

A novel primary care planning informatics tool informed by data-driven multimorbidity grouping: User-centered design and feasibility testing

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Abstract

Background: Patients with multimorbidity have complex healthcare needs and are at high-risk for adverse health outcomes. Primary care teams need tools to effectively and proactively plan care for these patients. We developed VET-PATHS (VETeran Panel management Tool for High-risk Subgroups), a novel care planning informatics tool for complex primary care patients. VET-PATHS a) groups patients by chronic condition profile via latent class analysis of electronic health record (EHR) data, then b) jumpstarts care planning by suggesting ‘care steps’ based on data-driven high-priority care for the group, indicated as not receive by EHR.

Objective: Iteratively adapt VET-PATHS with user input, then test feasibility and acceptability of tool use by frontline primary care teams for their empaneled high-risk patients.

Methods: Three rounds of user-centered design sessions with 17 primary care providers and registered nurses were held at 5 sites from 2019-2021, for feedback on VET-PATHS layout, content, and user-interface. Feedback was summarized into 4 user experience domains (useful, desirable, credible, and usable), leading to progressively updated prototypes. After national tool release, we conducted a pilot intervention study in 2023-2024 with 6 primary care teams at 4 sites. Teams used VET-PATHS during asynchronous regular meetings. Tool use and resulting care plans were assessed by templated observation during meetings and post-pilot chart review. Individual qualitative interviews were analyzed by rapid template analysis for themes of feasibility, acceptability, and utility.

Results: User-centered feedback led to updates in tool content, context (e.g., use in proactive panel management), targeting of users (e.g., focusing on primary care providers as the principal users), and layout of informational displays. Pilot intervention teams used VET-PATHS over 4-8 weekly team meetings (mean length, 24 min (range 16-49m)), in which they actively reviewed 80% (280/351) of empaneled high-risk patients visible in the tool. Tool use prompted teams to plan 127 new actions for 91 unique patients (33% of patients reviewed), and document >1 new care plans for 19% of patients reviewed. Common actions included requests to return to clinic (27%), referrals (20%), or vaccinations (19%). Of actions planned, 53 (42%) were received by patients. Four teams with general patient panels (n=11 interviews) described higher acceptability. Two ‘focused’ teams with smaller more homogenous patient panels, e.g. substance use disorder, (n=3 interviews) found care steps less useful. Teams described how VET-PATHS improved efficiency of care planning through automated patient grouping and identification of care gaps, and increased multidisciplinary role involvement.

Conclusions: User-centered improvements to VET-PATHS were designed to help clinicians process and use complex information about patient multimorbidity to efficiently create new care plans. In subsequent production, VET-PATHS was

acceptable and feasible to use by frontline primary care teams, particularly with larger, more heterogenous patient panels, and led to concrete changes to clinical care delivery. Clinical Trial: N/A

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Original Manuscript

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Abstract

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which they actively reviewed 80% (280/351) of empaneled high-risk patients visible in the tool. Tool use prompted teams to plan 127 new actions for 91 unique patients (33% of patients reviewed), and document ≥ 1 new care plans for 19% of patients reviewed. Common actions included requests to return to clinic (27%), referrals (20%), or vaccinations (19%). Of actions planned, 53 (42%) were received by patients. Four teams with general patient panels (n=11 interviews) described higher acceptability. Two 'focused' teams with smaller more homogenous patient panels, e.g. substance use disorder, (n=3 interviews) found care steps less useful. Teams described how VET-PATHS improved efficiency of care planning through automated patient grouping and identification of care gaps, and increased multidisciplinary role involvement.

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Keywords: Complex Care; Panel Management; Population Health; Primary Care; Multimorbidity; Care Planning

Introduction

The number of patients with multimorbidity (i.e., multiple chronic health conditions) and complex health needs is increasing as chronic diseases accumulate at younger ages.^{1,2} In the Veterans Health Administration (VHA) and other healthcare systems, the top 10% of patients who are most complex account for 80% of healthcare utilization.³ Patients with multimorbidity also are high risk for worse health outcomes, including functional decline^{4,5} and death.⁶ These patients require greater time and effort from healthcare staff in primary care visits,^{4,7,8} potentially adding to clinician burnout.^{9,10} Delivering care that effectively improves health outcomes for these patients is an ongoing, but important challenge requiring innovative solutions.

Many healthcare systems, including VHA, have risk-prediction scores that identify patients at high-risk for hospitalization or other adverse events, however clinicians are left wondering what to do once a patient is identified as high-risk¹¹. “One size fits all” interventions for high-risk patients have not been successful,^{12,13} in part due to heterogeneity in concurrent multimorbidity. In VHA, primary care teams have access to tools that highlight which of their patients are high-risk, but have described feeling overwhelmed by volume of patient health information to review and lack of guidance on what care needs are most important for high-risk patients.^{14–16} Other tools are focused on specific health needs or diseases, such as preventative care, to identify care gaps.¹⁷ However, to our knowledge, no tools within or outside VHA currently exist that identify and prioritize care needs across health conditions for high-risk patients with complex multimorbidity.

