Business Dynamics: Systems Thinking and Modeling for a Complex World. New York: McGraw-Hill Companies, Inc.; 2000.

118. Imel ZE, Laska K, Jakupcak M, Simpson TL. Meta-analysis of dropout in treatments for posttraumatic stress disorder. J. Consult. Clin. Psychol. 2013;81:394–404.

119. Goetter EM, Bui E, Ojserkis RA, Zakarian RJ, Brendel RW, Simon NM. A systematic review of dropout from psychotherapy for posttraumatic stress disorder among Iraq and Afghanistan combat Veterans. J. Trauma. Stress. 2015;28:401–9.

120. Holowka DW, Marx BP, Gates MA, Litman HJ, Ranganathan G, Rosen RC, et al. PTSD diagnostic validity in Veterans Affairs electronic records of Iraq and Afghanistan Veterans. J. Consult. Clin. Psychol. 2014;82:569–79.

121. Lapham GT, Rubinsky AD, Shortreed SM, Hawkins EJ, Richards J, Williams EC, et al. Comparison of provider-documented and patient-reported brief intervention for unhealthy alcohol use in VA outpatients. Drug Alcohol Depend. 2015;153:159–66.

122. Diaz M. Pasteur and parachutes: When statistical process control is better than a randomized controlled trial. Qual. Saf. Health Care. 2005;14:140–3.

123. Provost, L.P., Murray, S.K. The healthcare data guide. San Francisco, CA: Jossey-Bass.; 2011.

124. Benneyan JC, Lloyd RC, Plsek PE. Statistical process control as a tool for research and healthcare improvement. Qual. Saf. Health Care. 2003;12:458–464.

125. Mohammed MA, Worthington P, Woodall WH. Plotting basic control charts: tutorial notes for healthcare practitioners. Qual. Saf. Health Care. 2008;17:137–45.

126. Ogrinc G, Mooney SE, Estrada C, Foster T, Goldmann D, Hall LW, et al. The SQUIRE (Standards for QUality Improvement Reporting Excellence) guidelines for quality improvement reporting: explanation and elaboration. Qual. Saf. Health Care. 2008;17:i13–32.

127. Duclos A, Voirin N. The p-control chart: a tool for care improvement. Int. J. Qual. Health Care. 2010;22:402–7.

128. Faul, F, Erdfelder, E, Lang, AG, Buchner, A. G\* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. 39 175-11. Behav. Res. Methods. 2007;39:11.

129. Committee on Optimizing Scheduling in Health Care, Institute of Medicine. Transforming Health Care Scheduling and Access: Getting to Now [Internet]. Kaplan G, Lopez MH, McGinnis JM, editors. Washington (DC): National Academies Press (US); 2015 [cited 2016 Oct 4]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK316132/

130. Smith, M., Saunders, R., Stuckhardt, L. Best care at lower cost: The path to continuously learning health care in America. McGinnis, editor. Washington, DC: The National Academies Press; 2013.

131. Green LW. Making research relevant: if it is an evidence-based practice, where’s the practice-based evidence? Fam. Pract. 2008;25:i20–4.

132. Frenk SM, Sautter JM, Paulose-Ram R. Prevalence and trends in psychotropic medication use among US male veterans, 1999-2010. Pharmacoepidemiol. Drug Saf. 2015;24:1215–9.

133. Garcia HA, Finley EP, Ketchum N, Jakupcak M, Dassori A, Reyes SC. A survey of perceived barriers and attitudes toward mental health care among OEF/OIF veterans at VA outpatient mental health clinics. Mil. Med. 2014;179:273–278.

134. Martinez RG, Lewis CC, Weiner BJ. Instrumentation issues in implementation science. Implement. Sci. 2014;9:1.

135. Lewis CC, Stanick CF, Martinez RG, Weiner BJ, Kim M, Barwick M, et al. The Society for Implementation Research Collaboration Instrument Review Project: A methodology to promote rigorous evaluation. Implement. Sci. 2015;10:2.

136. Zhang R, Mahadevan S. Model uncertainty and Bayesian updating in reliability-based inspection. Struct. Saf. 2000;22:145–60.

137. Zhang Z, Hamagami F, Lijuan Wang L, Nesselroade JR, Grimm KJ. Bayesian analysis of longitudinal data using growth curve models. Int. J. Behav. Dev. 2007;31:374–83.

138. Hyndman, R.J., Khandakar, Y. Automatic time series forecasting: The forecast package for R. J. Stat. Softw. 2008;26.

139. Marshall DA, Burgos-Liz L, IJzerman MJ, Osgood ND, Padula WV, Higashi MK, et al. Applying dynamic simulation modeling methods in health care delivery research—The SIMULATE checklist: Report of the ISPOR simulation modeling emerging good practices task force. Value Health. 2015;18:5–16.

