

BMJ Open Quality Interprofessional survey on medication reconciliation activities in the US Department of Veterans' Affairs: development and validation of an Implementation Readiness Questionnaire

Blake Lesselroth ^{1,2}, Victoria Lee Church,³ Kathleen Adams ⁴, Amanda Mixon,⁵ Amy Richmond-Aylor,⁶ Naomi Glasscock,⁷ Jack Wiedrick⁸

To cite: Lesselroth B, Church VL, Adams K, *et al*. Interprofessional survey on medication reconciliation activities in the US Department of Veterans' Affairs: development and validation of an Implementation Readiness Questionnaire. *BMJ Open Quality* 2022;**11**:e001750. doi:10.1136/bmjog-2021-001750

► Additional supplemental material is published online only. To view, please visit the journal online (<http://dx.doi.org/10.1136/bmjog-2021-001750>).

Received 22 March 2022
Accepted 20 September 2022



© Author(s) (or their employer(s)) 2022. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

For numbered affiliations see end of article.

Correspondence to

Dr Blake Lesselroth;
blake-lesselroth@ouhsc.edu

ABSTRACT

Background Medication reconciliation (MR) can detect medication history discrepancies at interfaces-in-care and help avoid downstream adverse drug events. However, organisations have struggled to implement high-quality MR programmes. The literature has identified systems barriers, including technology capabilities and data interoperability. However, organisational culture as a root cause has been underexplored.

Objectives Our objectives were to develop an implementation readiness questionnaire and measure staff attitudes towards MR across a healthcare enterprise.

Methods We developed and distributed a questionnaire to 170 Veterans' Health Affairs (VHA) sites using Research Electronic Data Capture (REDCap) software. The questionnaire contained 21 Likert-scale items that measured three constructs, such as: (1) the extent that clinicians valued MR; (2) perceptions of workflow compatibility and (3) perceptions concerning organisational climate of implementation.

Results 8704 clinicians and staff responded to our questionnaire (142 of 170 VHA facilities). Most staff believed reconciling medications can improve medication safety (approximately 90% agreed it was 'important'). However, most (approximately 90%) also expressed concerns about changes to their workflow. One-third of respondents prioritised other duties over MR and reported barriers associated with implementation climate. Only 47% of respondents agreed they had enough resources to address discrepancies when identified.

Interpretation Our findings indicate that an MR readiness assessment can forecast challenges and inform development of a context-sensitive implementation bundle. Clinicians surveyed struggled with resources, technology challenges and implementation climate. A strong campaign should include clear leadership messaging, credible champions and resources to overcome technical challenges.

Conclusions This manuscript provides a method to conduct a readiness assessment and highlights the importance of organisational culture in an MR campaign.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ While standardised medication reconciliation programmes can reduce life-threatening medication errors and are required to meet Joint Commission performance standards, they can be difficult to implement successfully.

WHAT THIS STUDY ADDS

⇒ We developed and validated a programme readiness assessment questionnaire to measure staff attitudes about medication reconciliation, concerns regarding workflow and perceptions about their organisational climate. Most clinicians in our enterprise struggle with workload, time constraints and lack of resources to reconcile medications effectively.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Implementation scientists can use this questionnaire to survey their workforce before implementing a programme to anticipate implementation barriers—or after an implementation—to identify failure modes and plan quality improvement campaigns.

The data can help assess site or network readiness for an MR change management programme.

INTRODUCTION

Discrepancies in medication histories collected during transitions-in-care increase the risk of preventable adverse drug events and the cost of healthcare.^{1–6} For this reason, policy-makers in the USA including The Joint Commission, expect healthcare organisations to implement routinised medication reconciliation (MR) procedures.^{7–11} The Institute of Healthcare Improvement (IHI) defines MR as 'the process of identifying the most accurate list of all medications a patient is

taking...and using this list to provide correct medications for patients anywhere within the healthcare system'.¹²

The US Department of Veterans' Affairs (VA) chartered a quality improvement (QI) initiative to update enterprise MR directives and disseminate an MR management 'toolkit'. The directives outlined staff responsibilities, including requiring personnel to review specific medication sources, applying a structured workflow and using standardised electronic health record (EHR) documentation. The toolkit included new dedicated EHR-MR functions and change management plans for technology deployment.