One promising approach is to develop individualized care plans for patients with multimorbidity. Care planning involves a comprehensive review of patient health and care history and development of a multidisciplinary action plan.¹⁸ Care planning has shown

promising results in specialized settings (e.g., geriatrics) and populations (e.g., diabetes).^{19–23} and is widely recommended for high-risk patients and those with complex multimorbidity.^{13,24,25} However, individualized care planning has not been successfully implemented in primary care due to the amount of time, effort, and resources required for this patient population, as well as varied care needs.^{12,23,26}

Population segmentation for primary care patients with multimorbidity could help bridge the gap between time-consuming individualized care planning, and ineffective one-size-fits-all interventions. Population segmentation is a popular analytic technique used by healthcare systems to identify groups of patients more similar to each other within the wider patient population.^{27–30} Data-driven segmentation applied to patients with complex multimorbidity could identify groups of patients for tailored, group-specific interventions. To date, population segmentation has not been bridged beyond observational uses to identify patients, to healthcare interventions within care delivery of high-risk patients.

In this paper, we describe the user-centered design and pragmatic pilot testing of VET-PATHS (VETeran PAnel management Tool for High-risk Subgroups), a novel clinical informatics tool to facilitate efficient and effective care planning for high-risk primary care patients with multimorbidity. VET-PATHS uses population segmentation to sort patients with high-risk scores for hospitalization into groups of patients with similar patterns of multimorbidity, and identify priority care gaps based on group-specific risks for hospitalization and a patient's prior receipt of care. In this study, frontline primary care teams gave input into VET-PATHS design, then used VET-PATHS to generate care plans for their empaneled high-risk patients tailored to multimorbidity groupings and individualized patient needs.

Methods

Primary Care Setting

VET-PATHS was designed for team-based management of high-risk patients with multimorbidity within the VHA. In the VHA, primary care is delivered to over 6 million Veterans across over 1100 facilities through multidisciplinary care teams (“Patient Aligned Care Teams” or PACTs).³¹ PACTs include a primary care clinician (PCP), registered nurse care manager (RN), clinical associate (CA, e.g., licensed vocational nurse), and administrative medical support administrator/clerk (MSA). Patients are empaneled to a specific PACT at a ratio of 1200 patients per full-time PCP. ‘Extended’ PACT multidisciplinary providers are shared across core PACTs and include embedded clinical pharmacists, social workers, mental health providers, and nutritionists. PACTs are encouraged to use ‘panel management’ tools during asynchronous (non-patient time) team meetings to identify and meet health needs for subpopulations of patients on their panel, such as identifying and contacting all empaneled patients currently due for cancer screening.¹⁷

VET-PATHS Patient Population

VET-PATHS displays a team’s empaneled primary care patients with a high VA Care Assessment Need (CAN) score. The CAN score is a validated risk prediction score for adverse outcomes used nationally in VHA.³² Patients are included in VET-PATHS if they have a CAN score > 90th percentile at any time within the past 1 year corresponding to an approximate 25% risk of hospitalization; patients with newly high CAN scores are added quarterly. Once included in VET-PATHS, patients remain visible within the tool for 12 months after their most recent qualifying CAN score.

Tool description

VET-PATHS is available in a VHA intranet website alongside other panel management tools and population health registries. The tool draws from databases of electronic health records to display patients actively empaneled with the team, and the

patients' up to date medical and healthcare information. Patients are first displayed in a panel view sortable by multimorbidity group label (described below) and key demographic and clinical information. A second individual patient-level view provides suggested care plan elements ('care steps', described below) tailored to the patient's group, alongside additional relevant patient health and utilization information (See Appendix 1 for tool screenshots).

1. Multimorbidity groups. Patient's assignment to multimorbidity groups is derived from previously described and validated population segmentation.^{33–36} Briefly, these models identify latent multimorbidity groups among high-risk Veterans using 31 chronic conditions³⁶ identified via healthcare encounters within the prior 24 months, based on ICD-10 codes from the U.S. Department of Health and Human Services' multiple chronic conditions framework³⁷ and expanded for Veteran care (e.g., inclusion of PTSD, Appendix 2). At the time of the pilot intervention reported here, there were 6 multimorbidity groups used in the tool, named for the most common diagnoses among patients assigned to that group: Cancer; Cardiometabolic; Liver; Mental Health; Substance Use, and Low Comorbidity. Veterans are uniquely assigned to a group if the models show a probability of matching > 70% to the group; patients are not required to have all of the group conditions to be assigned and often have differing but overlapping sets of conditions. Around 6-8% of high-risk patients do not meet the threshold for assignment to any group and are labeled 'unassigned'.