140. Simon HA. Bounded rationality and organizational learning. Organ. Sci. 1991;2:125–134.

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**References**

1. Williams EC, Rubinsky AD, Lapham GT, Chavez LJ, Rittmueller SE, Hawkins EJ, et al. Prevalence of clinically recognized alcohol and other substance use disorders among VA outpatients with unhealthy alcohol use identified by routine alcohol screening. Drug Alcohol Depend. 2014;135:95–103.

2. Hankin CS, Spiro III A, Miller DR, Kazis L. Mental disorders and mental health treatment among US Department of Veterans Affairs outpatients: The Veterans Health Study. Am. J. Psychiatry [Internet]. 2014 [cited 2016 Jan 7]; Available from: http://ajp.psychiatryonline.org/doi/10.1176/ajp.156.12.1924

3. Hoggatt KJ, Williams EC, Der-Martirosian C, Yano EM, Washington DL. National prevalence and correlates of alcohol misuse in women Veterans. J. Subst. Abuse Treat. 2015;52:10–6.

4. Fulton JJ, Calhoun PS, Wagner HR, Schry AR, Hair LP, Feeling N, et al. The prevalence of posttraumatic stress disorder in Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) Veterans: A meta-analysis. J. Anxiety Disord. 2015;31:98–107.

5. Watts BV, Shiner B, Zubkoff L, Carpenter-Song E, Ronconi JM, Coldwell CM. Implementation of evidence-based psychotherapies for posttraumatic stress disorder in VA specialty clinics. Psychiatr. Serv. 2014;65:648–653.

6. Karlin BE, Cross G. From the laboratory to the therapy room: National dissemination and implementation of evidence-based psychotherapies in the U.S. Department of Veterans Affairs Health Care System. Am. Psychol. 2014;69:19–33.

7. Karlin BE, Brown GK, Trockel M, Cunning D, Zeiss AM, Taylor CB. National dissemination of cognitive behavioral therapy for depression in the department of veterans affairs health care system: Therapist and patient-level outcomes. J. Consult. Clin. Psychol. 2012;80:707–18.

8. Ruzek JI, Karlin BE, Zeiss AM. Implementation of Evidence-Based Psychological Treatments in the Veterans Health Administration. In: McHugh RK, Barlow DH, editors. Dissem. Evid.-Based Psychol. Treat. N. Y. NY Oxf. Univ. Press. 2012.

9. Eftekhari A, Ruzek JI, Crowley JJ, Rosen CS, Greenbaum MA, Karlin BE. Effectiveness of National Implementation of Prolonged Exposure Therapy in Veterans Affairs Care. JAMA Psychiatry. 2013;70:949.

10. Department of Defense, Department of Veterans Affairs. The management of MDD Working Group. VA/DOD clinical practice guideline for management of major depressive disorder (MDD) [Internet]. 2009. Available from: http://www.healthquality.va.gov/guidelines/MH/mdd/MDDFULL053013.pdf

11. Department of Veterans Affairs, Department of Defense. VA/DoD Clinical practice guideline for the management of post-traumatic stress. [Internet]. 2010. Available from: http://www.healthquality.va.gov/guidelines/MH/ptsd/cpgPTSDFULL201011612c.pdf

12. Department of Veterans Affairs, Department of Defense. VA/DoD Clinical practice guideline for the management of substance use disorders. [Internet]. 2009. Available from: http://www.healthquality.va.gov/guidelines/MH/sud/sud\_full\_601f.pdf

13. Department of Veterans Affairs. Uniform mental health services in VA medical centers and clinics. Washington DC: Veterans Health Administration; 2008. Report No.: VHA Handbook 260.1.

14. Harris AHS, Humphreys K, Bowe T, Kivlahan DR, Finney JW. Measuring the quality of substance use disorder treatment: Evaluating the validity of the Department of Veterans Affairs continuity of care performance measure. J. Subst. Abuse Treat. 2009;36:294–305.

15. Department of Veterans Affairs, Veterans Health Administration, Office of Mental Health Operations. Mental Health Evaluation Center Information System [Internet]. 2014. Available from: https://spsites.dev.cdw.va.gov/sites/OMHO\_PEC/Pages/MHIS.aspx

16. Seal KH, Maguen S, Cohen B, Gima KS, Metzler TJ, Ren L, et al. VA mental health services utilization in Iraq and Afghanistan Veterans in the first year of receiving new mental health diagnoses. J. Trauma. Stress. 2010;n/a-n/a.

17. Mott JM, Mondragon S, Hundt NE, Beason-Smith M, Grady RH, Teng EJ. Characteristics of U.S. Veterans Who Begin and Complete Prolonged Exposure and Cognitive Processing Therapy for PTSD: Veterans in Evidence-Based Therapy for PTSD. J. Trauma. Stress. 2014;27:265–73.