Although MR is conceptually straightforward, institutions often struggle to implement best practices, inculcate new clinician habits or measure safety impact.^{8 13 14} In previous facility-level QI pilots within the VA, our team identified an array of sociotechnical issues mediating successful adoption.^{15–21} These findings echo prior research on MR implementation barriers including limited EHR interoperability (including prescription data), poor interface usability, competing organisational priorities, patient-centred social factors (eg, health literacy), and clinician time and staff resource constraints.^{5 22–28}

PROBLEM STATEMENT AND PURPOSE

The VA engaged our informatics team to assist with implementation of the new MR directives and toolkit across the enterprise. Our piloting efforts with prototype technology at one VA site provided us insights into potential implementation barriers.^{20 29} However, we did not know if these insights were generalisable. We needed to know what system characteristics were ubiquitous (eg, existing workflows, staff values, leadership climate), what barriers to anticipate, and what to include in our implementation plan. Furthermore, we needed a practical and scalable way

to gather this information. Our intention was to complete an enterprise readiness assessment before publicising the new directives or deploying the MR toolkit to measure baseline staff attitudes, forecast implementation barriers and identify management levers of change. To conduct this readiness assessment, we needed a validated questionnaire that could be used nationwide. The objectives of our study were to: (1) develop a validated MR readiness assessment questionnaire; (2) measure current MR practices and perceptions within a large government health system; and (3) identify generalisable organisational issues that could inform implementation or scaling of our MR QI campaign. This report should interest safety officers, healthcare administrators, policymakers, implementation scientists and informaticians.

METHODS

Study design overview

We developed and distributed a cross-sectional MR implementation readiness questionnaire. Development included a derivation phase, a validation phase and a final distribution phase (figure 1). During the derivation phase, we piloted a patient-centred MR technology at a single facility and distributed a postdeployment questionnaire to primary care providers because they were responsible for MR at this facility.^{20 29} The postdeployment context helped identify implementation constructs with the greatest effect on adoption (ie, predictive validity).³⁰ We then adapted this questionnaire to measure beliefs of all clinicians (not just primary care providers) and activities throughout the enterprise before nationwide toolkit implementation. During the validation phase, we iteratively tested and adjusted the questionnaire to improve psychometric properties. During the final

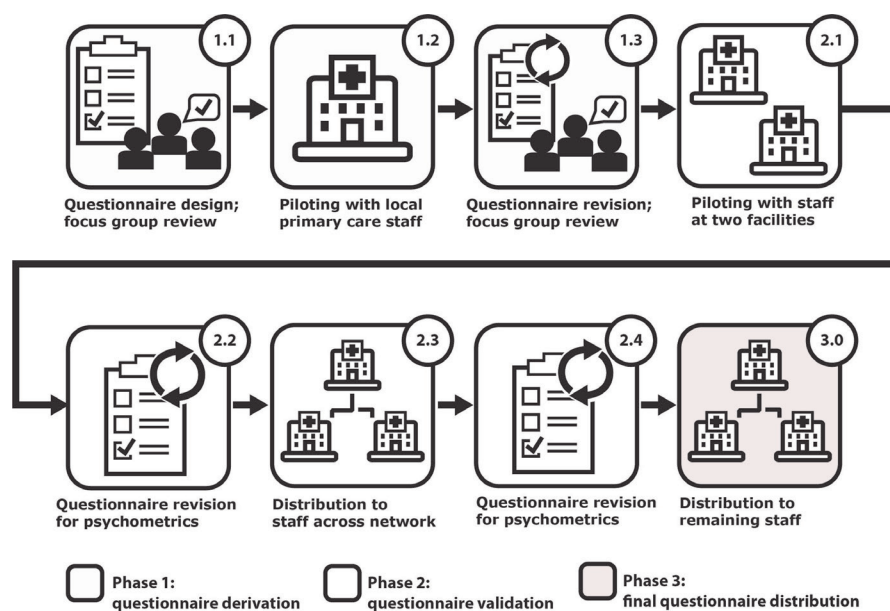


Figure 1 Workflow for development and validation of our readiness assessment questionnaire (created by the authors; BMJ is granted permission to reproduce).