2. Care steps. VET-PATHS also provides suggested care plan components for the primary care team to consider for each patient. These are called "care steps" in the tool, and are tailored to each multimorbidity group's unique needs. Based on data automatically drawn from the patient's electronic health record (EHR), the individual patient-level view displays each care step as 1) applicable to the patient, but not yet received ('due'), 2) applicable and already received, with date of receipt ('done'), or 3) not applicable to the

individual patient ('N/A'). Care step status based on receipt of healthcare is updated daily. Three types of care steps are visible within the tool. First, some care steps target common gaps in quality metrics for a multimorbidity group. For example, a care step may suggest HgbA₁C testing in patients with diabetes, if due, based on prominent group-level gaps in this metric for Mental Health Group patients. Other care steps highlight common gaps in healthcare services within the group in response to adverse medical events,³⁴ for example, screening for fall risk-factors in groups with comparatively high rates of medically-documented falls, or nephrology referral in groups with a frequent diagnosis of advanced kidney disease but underuse of this guideline-recommended service. Third, care steps address unique risk factors for hospitalization identified for each group based on their EHR data,³⁴ for example, addressing alcohol use above recommended limits for groups with comparatively higher hospitalization risk in patients with alcohol use disorder. Care steps for each group were developed and iteratively revised based on two multi-specialty clinical expert panel reviews, observed and predicted differences in outcomes and utilization patterns across groups,^{34,38} and frontline staff feedback during preliminary testing. Care steps 'due' for patients in the group may or may not be individually appropriate, and are presented within the tool as optional suggestions. The need for clinician review and agreement was emphasized in tool training, graphics, and documentation. During the pilot, 4 of 6 multimorbidity groups had care steps programmed and available for preliminary testing and were the focus of the pilot intervention (Cardiometabolic; Liver; Mental Health; and Substance Use Groups).

Iterative user centered design and prototype development

From 2019-2021, we conducted three rounds of user-centered design to develop VET-PATHS content and user-interface.³⁹ Target primary care clinical users were recruited via staff meetings and purposeful outreach to clinicians already serving as champions in

related projects. Eligible users were either primary care clinicians (PCPs) or registered nurse care managers (RNs) within an active primary care team role at a VHA site. For each round, we conducted 20-45 minute virtual or in-person individual semi-structured interviews. Prototypes were updated based on interviewee input between each round. Round one (2019) used paper and static screen mock-ups, displaying fictional patient data to interview participants. Participants were asked about interpretation of displayed clinical information, design features, and perceived usefulness. Round two (2019) was completed using electronic visuals (screenshots, pictures) of an updated prototype completed with simulated patient information. Participants were asked in this phase about clinical interpretation, design features, and potential workflows for tool use. Round three (2021) used an interactive web-based version of the tool. This version displayed the clinician's actual patient panel and patients' real-time health information. In this round, participants were asked to 'walk through' how they would navigate, interpret, and use different parts of the tool, and describe how the content related to the care or understanding of their patients.

Interviews and walk-throughs were audio-recorded and conducted by a PhD-level staff member, with a research coordinator taking detailed notes verified with via recording review for accuracy and completeness. Feedback was summarized into deductive categories guided by 4 user experience domains (useful, desirable, credible, and usable),⁴⁰ as well as validation of the tool content for real-world patient care (Round 3 only). Updates based on the summary reports were made to the tool between each design round, and user interview guides were refined in response to results and Veteran stakeholder board (2019) feedback. Following these three rounds of user-centered improvements, the tool was released for nation-wide clinical use in 2021.

Intervention Pilot Study

In 2023-2024 we conducted a pilot intervention study with frontline PACTs to

examine the feasibility, acceptability, and perceived utility of using the tool to develop care plans for empaneled patients with complex multimorbidity. Outreach to potentially interested teams was based on recommendation by site leadership and peer referral. After a clinician 'champion' from a team agreed to participate, the team was trained on tool use. Study facilitators then scheduled 30-minute weekly or bi-weekly meetings, during which the team met to review and discuss their patients displayed in VET-PATHS by multimorbidity group, for a maximum of 8 weeks. Champions could include any core or extended PACT members in their meetings at their discretion. Teams were provided optional, adaptable documentation templates to track care planned for a patient in the main EHR. Study facilitators supported team meetings, including answering technological questions if asked (for example, how to navigate screens within the tool), but were instructed to not provide unsolicited prompts on tool use, advise teams on clinical interpretation or application of information, or otherwise direct how teams used the tool for patient care.