18. Harpaz-Rotem I, Rosenheck RA. Serving those who served: Retention of newly returning Veterans from Iraq and Afghanistan in mental health treatment. Psychiatr. Serv. [Internet]. 2014 [cited 2016 Jan 7]; Available from: http://ps.psychiatryonline.org/doi/10.1176/ps.62.1.pss6201\_0022

19. Rubinsky AD, Chen C, Batki SL, Williams EC, Harris AHS. Comparative utilization of pharmacotherapy for alcohol use disorder and other psychiatric disorders among U.S. Veterans Health Administration patients with dual diagnoses. J. Psychiatr. Res. 2015;69:150–7.

20. Oliva EM, Trafton JA, Harris AHS, Gordon AJ. Trends in Opioid Agonist Therapy in the Veterans Health Administration: Is Supply Keeping up with Demand? Am. J. Drug Alcohol Abuse. 2013;39:103–7.

21. Shiner B, D’Avolio LW, Nguyen TM, Zayed MH, Young-Xu Y, Desai RA, et al. Measuring Use of Evidence Based Psychotherapy for Posttraumatic Stress Disorder. Adm. Policy Ment. Health Ment. Health Serv. Res. 2013;40:311–8.

22. Lin LA, Bohnert AS, Ilgen MA, Pfeiffer PN, Ganoczy D, Blow FC. Outpatient provider contact prior to unintentional opioid overdose among VHA service users. Psychiatr. Serv. [Internet]. 2015 [cited 2016 Jan 7]; Available from: http://ps.psychiatryonline.org/doi/abs/10.1176/appi.ps.201400194

23. Harris AHS, Bowe T, Del Re AC, Finlay AK, Oliva E, Myrick HL, et al. Extended Release Naltrexone for Alcohol Use Disorders: Quasi-Experimental Effects on Mortality and Subsequent Detoxification Episodes. Alcohol. Clin. Exp. Res. 2015;39:79–83.

24. Kaplan MS, Huguet N, McFarland BH, Newsom JT. Suicide among male veterans: a prospective population-based study. J. Epidemiol. Community Health. 2007;61:619–24.

25. Desai RA, Dausey DJ, Rosenheck RA. Mental health service delivery and suicide risk: The role of individual patient and facility factors. Am. J. Psychiatry [Internet]. 2014 [cited 2016 Jan 7]; Available from: http://ajp.psychiatryonline.org/doi/10.1176/appi.ajp.162.2.311

26. Steenkamp MM, Litz BT. Psychotherapy for military-related posttraumatic stress disorder: Review of the evidence. Clin. Psychol. Rev. 2013;33:45–53.

27. Bradley R, Greene J, Russ E, Dutra L, Westen D. A Multidimensional Meta-Analysis of Psychotherapy for PTSD. Am. J. Psychiatry. 2005;162:214–27.

28. Bisson JI, Roberts NP, Andrew M, Cooper R, Lewis C. Psychological therapies for chronic post-traumatic stress disorder (PTSD) in adults. In: The Cochrane Collaboration, editor. Cochrane Database Syst. Rev. [Internet]. Chichester, UK: John Wiley & Sons, Ltd; 2013 [cited 2016 Oct 3]. Available from: http://doi.wiley.com/10.1002/14651858.CD003388.pub4

29. Barrera TL, Mott JM, Hofstein RF, Teng EJ. A meta-analytic review of exposure in group cognitive behavioral therapy for posttraumatic stress disorder. Clin. Psychol. Rev. 2013;33:24–32.

30. Tuerk PW, Yoder M, Grubaugh A, Myrick H, Hamner M, Acierno R. Prolonged exposure therapy for combat-related posttraumatic stress disorder: An examination of treatment effectiveness for Veterans of the wars in Afghanistan and Iraq. J. Anxiety Disord. 2011;25:397–403.

31. Powers MB, Halpern JM, Ferenschak MP, Gillihan SJ, Foa EB. A meta-analytic review of prolonged exposure for posttraumatic stress disorder. Clin. Psychol. Rev. 2010;30:635–641.

32. Schnurr PP, Friedman MJ, Engel CC, Foa EB. Cognitive behavioral therapy for posttraumatic stress disorder in women: A randomized controlled trial. JAMA [Internet]. 2007; Available from: http://archneur.jamanetwork.com/article.aspx?articleid=205769

33. Forbes D, Lloyd D, Nixon RDV, Elliott P, Varker T, Perry D, et al. A multisite randomized controlled effectiveness trial of cognitive processing therapy for military-related posttraumatic stress disorder. J. Anxiety Disord. 2012;26:442–452.

34. Monson CM, Schnurr PP, Resick PA, Friedman MJ, Young-Xu Y, Stevens SP. Cognitive processing therapy for veterans with military-related posttraumatic stress disorder. J. Consult. Clin. Psychol. 2006;74:898–907.