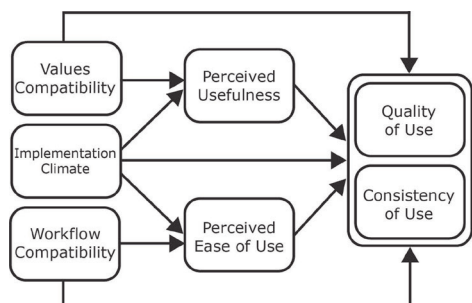


Figure 2 The effective technology use model describing attributes of the user, climate, workflow and technology that mediate innovation adoption (created by the authors; BMJ is granted permission to reproduce).

distribution phase, we administered the questionnaire to the remaining facilities in our network.

Theory

We adapted Davis' Technology Acceptance Model (TAM)—a ubiquitous technology adoption model—to study environmental, technical and attitudinal variables mediating user adoption of a technology.^{31 32} Our effective technology use (ETU) model is an 'added-variables TAM' measuring three independent predictors influencing adoption: (1) user values compatibility; (2) workflow compatibility and (3) implementation climate (figure 2).²⁹ We defined user values compatibility as the degree of alignment between staff values and purpose of the innovation; workflow compatibility as the degree of alignment between current-state and future-state workflows; and implementation climate as a composite estimate of social influence (eg, management expectations) and facilitating conditions (eg, technology support).

Phase 1: derivation

Our first questionnaire included items measuring each ETU construct (online supplemental file 1). For face validity, we conducted interviews with two focus groups of primary care physicians and made revisions based on the feedback (figure 1; 1.1).^{30 33} For criterion-predictive validity (ie, the relationship between clinician perceptions and technology adoption) we piloted the questionnaire with primary care providers at one VA facility (figure 1; 1.2).²⁰

In preparation for enterprise-wide distribution, we updated the questions to account for the larger number of facilities. We expanded our scope to include more than primary care providers (figure 1; 1.3). We had not yet implemented the new MR toolkit and thus removed questions asking about perceptions of the MR technology. We formatted responses using a five-point Likert scale anchored by 5 = 'strongly agree' and 1 = 'strongly disagree'. The first scale measured user values compatibility (eg, 'reconciling medications is an important way to improve patient safety'). The second scale measured workflow compatibility (eg, 'MR makes me do extra work'). The third scale measured implementation climate

(eg, 'our local clinical leadership has acted to remove obstacles encountered in our MR process').

For face validity, we interviewed four clinician focus groups that included nurses, physicians, pharmacists and allied care professionals from six medical centres. Interview scripts explored the roles and expectations of interdisciplinary teams. We also asked administrators knowledgeable about local management practices to provide feedback on climate questions.

Phase 2: validation

We piloted our questionnaire at two VA facilities and modified it based on principal component analysis and Cronbach's alpha scores (figure 1; 2.1 and 2.2). The validation phase questionnaire included three scales and 22 individual questions. Maximum cumulative score for values, workflow and climate were 35, 40 and 35, respectively.

We used REDCap software to distribute the questionnaire to network facilities (figure 1; 2.3).^{34 35} All VA personnel were eligible for participation, including clinician roles, other patient-facing roles and non-patient facing administrative roles. Although there are an estimated 367 000 care professionals and support staff across all VA facilities, VA Human Resource policies forbid collection of individually identifiable data. Therefore, we could not directly measure the respondent pool (ie, questionnaire response denominator), contact non-respondents for follow-up or prevent multiple participation. We used purposive snowball sampling, contacting facility-based personnel including clinical department chiefs, hospital executives, safety officers, public affairs officers and MR champions. The email included the purpose of the evaluation, a description of the questionnaire, a request to distribute and a link to the REDCap questionnaire. To maximise responses, we sent three different emails, distributed at 2-week intervals. We also placed reminder calls and emails to our contact list.