Data on tool use and resulting clinical activity was collected from multiple sources. First, study facilitators directly observed team discussion and actions intended during their meetings, recording observations into a structured template. Second, manual chart reviews were completed by study staff approximately 60 days after the team's final meeting. For both facilitator observation and chart review, actions considered related to VET-PATHS meetings included: 1) tool-suggested care steps discussed and related intended actions (e.g., based on VET-PATHS care steps, team decided a patient should receive a vaccine; PCP stated a patient should get updated lab tests); 2) new individualized care plans documented in the EHR after the team meeting tracking intended actions, using a recommended 'Care Plan' note template or note addendum; 3) intended actions carried out or ordered (e.g., phone call by nurse to discuss vaccination documented; lab order placed in the EHR by the PCP); and 4) actions received (e.g., patient actually received the vaccine;

patient completed lab test). Two study members completed data abstraction for clinical activity independently, using pre-specified case definitions. Agreement between abstractors was 92%, with remaining differences resolved by discussion. Third, at the conclusion of the 8-week pilot period, team members were asked to complete the System Usability Scale (SUS)⁴¹, adapted to the VET-PATHS tool and its functions. SUS questions are scored on a 1-5 Likert scale, with a maximum possible total of 100 points (higher is more usable); a score of 68.0 (industry average) or higher is considered 'acceptable' usability.^{41,42} Fourth, qualitative baseline interviews with the PACT champion, and post-intervention individual interviews with each participating team member were conducted by trained study staff. Interviews were audio-recorded and transcribed using Microsoft Teams, then transcripts verified by another study team member. Interview topics included contextual aspects (e.g. typical patient care and panel management workflows, usual team workload division, staffing shortages) that informed pre-pilot team training and meeting logistics, and other factors that influenced team acceptability⁴³ and usability of the tool (e.g., competing clinic initiatives) in both pre- and post-pilot interviews. Qualitative data were analyzed by team and clinical role. Two study qualitative analysts not involved in the user-design testing nor pilot intervention completed rapid template analysis of transcripts⁴⁴, with result interpretation supported by discussion and consensus among the larger study team.

This work was carried out as a quality improvement evaluation and designated non-research under the terms of a signed attestation from the VHA Office of Primary Care (OPC). This VHA documentation ensures that work not carried out under a human subjects protocol is part of institutionally-sanctioned quality improvement activities.

Results

User centered design (prototype development) phase

A total of 17 clinical users (Table 1), including primary care clinicians (n=5, PCPs)

and nurse care managers and/or nursing supervisors (n=12, RN) completed interviews at 5 VHA primary care sites across the U.S. (Northeast, n=8; Midwest, n=3; South, n=4; West n=2). Round one of user interviews (n=6 RN, paper prototype) led to refining the tool and workflows to target PCPs for care recommendations within care steps (usefulness). The prototype was perceived as desirable for some contexts, including proactive panel management, improving understanding of new patients to a provider, and prospectively identifying patients in need of intensive follow-up. Tool credibility was perceived as boosted by specific factors, including integration into a currently used portal, and use of established diagnosis and risk-prediction scores. Round two (n=2 PCPs, n=6 RNs, electronic prototype) revealed user perception of the tool as useful in specific contexts: panel management for a group of patients, providing feedback to a patient on why care steps might be recommended, or in preparation for a patient visit. Tool content was seen as desirable if information did not overlap with existing tools, integrated with the EHR, and if the care steps were non-redundant with current 'clinical reminders' staff were already asked to complete during encounters. Credibility was felt to be enhanced by regular and visible updates. In round three of interviews (n=3 PCPs, web-based interactive prototype) users were interviewed as they 'walked-through' the tool. They perceived usefulness as related to the type of information displayed and integration with EHR. The care steps were perceived as desirable to cover gaps in care not previously considered for the patients. Credibility was felt to be related to the transparency of the data origins underlying the care steps. All three rounds led to updates made to the tool content, format, graphics, and text (see Appendix 3 for overview of changes, such as views and content updates, terminology revisions, and formatting changes).

Table 1. Participant characteristics in VET-PATHS development and pilot testing.

User-centered prototype development, N=17			
Round	Role	Type of prototype test	Site / region
1	6 nurses (RN)	Paper prototype	Urban, VAMC (Northeast)
2	2 PCPs	Paper prototype	Urban, VAMC (Northeast)
	6 nurses (RN)	Screen-shot visuals with simulated patient data	Urban, VAMC (Midwest) Urban, VAMC (South)
3	3 PCPs	Web-based interactive with actual patient data	Urban, VAMC (South) Urban, VAMC (West)
Feasibility pilot intervention, N=23 (6 teams)			
Team	Team Type*	Patient Panel size	Site / region
A	General	476	Urban, VAMC (Northeast)
B	General	862	Rural, CBOC (Northeast)
C	General	143	Urban, VAMC (Western)
D	General	208	Rural, CBOC (Western)
E	Focused	112	Urban, VAMC (Northeast)
F	Focused	103	Urban, VAMC (Northeast)
<i>GENERAL</i>		<i>342 (median)</i>	-
<i>FOCUS</i>		<i>108 (median)</i>	-

Table footnote. RN = registered nurse care manager or nursing supervisor; PCP = primary care clinician. VAMC = VA medical center affiliated clinic; CBOC = Community-based outpatient clinic. *General primary care teams care for heterogenous patient panels; Focused teams provide medical or topic-specific care to more homogenous patients (e.g., patients living with substance use disorders).