35. Gloaguen V, Cottraux J, Cucherat M. A meta-analysis of the effects of cognitive therapy in depressed patients. J. Affect. Disord. 1998;49:59–72.

36. Butler A, Chapman J, Forman E, Beck A. The empirical status of cognitive-behavioral therapy: A review of meta-analyses. Clin. Psychol. Rev. 2006;26:17–31.

37. Tolin DF. Is cognitive–behavioral therapy more effective than other therapies? Clin. Psychol. Rev. 2010;30:710–720.

38. Wampold BE, Minami T, Baskin TW. A meta-(re) analysis of the effects of cognitive therapy versus “other therapies” for depression. J. Affect. Disord. 2002;68:159–165.

39. Minami T, Wampold BE, Serlin RC, Hamilton EG, Brown GSJ, Kircher JC. Benchmarking the effectiveness of psychotherapy treatment for adult depression in a managed care environment: A preliminary study. J. Consult. Clin. Psychol. 2008;76:116–124.

40. Merrill KA, Tolbert VE, Wade WA. Effectiveness of cognitive therapy for depression in a community mental health center: A benchmarking study. J. Consult. Clin. Psychol. 2003;71:404–409.

41. Feng C-Y, Chu H, Chen C-H, Chang Y-S, Chen T-H, Chou Y-H, et al. The effect of cognitive behavioral group therapy for depression: A meta-analysis 2000-2010. Worldviews Evid. Based Nurs. 2011;9:2–17.

42. McDermut W, Miller IW, Brown RA. The efficacy of group psychotherapy for depression: A meta-analysis and review of the empirical research. Clin. Psychol. Sci. Pract. 2006;8:98–116.

43. Hofmann SG, Asnaani A, Vonk IJJ, Sawyer AT, Fang A. The efficacy of cognitive behavioral therapy: A review of meta-analyses. Cogn. Ther. Res. 2012;36:427–440.

44. Powers MB, Zum V ouml rde Sive V ouml rding MB, Emmelkamp PMG. Acceptance and Commitment Therapy: A meta-analytic review. Psychother. Psychosom. 2009;78:73–80.

45. Forman EM, Herbert JD, Moitra E, Yeomans PD, Geller PA. A randomized controlled effectiveness trial of Acceptance and Commitment Therapy and cognitive therapy for anxiety and depression. Behav. Modif. 2007;31:772–799.

46. Walser RD, Karlin BE, Trockel M, Mazina B, Taylor CB. Training in and implementation of Acceptance and Commitment Therapy for depression in the Veterans Health Administration: Therapist and patient outcomes. Behav. Res. Ther. 2013;51:555–563.

47. Stewart MO, Raffa SD, Steele JL, Miller SA, Clougherty KF, Hinrichsen GA, et al. National dissemination of interpersonal psychotherapy for depression in veterans: Therapist and patient-level outcomes. J. Consult. Clin. Psychol. 2014;82:1201–1206.

48. Cuijpers P, Geraedts AS, van Oppen P, Andersson G, Markowitz JC, van Straten A. Interpersonal psychotherapy for depression: A meta-analysis. Am. J. Psychiatry. 2011;

49. Cuijpers P, van Straten A, Andersson G, van Oppen P. Psychotherapy for depression in adults: A meta-analysis of comparative outcome studies. J. Consult. Clin. Psychol. 2008;76:909–922.

50. Fournier JC, DeRubeis RJ, Hollon SD. Antidepressant drug effects and depression severity: A patient-level meta-analysis. JAMA [Internet]. 2010; Available from: http://archfaci.jamanetwork.com/article.aspx?articleid=185157

51. Cipriani A, Furukawa TA, Salanti G, Geddes JR, Higgins JP, Churchill R, et al. Comparative efficacy and acceptability of 12 new-generation antidepressants: A multiple-treatments meta-analysis. The Lancet. 2009;373:746–758.

52. Barrett B, Byford S, Knapp M. Evidence of cost-effective treatments for depression: A systematic review. J. Affect. Disord. 2005;84:1–13.

53. Miller WR, Wilbourne PL. Mesa Grande: A methodological analysis of clinical trials of treatments for alcohol use disorders. Addiction. 2002;97:265–277.

54. Morgenstern J, Blanchard KA, Morgan TJ, Labouvie E, Hayaki J. Testing the effectiveness of cognitive-behavioral treatment for substance abuse in a community setting: Within treatment and posttreatment findings. J. Consult. Clin. Psychol. 2001;69:1007–1017.

55. Irvin JE, Bowers CA, Dunn ME, Wang MC. Efficacy of relapse prevention: A meta-analytic review. J. Consult. Clin. Psychol. 1999;67:563–570.

56. Witkiewitz K, Marlatt GA. Relapse prevention for alcohol and drug problems: That was Zen, this is Tao. Am. Psychol. 2004;59:224–235.