After 5 months, we conducted an interim data analysis of psychometric properties. We made three adjustments to improve validity and the informativeness of each scale (figure 1; 2.4). First, we updated language for user values compatibility questions to correct for positive skewness in the response distribution and limit social desirability bias. Second, we changed scale order, moving 'user values compatibility' to the second section to eliminate any primacy effect. Third, we removed an item from the workflow compatibility scale to improve internal consistency.

Phase 3: final distribution

Our final distribution phase questionnaire included 3 scales and a total of 21 individual questions (online supplemental file 2). Maximum cumulative score for each section was 35. We distributed this questionnaire to the remaining facilities in our network (figure 1; 3.0).

Statistical analysis

We collected all data in REDCap and performed all statistical analysis using Stata (V.15).³⁶ To measure item cohesion (ie, internal consistency) for each scale, we calculated the Cronbach's alpha and intra-class correlation coefficients (ICCs). To calculate ICCs, we used the consistency ICC of average measurements among items, computed from a two-way mixed-effects ANOVA model.

Item-level data were heavily skewed to the left (ie, asymmetrically heavier weight of positive responses for positively coded items). Therefore, we calculated medians and IQR for each item. We summated overall values for each scale (reverse-coding negatively coded items) and examined associations between scales and clinical business units using regression analyses. We adjusted models for respondent tenure at the VA. We addressed missing data (just 2% of responses were missing some information) through pairwise deletion. We conducted meta-analyses to summarise scores and regression results for each scale across the entire VA; this method of summary remains valid regardless of differences in questionnaire versions (validation phase vs distribution phase).

Permissions and patient/public involvement

The Portland VA Medical Center Office of Research & Development reviewed this work and determined the project to be non-research operations and QI work. The VA Office of Personnel Management also reviewed and approved this work. There was no patient or public involvement in this work.

RESULTS

Descriptive statistics and validation data

We distributed the validation phase questionnaire between 23 October 2015 and 12 May 2016 and the final distribution questionnaire between 3 May, 2016 and 18 July 2016. We received responses from staff at 142 of 170 facilities. While we did not have data on the actual breakdown of employee roles within the population, we suspected that nurses and providers were over-represented. We received 8704 responses (8515 with all scales completed)—4790 nurses (55%), 1530 providers (18%), 1020 pharmacy staff (12%), 370 administrative staff (4%), 637 'other clinical staff' (7%), 246 social workers (3%) and 111 staff (1%) that did not report a role (online supplemental table

1S). A total of 3310 respondents (38%) had completed 0–5 years of service and 1262 respondents (14%) had completed more than 20 years of service.

Table 1 includes construct validity, internal consistency and comparative performance statistics for the validation and distribution questionnaires.

Minor differences in calculated internal consistency between versions were negligible and consistent with sampling variance (ie, z-scores less than 2 in magnitude for all three scales, and jointly $p=0.17$ when combined using Fisher's method to evaluate the omnibus hypothesis of no change in consistency across versions).

Comparing responses to the validation questionnaire and distribution questionnaire

User values compatibility scores were significantly lower in the distribution questionnaire (mean sum 29.4 vs mean sum 26.5; $p<0.001$; table 2). This was expected; we had sought to limit inflation of attitudes secondary to social desirability bias. We did not identify any significant differences in the distribution of responses in the workflow compatibility and implementation climate scales. Comparing the measurement properties using Rache response characteristic curves across versions, we saw a large improvement in curve symmetry and informativeness of responses for user values compatibility, and a small improvement for workflow compatibility (online supplemental figure 1S). The response characteristics curves for implementation climate were similar between questionnaires.