Feasibility Pilot Intervention

Six teams (23 clinical staff) participated in pilot testing of VET-PATHS within real-world clinical settings at 4 VHA sites (2 community clinics, 2 VHA medical centers) across two U.S. regions (Table 1). Four teams represented typical PACTs in VHA, providing general primary care to larger panels (median 342 total patients per team, 15% of panel appearing as high-risk in VET-PATHS). Two teams provided primary care focused on patient populations with specific medical conditions, and had smaller patient panels (median 108 total patients, 56% of panel as high-risk within VET-PATHS). Teams conducted between 4-8 meetings each across an 8-week period. The mean length of meetings was 24 minutes (range 16-49). A range of multidisciplinary roles attended meetings, with PCP Champions attending all meetings. General teams had attendance at most meetings from

'core' team members (RN, CA, MSA), while focused teams more often had other extended PACT members attend (Table 2).

Table 2. VET-PATHS feasibility results among 6 pilot teams (4 general (GEN), 2 focused (FOC)).

	Team A (GEN)	Team B (GEN)	Team C (GEN)	Team D (GEN)	Team E (FOC)	Team F (FOC)	GEN Mean (SD)	FOC Mean (SD)
HR patients in tool	n=88	n=91	n=24	n=27	n=60**	n=61	n=58 (32)	n=61 (0.5)
HR patients reviewed in meetings	88% (77/88)	96% (87/91)	96% (23/24)	100% (27/27)	65% (39 /60)	44% (27/61)	94.7% (4.5%)	54.6% (10.4%)
Team meetings	8	6	6	5	6	4	6.3 (1.1)	5.0 (1.0)
Time reviewing patients per meeting	21	49	21	17	16	19	27.0 (12.8)	17.6 (1.4)
Attended meetings by role	100% PCP*, 13% RN, 88% MSA*	100% PCP*, 100% RN*, 50% CA, 100% MSA*	100% PCP*, 83% RN, 83% CA*, 67% MSA*	100% PCP*, 100% RN*, 100% CA, 80% SW*	100% PCP*, 60% Psych, 40% Pharm, 40% SW	100% PCP*, 100% Pharm 100% RN, 100% CA*	74% Core, 20% Non-Core	50% Core, 40% Non-Core
Care steps 'due' & discussed	130	165	36	41	43	36	93 (55.9)	39.5 (3.5)
Total new actions intended	31% (40/130)	28% (47/165)	58% (21/36)	10% (8/41)	26% (11/43)	- (0/36)	29.5 (16.0)	-
Of above, additional actions (not care steps)	12	14	6	1	3	0	8.3 (5.6)	-
Care plans documented	22% (17/77)	25% (22/87)	39% (11/23)	15% (4/27)	5% (2/39)	- (0/27)	24% (52/214)	3% (2/66)

Table footnote. PCP = primary care clinician, Psych = mental health provider (e.g., team clinical psychologist or psychiatrist), Pharm = pharmacist, CA = clinical associate (e.g., licensed practical nurse), RN = nurse care manager, MSA = administrative clerk, SW = social worker. ^aProvided post-test qualitative interview. ^bNumber shown in tool exceeds high-risk patients at baseline, due to update in patients at time of first pilot team meeting, after baseline demographic data pulled. HR=High-risk, predicted > 90th percentile of risk for hospitalization within 1 year.

Teams actively reviewed 80% (n=280/351) of the patients visible within the VET-PATHS, with more patients reviewed by general teams (93%, 214/230) than focused teams (55%, 66/121, Table 2). A total of 1343 care steps were possible for the 351 patients within 4 multimorbidity groups, and 596 (44%) care steps were 'due' care suggestions for patients. For the 280 patients reviewed, 451 care steps were 'due' and discussed by the team. Teams verbally discussed and intended 127 actions for 91 unique patients, documenting 76 new care plans (plans were counted once only, per patient) in the EHR among patients reviewed following a team meeting. Of actions, most actions (91) were based on care steps recommended within the tool, the remainder (36) were additional actions that the teams added after reviewing the patient's information in the tool, for example, placing an order to schedule a return visit for patients not seen recently in primary care. Of 127 actions planned, 69 (54%) led to an order placed or the team documenting an action to provide the care to the patient, and 53 (42%) of actions were documented as received or declined by the patient (Figure 1). Of specific care steps within the tool, uptake (team intended action on suggestions from VET-PATHS care steps) varied by multimorbidity group and care step. Intended uptake ranged from 11% (Liver Group care steps) to 37% (Substance Use Group care steps), with greater uptake of items with less effort to deliver, such as vaccination or laboratory orders, and less uptake of items requiring more complex decision making or discussion with patients, such as referrals to palliative care or specialists (Appendix 4).

Figure 1. Care steps and actions received by patients during pilot test.