57. Magill M, Ray LA. Cognitive-behavioral treatment with adult alcohol and illicit drug users: A meta-analysis of randomized controlled trials. J. Stud. Alcohol Drugs [Internet]. 2009; Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/pmc2696292/

58. Ball SA, Martino S, Nich C, Frankforter TL, Van Horn D, Crits-Christoph P, et al. Site matters: Multisite randomized trial of motivational enhancement therapy in community drug abuse clinics. J. Consult. Clin. Psychol. 2007;75:556–567.

59. Lundahl B, Burke BL. The effectiveness and applicability of motivational interviewing: A practice-friendly review of four meta-analyses. J. Clin. Psychol. 2009;65:1232–1245.

60. Burke BL, Arkowitz H, Menchola M. The efficacy of motivational interviewing: A meta-analysis of controlled clinical trials. J. Consult. Clin. Psychol. 2003;71:843–861.

61. Rubak S, Sandbæk A, Lauritzen T, Christensen B. Motivational interviewing: a systematic review and meta-analysis. Br. J. Gen. Pract. 2005;55:305–12.

62. Nunes EV, Levin FR. Treatment of depression in patients with alcohol or other drug dependence: A meta-analysis. JAMA. 2004;291:1887–1896.

63. Jonas DE, Amick HR, Feltner C, Bobashev G, Thomas K, Wines R, et al. Pharmacotherapy for adults with alcohol use disorders in outpatient settings. JAMA. 2014;311:1889–12.

64. Anton RF, O’Malley SS, Ciraulo DA, Cisler RA. Combined pharmacotherapies and behavioral interventions for alcohol dependence: The COMBINE study: A randomized controlled trial. JAMA [Internet]. 2006; Available from: http://jama.jamanetwork.com/article.aspx?articleid=202789

65. Streeton C, Whelan G. Naltrexone, a relapse prevention maintenance treatment of alcohol dependence: A meta-analysis of randomized controlled trials. Alcohol Alcohol. 2001;36:544–552.

66. Anton RF, Moak DH, Latham P, Waid LR, Myrick H, Voronin K, et al. Naltrexone Combined With Either Cognitive Behavioral or Motivational Enhancement Therapy for Alcohol Dependence: J. Clin. Psychopharmacol. 2005;25:349–57.

67. Pettinati HM, O’Brien CP, Rabinowitz AR, Wortman SP, Oslin DW, Kampman KM, et al. The Status of Naltrexone in the Treatment of Alcohol Dependence: Specific Effects on Heavy Drinking. J. Clin. Psychopharmacol. 2006;26:610–25.

68. Rösner S, Hackl-Herrwerth A, Leucht S, Vecchi S, Srisurapanont M, Soyka M. Opioid antagonists for alcohol dependence. Cochrane Database Syst. Rev. 2010;12.

69. Mason BJ, Lehert P. Acamprosate for alcohol dependence: A sex-specific meta-analysis based on individual patient data. Alcohol. Clin. Exp. Res. 2011;36:497–508.

70. Rosner S, Leucht S, Lehert P, Soyka M. Acamprosate supports abstinence, Naltrexone prevents excessive drinking: Evidence from a meta-analysis with unreported outcomes. J. Psychopharmacol. (Oxf.). 2007;22:11–23.

71. Franck J, Jayaram-Lindström N. Pharmacotherapy for alcohol dependence: status of current treatments. Curr. Opin. Neurobiol. 2013;23:692–699.

72. Hser Y-I, Saxon AJ, Huang D, Hasson A, Thomas C, Hillhouse M, et al. Treatment retention among patients randomized to buprenorphine/naloxone compared to methadone in a multi-site trial: Treatment retention on buprenorphine/methadone. Addiction. 2014;109:79–87.

73. West SL, O’Neal KK, Graham CW. A meta-analysis comparing the effectiveness of buprenorphine and methadone. J. Subst. Abuse. 2001;12:405–414.

74. Barnett PG, Rodgers JH, Bloch DA. A meta-analysis comparing buprenorphine to methadone for treatment of opiate dependence. Addiction [Internet]. 2001; Available from: http://onlinelibrary.wiley.com/doi/10.1046/j.1360-0443.2001.9656834.x/full

75. Marsch LA. The efficacy of methadone maintenance interventions in reducing illicit opiate use, HIV risk behavior and criminality: A meta-analysis. Addiction [Internet]. 1998; Available from: http://onlinelibrary.wiley.com/doi/10.1046/j.1360-0443.1998.9345157.x/full

76. Degenhardt L, Bucello C, Mathers B, Briegleb C, Ali H, Hickman M, et al. Mortality among regular or dependent users of heroin and other opioids: A systematic review and meta-analysis of cohort studies. Addiction. 2010;106:32–51.