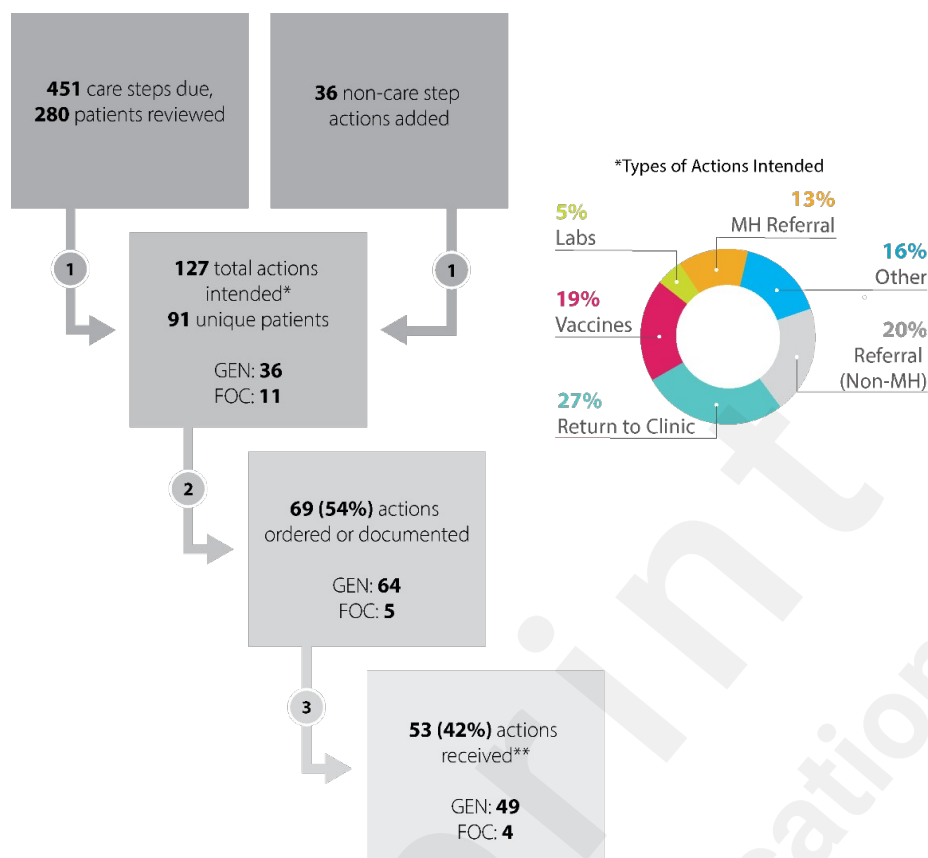


Figure footnote. **12 of 53 (23%) due to no-show or patient declined. GEN = general team counts. FOC = focused team counts. MH = mental health.

Tool usability surveys were completed by 15 of 19 participating users (79%). The mean SUS score was 69.9 (SD=7.8). Usability was scored similarly between general and focused teams (general, mean=69.3 (SD=7.9); focused, mean = 71.3 (SD=8.5)).

Experiences with the tool and use in team meetings was described by 14 team members within post-test interviews (Table 3). All teams contributed at least one post-pilot interview, and all team roles were represented (interview participants are starred in Table 2). Three main themes were identified. First, participants described efficiency related to the tool's grouping of patients, *"This was new for me and my team to have a way to characterize groups further and have these buckets to think about. [...] It helped me get to know some of my patients,"* (PCP, General Team). Second, teams described the tool making them aware of care 'gaps' that had been previously hard to identify, *"it focused our efforts on certain aspects of their care that [...] maybe we have neglected,"* (PCP, General

Team). Third, participants described VET-PATHS as enabling the whole team's involvement in patient care planning, *"it definitely helped us to work together as a team to sort through some of our higher risk panel [...] to reevaluate some of our Veterans a little bit more thoroughly,"* (RN, General Team).

When examined by teams and roles, general teams overall described high acceptability of the tool content, and mixed acceptance of care steps depending on the type of care step and group. They desired more automatic integration with the primary EHR, for example, one-click placement of orders recommended by care steps. Focused teams reported lower usability of the tool for their more specific patient needs, and often felt they had already addressed or did not find the care steps suggested appropriate for their specific patient panels. Acceptability of the tool and specific care steps also varied across roles and teams. Team members newer to panel management, less familiar with their patients, or serving more heterogenous patients perceived more utility than those with more established panel management processes, well-known or more homogenous patient panels. Among roles, PCPs and RNs reported overall high acceptability of the tool, with positive perceptions of the patient grouping functions, and particular support for advancing the multidisciplinary team member contributions to care planning. MSAs and clinical associates described acceptability of the tool as they perceived it facilitating their more support-based role to the PCP.