77. Centers for Medicare & Medicaid Services Alliance to Modernize Healthcare (CAMH). Independent Assessment of the Health Care Delivery Systems and Management Processes of the Department of Veterans Affairs (Volume 1: Integrated Report) [Internet]. Available from: http://www.va.gov/opa/choiceact/documents/assessments/Integrated\_Report.pdf

78. Rosenheck RA. Organizational process: A missing link between research and practice. Psychiatr. Serv. [Internet]. 2014 [cited 2016 Jan 7]; Available from: http://focus.psychiatryonline.org/doi/10.1176/appi.ps.52.12.1607

79. Proctor E, Silmere H, Raghavan R, Hovmand P, Aarons G, Bunger A, et al. Outcomes for implementation research: Conceptual distinctions, measurement challenges, and research agenda. Adm. Policy Ment. Health Ment. Health Serv. Res. 2011;38:65–76.

80. Proctor EK, Powell BJ, McMillen JC. Implementation strategies: Recommendations for specifying and reporting. Implement. Sci. 2013;8:139.

81. Flaspohler P, Duffy J, Wandersman A, Stillman L, Maras MA. Unpacking prevention capacity: An intersection of research-to-practice models and community-centered models. Am. J. Community Psychol. 2008;41:182–96.

82. Powell BJ, McMillen JC, Proctor EK, Carpenter CR, Griffey RT, Bunger AC, et al. A compilation of strategies for implementing clinical innovations in health and mental health. Med. Care Res. Rev. 2012;69:123–157.

83. Damschroder LJ, Aron DC, Keith RE, Kirsh SR, Alexander JA, Lowery JC, et al. Fostering implementation of health services research findings into practice: A consolidated framework for advancing implementation science. Implement. Sci. 2009;4:50.

84. Chambers D, R Glasgow, K Strange. The dynamic sustainability framework: Addressing the paradox of sustainment amid ongoing change. Implement. Sci. 2013;117.

85. Scaccia JP, Cook BS, Lamont A, Wandersman A, Castellow J, Katz J, et al. A practical implementation science heuristic for organizational readiness: R = MC. J. Community Psychol. 2015;43:484–501.

86. Glasgow RE, Lichtenstein E, Marcus AC. Why don’t we see more translation of health promotion research to practice? Rethinking the efficacy-to-effectiveness transition. Am. J. Public Health. 2003;93:1261–1267.

87. Bates DW, Saria S, Ohno-Machado L, Shah A, Escobar G. Big data in health care: Using analytics to identify and manage high-risk and high-cost patients. Health Aff. (Millwood). 2014;33:1123–31.

88. Buntin MB, Burke MF, Hoaglin MC, Blumenthal D. The benefits of health information technology: A review of the recent literature shows predominantly positive results. Health Aff. (Millwood). 2011;30:464–71.

89. Heitmueller A, Henderson S, Warburton W, Elmagarmid A, Pentland AS, Darzi A. Developing public policy to advance the use of big data in health care. Health Aff. (Millwood). 2014;33:1523–30.

90. Charns M. The sustainability of new programs and innovations: A review of the empirical literature and recommendations for future research. [cited 2016 Sep 30]; Available from: http://www.implementationscience.com/imedia/1135790039679889\_manuscript.pdf

91. Forrester, J.W. The model versus a modeling process. Syst. Dyn. Rev. 1985;133–4.

92. Morecroft J, Sherman J. Modeling for learning organizations. Portland OR: Productivity Press; 1994.

93. Rahmandad H, Repenning N, Sterman J. Effects of feedback delay on learning. Syst. Dyn. Rev. 2009;25:309–38.

94. Sterman JD. Learning from evidence in a complex world. Am. J. Public Health. 2006;96:505–514.

95. S Glasser, W Ellis, J Chin, C Glazner, V Kane. A Model For Eliminating Veteran Homelessness in the USA. Delft, Netherlands; 2014.

96. Zeilinger LG, Director UE. United States Interagency Council on Homelessness United States Interagency Council on Homelessness. [cited 2016 Jan 7]; Available from: http://usich.gov/resources/uploads/asset\_library/USICH\_Ending\_Homelessness\_Among\_Veterans\_Rpt\_February\_2013\_FINAL.pdf

97. U.S. Department of Housing and Urban Development. The 2014 Annual Homeless Assessment Report (AHAR) to Congress: PART 1 Point-in-Time Estimates of Homelessness. [Internet]. 1996. Available from: https://www.hudexchange.info/resources/documents/2014-AHAR-Part1.pdf

98. T Rust, K Saeed, Bar-On, O Pavlov. Re-designing policy and process in health care service delivery: a system dynamics case study. Delft, Netherlands.;

99. Department of Veterans Affairs. Veterans Benefits Administration Reports, Detailed claims data [Internet]. 2015. Available from: http://benefits.va.gov/REPORTS/detailed\_claims\_data.asp

100. Lich KH, Tian Y, Beadles CA, Williams LS, Bravata DM, Cheng EM, et al. Strategic Planning to Reduce the Burden of Stroke Among Veterans: Using Simulation Modeling to Inform Decision Making. Stroke. 2014;45:2078–84.