Table 3. Post-pilot qualitative interview results, by role and by team

By Role			
Role	n	Themes	Example Quotes
PCP	n=6	Helpful to have groups to characterize patients; positive about team-based discussion. Some mixed acceptability of care steps.	<i>"Maybe I'm thinking their problems, their core issues lie here. But according to VET-PATHS profiling, they're more of 'this flavor,' right? And that was helpful to crosscheck [...] my characterization of certain patients and their risk." - PCP</i>

			(GEN)
RN	n=2	Helpful for organizational process (sorting, tracking), and exposing tasks not previously considered for patients. Both described processes improving team collaboration	<i>"Having the high-risk patients there and what to consider approaching, it's almost like a checklist, like 'did we do this, did we do that?' It's nice to have." - RN (FOC)</i>
CA	n=2	Acceptable if used in conjunction with PCP, to reduce PCP burden	<i>"As the [CA], it falls under my category...to get the provider all the information that she needs at a glance to make her job easier." – CA (FOC)</i>
MSA	n=3	Acceptable if in conjunction with PCP. Tool increased understanding of patient clinical needs, helped clerks prioritize their tasks according to clinical urgency, which they often didn't have insight into.	<i>"It's a very helpful... because for us, we schedule the patients and we were getting informed and that the patients' needs are our priorities." - MSA (GEN)</i>
Other	n=1	Improved ability of team to collaboratively discuss patients	<i>"Was helpful to go over the high-risk patients as a team... it's good to have a list just so nobody falls through the cracks." – SW (FOC)</i>

By Team

Team (n)	Contextual factors	Acceptability/Utility	Quotes
Team A n=2	General team. Non-PCP staff turnover during pilot. No prior panel management process.	Positive in helping identify most at-risk patients, and highlighting need; some concerns about documenting care step assignment/tracking.	<i>"I think it was a nice tool to pull out who are my high-risk patients. I think it helped me identify who had not been seen in some time [...]. [One care step] for a lot of my patients did not seem appropriate [...] but put it in the forefront." - PCP (GEN)</i>
Team B n=3	General team. No prior panel management process.	Positive about tool content (especially subgrouping), overall felt context and navigation were acceptable; positive reflection on increase of interdisciplinary discussion.	<i>"It was helpful in bringing the team together and focusing on Veterans who are medically and psychosocially complicated." – PCP (GEN)</i> <i>"It broke out very straightforward on the things that we need to concentrate on." – MSA (GEN)</i>
Team C n=3	General team. Recently inherited	Positive about tool, felt it was useful for	<i>"Having sort of clear buckets and care steps that are</i>

	~50% of high-risk patients. Significant panel management experience.	both subgroups and care steps. Some challenges with administrative implementation of care steps (e.g., reaching patients post-meeting).	<i>evidence based or evidence informed, I think was really innovative and that's [what] I'm very excited about."</i> -PCP (GEN)
Team D n=3	General team. Significant prior experience in panel management.	Positive about tool, especially subgrouping and increasing interdisciplinary discussion. Felt care steps less useful, primarily due to feeling these were not applicable or already done for patients.	<i>"It kind of validated that we were actually on the right focus. Not necessarily that it made us. Like we were already doing it. I felt like it matched what we were doing with the for the patients."</i> -RN (FOC)
Team E n=1	Focused team for specific care population. Doing regular pre-visit huddles, but not full team meetings.	Some concerns about applicability of care steps to more specific population, many of whom already received suggested care.	<i>"It's not that helpful to see a list of your sickest Veterans and then have them just check off all of the boxes."</i> -PCP (FOC)
Team F n=2	Focused team for specific care population. Already doing multidisc. team meetings, but not with panel tools.	Some concerns about utility of care steps for more specific population, many of whom already received suggested care.	<i>"The care steps that [were] listed on there, those are things that we'd already done, and we needed to go beyond those initial care steps to what's next"</i> -CA (FOC)

Table footnote. PCP = Primary care clinicians (MD, Nurse Practitioner); RN = Registered Nurse; CA = clinical associate (e.g., licensed vocational nurse, care technician); MSA = administrative clerk.

Discussion

VET-PATHS is an innovative informatics tool designed to improve health outcomes for patients with complex multimorbidity, using an efficient team- and data-driven patient grouping- approach. We found evidence that the unique features of the tool, including the application of population segmentation models to a clinical team's patient panel, automatic identification of data-driven 'care step' suggestions, and workflows that enabled multidisciplinary input into patient care, were noticed by teams and perceived as useful and desirable. In particular, general primary care teams reported high VET-PATHS acceptability

and utility, and were able to review 44-96% of their empaneled patients in the tool over 4-8 brief team meetings, and planning a change in care for 1 in every 3 patients reviewed, such as new vaccines, lab tests, or evidence-based consults. The development and evaluation process described demonstrate how iterative user-centered design and preliminary testing of a tool via learning health system approach (applying health system data patterns to inform current patient care) ⁴⁵ can be made more feasible, acceptable and useful to front-line clinicians over time.

Based on the observations and feedback from this pilot, we plan to focus future use of the tool on general primary care teams with heterogenous patient panels, which care for almost 90% of high-risk patients in the VHA.⁴⁶ We are currently revising the tool with clinical group, care step, and functionality updates, including contemporary data-driven multimorbidity groups, expanded care steps, increased comprehensive care summarized data based on team feedback, and greater explanation of data sources and methodology within the tool. Prompts for shared-decision making and/or patient interface with care recommendations may increase the uptake of care steps that require more complex discussion with patients.