101. Lyon AR, Maras MA, Pate CM, Igusa T, Vander Stoep A. Modeling the impact of school-based universal depression screening on additional service capacity needs: A system dynamics approach. Adm. Policy Ment. Health Ment. Health Serv. Res. [Internet]. 2015 [cited 2016 Jan 7]; Available from: http://link.springer.com/10.1007/s10488-015-0628-y

102. Stetler CB, Legro MW, Rycroft-Malone J, Bowman C, Curran G, Guihan M, et al. Role of “external facilitation” in implementation of research findings: A qualitative evaluation of facilitation experiences in the Veterans Health Administration. Implement. Sci. 2006;1:23.

103. Rycroft-Malone J, Kitson A, Harvey G, McCormack B, Seers K, Titchen A, et al. Ingredients for change: Revisiting a conceptual framework. Qual. Saf. Health Care. 2002;11:174–180.

104. Rycroft-Malone J. The PARIHS framework—A framework for guiding the implementation of evidence-based practice. J. Nurs. Care Qual. 2004;19:297–304.

105. Vest JR, Gamm LD. A critical review of the research literature on Six Sigma, Lean and StuderGroup’s Hardwiring Excellence in the United States: The need to demonstrate and communicate the effectiveness of transformation strategies in healthcare. Implement. Sci. 2009;4:35.

106. Mazzocato P, Savage C, Brommels M, Aronsson H, Thor J. Lean thinking in healthcare: A realist review of the literature. BMJ Qual. Saf. 2010;19:376–82.

107. DelliFraine JL, Langabeer JR, Nembhard IM, others. Assessing the evidence of Six Sigma and Lean in the health care industry. Qual. Manag. Healthc. 2010;19:211–225.

108. Martinez-Moyana IJ, Richardson GP. Best practices in system dynamics modeling. Syst. Dyn. Rev. 2013;12–123.

109. Sterman JD. Learning in and about complex systems. Syst. Dyn. Rev. 1994;10:291–330.

110. Senge, P.M. The fifth discipline: The art and practice of the learning organization. Broadway Business; 2006.

111. System Dynamics Review [Internet]. Available from: http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1099-1727

112. Mott JM, Grubbs KM, Sansgiry S, Fortney JC, Cully JA. Psychotherapy utilization among rural and urban Veterans from 2007 to 2010. J. Rural Health. 2015;31:235–43.

113. Mott JM, Hundt NE, Sansgiry S, Mignogna J, Cully JA. Changes in psychotherapy utilization among veterans with depression, anxiety, and PTSD. Psychiatr. Serv. [Internet]. 2014 [cited 2016 Jan 7]; Available from: http://ps.psychiatryonline.org/doi/10.1176/appi.ps.201300056

114. Ventana Systems Inc. Vensim@ Version 6.3. 2014.

115. Roberts, N, Anderson, D, Deal, R, Shaffer, W. Introduction to computer simulation: A system dynamics modeling approach. Reading, MA: Addison Wesley; 1983.

116. Meadows, D.H, Robinson, J.M. The Electronic Oracle: Computer models and social decisions. New York: John Wiley; 1985.

117. Sterman, J.D. Business Dynamics: Systems Thinking and Modeling for a Complex World. New York: McGraw-Hill Companies, Inc.; 2000.

118. Imel ZE, Laska K, Jakupcak M, Simpson TL. Meta-analysis of dropout in treatments for posttraumatic stress disorder. J. Consult. Clin. Psychol. 2013;81:394–404.

119. Goetter EM, Bui E, Ojserkis RA, Zakarian RJ, Brendel RW, Simon NM. A systematic review of dropout from psychotherapy for posttraumatic stress disorder among Iraq and Afghanistan combat Veterans. J. Trauma. Stress. 2015;28:401–9.

120. Holowka DW, Marx BP, Gates MA, Litman HJ, Ranganathan G, Rosen RC, et al. PTSD diagnostic validity in Veterans Affairs electronic records of Iraq and Afghanistan Veterans. J. Consult. Clin. Psychol. 2014;82:569–79.

121. Lapham GT, Rubinsky AD, Shortreed SM, Hawkins EJ, Richards J, Williams EC, et al. Comparison of provider-documented and patient-reported brief intervention for unhealthy alcohol use in VA outpatients. Drug Alcohol Depend. 2015;153:159–66.

122. Diaz M. Pasteur and parachutes: When statistical process control is better than a randomized controlled trial. Qual. Saf. Health Care. 2005;14:140–3.