Patients with multimorbidity are increasingly prevalent and costly for health systems to care for.^{1,2,4} In the face of primary care staffing shortages,⁴⁷ there is a growing mismatch between available clinical resources and the effort needed to provide personalized and effective care to patients with multimorbidity.^{7,8} Tools to facilitate care planning could improve efficiency and effectiveness of care for this population, but barriers to use exist. A 2018 survey of 1,804 VHA PACT clinicians found that informatics tool use for complex patients was impeded by feelings of being “overwhelmed” by the amount and variety of information displayed, and lack of guidance from tools on what patient needs to prioritize.¹⁴ In VHA, as in other health systems, registries of patients predicted to have high risk for

adverse events are provided to teams, but do not help clinicians identify actions to take to lower risk.¹⁵ User design and pilot data from VET-PATHS could be applied by other health systems to similar interventions supporting care planning for high-risk patients and patients with multimorbidity. Concrete insights applicable to future use of VET-PATHS and similar tools includes the length of time needed for tool use in panel management workflows, need for specific team roles to participate, and the importance of documenting and following up on new care plans made during tool use. The next crucial step is a trial of the effectiveness of using VET-PATHS in real-world primary care settings on patient and clinician outcomes. Testing tools like VET-PATHS in real-world settings will also build evidence for how panel management tools for patients with multimorbidity can be best integrated into typical primary care team workflows.

Limitations

There are strengths and limitations to this study. User-centered design interviews were conducted with frontline clinical staff in multiple team roles, but concentrated on large medical centers which may not represent the views of staff in community-based clinics. Feasibility pilot teams were supported by trained facilitators, which may not be pragmatic to offer throughout health systems. However, brief training and 'champion user' facilitation are commonly used approaches by health systems helping healthcare teams adopt new technology tools.⁴⁸ Additionally, as previously described, facilitators had key roles in training at the onset, then smaller technical assistance roles for subsequent meetings that could be filled by lower-resource methods (e.g., on-demand assistance services or more in-depth reference materials). VET-PATHS is focused on Veterans in primary care settings at high-risk of hospitalization, so results may not fully generalize to patient populations in other healthcare settings. Lastly, as this study was focused on how the tool was used to initiate new care plans during meetings occurring outside of face-to-face patient care, we did not

have follow-up data on the subsequent patient experience or shared-decision making that will be integral to future capture of the full impact of personalized care planning for high-risk primary care patients.

Conclusions

VET-PATHS, developed through user-centered design and testing, was feasible and acceptable for primary care teams to use to develop new care plans for their patients with complex multimorbidity, and led to several documented clinical impacts including delivery of new evidence-based care to patients. VET-PATHS is a promising approach to fill the critical need for efficient and effective approaches for teams managing complex high-risk patients. The models and functionality in VET-PATHS could be applied to other patient populations or healthcare settings. Using a learning health system approach, multimorbidity group and care step information within VET-PATHS is being iteratively updated, in response to changing EHR data patterns and clinician feedback. Future directions include a planned effectiveness trial of VET-PATHS with primary care teams and ongoing study of the impact of iterative updates to VET-PATHS.

Conflict of Interest:

The authors have no conflicts of interest or disclosures.

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Abbreviations:

CA – Clinical Associate

CAN – Care Assessment Need

CBOC - Community-based outpatient clinic

EHR – Electronic Health Record

FOC – focused primary care team

GEN – general primary care team

RN – Registered Nurse

MSA – Medical Support Assistant

OPC – Office of Primary Care

PCAT – Primary Care Analytics Team

PCP – Primary Care Clinician

PTSD – Post-Traumatic Stress Disorder

VAMC - VA medical center affiliated clinic

VHA – Veterans Health Administration

VET-PATHS – VETeran PAnel management Tool for High-risk Subgroups

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Data Availability: Data for this study was collected as part of a national evaluation effort through the Veterans Health Administration Office of Primary Care. As such, no datasets will be available for dissemination or sharing outside the institution. Analytic plans and detailed methods, outside those shared through scientific publications and conference

proceedings, can be made available upon reasonable request.

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Supplementary Files

Multimedia Appendixes

Tool snapshots.

URL: <http://asset.jmir.pub/assets/ae27e3f5c020e19d7a43b9d1d51136c8.docx>

Chronic conditions used to define multimorbidity groups.

URL: <http://asset.jmir.pub/assets/971dac011fcc281823bd59f123489435.docx>

User centered design phase results.

URL: <http://asset.jmir.pub/assets/57590cf6add0589fa8d6f7ef002a3352.docx>

Specific care step uptake by multimorbidity group (4 of 6 groups with active care steps at time of pilot).

URL: <http://asset.jmir.pub/assets/971acf1266c18e7995d0ad61d4af8316.docx>