123. Provost, L.P., Murray, S.K. The healthcare data guide. San Francisco, CA: Jossey-Bass.; 2011.

124. Benneyan JC, Lloyd RC, Plsek PE. Statistical process control as a tool for research and healthcare improvement. Qual. Saf. Health Care. 2003;12:458–464.

125. Mohammed MA, Worthington P, Woodall WH. Plotting basic control charts: tutorial notes for healthcare practitioners. Qual. Saf. Health Care. 2008;17:137–45.

126. Ogrinc G, Mooney SE, Estrada C, Foster T, Goldmann D, Hall LW, et al. The SQUIRE (Standards for QUality Improvement Reporting Excellence) guidelines for quality improvement reporting: explanation and elaboration. Qual. Saf. Health Care. 2008;17:i13–32.

127. Duclos A, Voirin N. The p-control chart: a tool for care improvement. Int. J. Qual. Health Care. 2010;22:402–7.

128. Faul, F, Erdfelder, E, Lang, AG, Buchner, A. G\* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. 39 175-11. Behav. Res. Methods. 2007;39:11.

129. Committee on Optimizing Scheduling in Health Care, Institute of Medicine. Transforming Health Care Scheduling and Access: Getting to Now [Internet]. Kaplan G, Lopez MH, McGinnis JM, editors. Washington (DC): National Academies Press (US); 2015 [cited 2016 Oct 4]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK316132/

130. Smith, M., Saunders, R., Stuckhardt, L. Best care at lower cost: The path to continuously learning health care in America. McGinnis, editor. Washington, DC: The National Academies Press; 2013.

131. Green LW. Making research relevant: if it is an evidence-based practice, where’s the practice-based evidence? Fam. Pract. 2008;25:i20–4.

132. Frenk SM, Sautter JM, Paulose-Ram R. Prevalence and trends in psychotropic medication use among US male veterans, 1999-2010. Pharmacoepidemiol. Drug Saf. 2015;24:1215–9.

133. Garcia HA, Finley EP, Ketchum N, Jakupcak M, Dassori A, Reyes SC. A survey of perceived barriers and attitudes toward mental health care among OEF/OIF veterans at VA outpatient mental health clinics. Mil. Med. 2014;179:273–278.

134. Martinez RG, Lewis CC, Weiner BJ. Instrumentation issues in implementation science. Implement. Sci. 2014;9:1.

135. Lewis CC, Stanick CF, Martinez RG, Weiner BJ, Kim M, Barwick M, et al. The Society for Implementation Research Collaboration Instrument Review Project: A methodology to promote rigorous evaluation. Implement. Sci. 2015;10:2.

136. Zhang R, Mahadevan S. Model uncertainty and Bayesian updating in reliability-based inspection. Struct. Saf. 2000;22:145–60.

137. Zhang Z, Hamagami F, Lijuan Wang L, Nesselroade JR, Grimm KJ. Bayesian analysis of longitudinal data using growth curve models. Int. J. Behav. Dev. 2007;31:374–83.

138. Hyndman, R.J., Khandakar, Y. Automatic time series forecasting: The forecast package for R. J. Stat. Softw. 2008;26.

139. Marshall DA, Burgos-Liz L, IJzerman MJ, Osgood ND, Padula WV, Higashi MK, et al. Applying dynamic simulation modeling methods in health care delivery research—The SIMULATE checklist: Report of the ISPOR simulation modeling emerging good practices task force. Value Health. 2015;18:5–16.

140. Simon HA. Bounded rationality and organizational learning. Organ. Sci. 1991;2:125–134.

**Figure 1. Intake evaluation and patient panel stock-and-flow**

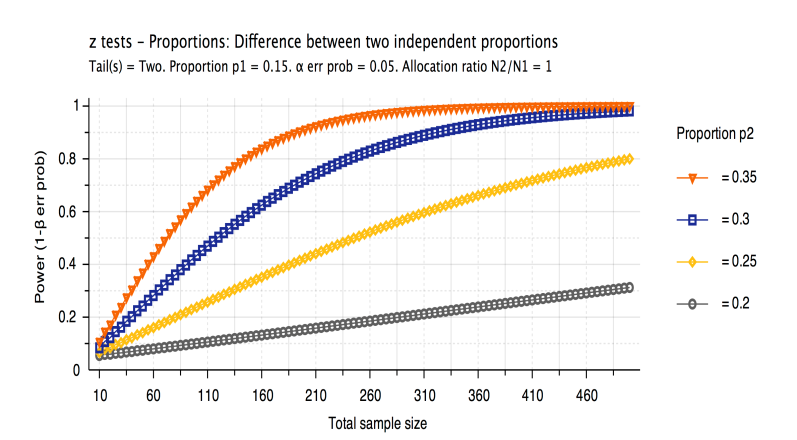
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**Figure 2. Team X 60 minute psychotherapy scheduling and service delivery stock-and-flow**

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**Figure 3.**



**Figure 4. Power Analyses**