Staff beliefs and values regarding MR

Overall, most respondents valued and supported MR values and activities. In the validation phase questionnaire, 7592 (92.5%) of 8200 respondents agreed or strongly agreed with the statement 'reconciling medications is an important way to improve medication safety' (table 3). In the distribution phase questionnaire, 325 (74.7%) of 434 respondents agreed with the statement 'I believe it is crucial to review every single medication with the patient or caregiver during the interview' (table 4). In the validation phase questionnaire, over 80% of respondents believed it was 'valuable' for a patient to complete a medication review at every encounter (table 3), and in the distribution phase questionnaire, 80% of respondents

Table 1 Questionnaire validity statistics (created by the authors; BMJ has permission to reproduce)

Construct	Validation questionnaire				Distribution questionnaire				Z
	N	α	ICC	ICC 95% CI	N	α	ICC	ICC 95% CI	
User values compatibility	8200	0.84	0.823	0.817 to 0.828	434	0.83	0.832	0.807 to 0.855	0.48
Workflow compatibility	8180	0.77	0.766	0.759 to 0.774	433	0.73	0.728	0.687 to 0.766	-1.82
Implementation climate	8162	0.84	0.842	0.837 to 0.848	431	0.86	0.863	0.842 to 0.882	1.17

Fisher's combined $p=0.17$.

ICC, intraclass correlation coefficient; N, completed responses; Z, z-score of comparison of ICC across questionnaire versions (final—validation); α , Cronbach's alpha.

Table 2 Questionnaire response summaries (created by the authors; BMJ has permission to reproduce)

Construct	Validation questionnaire			Distribution questionnaire			Meta-analytic average		
	N	Mean	Mean 95% CI	N	Mean	Mean 95% CI	I ²	Mean	Mean 95% CI
User values compatibility	8200	29.4	29.3 to 29.5	434	26.5	26.1 to 27.0	0.99*	28.0	25.1 to 30.8
Workflow compatibility†	8180	20.1	20.0 to 20.2	433	20.1	19.6 to 20.5	0.00	20.1	20.0 to 20.2
Implementation climate	8162	23.3	23.1 to 23.4	431	23.2	22.7 to 23.7	0.00	23.2	23.1 to 23.4

The values of compatibility scales scores are significantly different between the validation questionnaire and the distribution questionnaire. We anticipated our changes would address any social desirability bias.

*Significant heterogeneity.

†Values rescaled by 7/8 in the validation version to correct for differing scale maxima (40 validation vs 35 distribution).

I², empirical Bayes meta-analysis heterogeneity coefficient; n, completed.

agreed it is ‘crucial’ for the patient to leave every encounter with a correct list of medications.

Only 65.4% of respondents answering the validation-phase questionnaire agreed that their time was ‘well spent’ correcting and updating medications. Only

36.7% of respondents answering the distribution-phase questionnaire agreed that their time was ‘best spent’ doing these activities (table 4). Pharmacist and nurse user values compatibility scores tended to be higher (ie, more positive) than physicians and physician

Table 3 Questionnaire item responses for the validation phase

Questionnaire item	Median (IQR)	Agreement* (%)
User values compatibility subscale	30 (27–33)	
Reconciling medications is an important way to improve medication safety	5 (4–5)	92.5
Reconciling medication lists with the patient is an important way to decrease medication errors	5 (4–5)	92.0
My time is well spent with the patient updating the patient medication list	4 (3–5)	65.4
I am not responsible for reconciling medications that other providers prescribe†	2 (1–3)	17.4
I believe it is important to review medications from all sources with a patient	5 (4–5)	92.3
I believe it is valuable for the patient to complete a medication history/review at each encounter	4 (4–5)	81.0
It is important for the patient to leave an encounter (or hospitalisation) with an updated list of their medications	5 (4–5)	90.7
Workflow Compatibility Subscale	23 (20–26)	
Medication reconciliation requires a lot of mental effort	3 (2–4)	49.9
It is difficult to identify significant medication discrepancies	3 (2–4)	27.0
I rate medication reconciliation a high priority given my other competing priorities†	4 (3–4)	63.5
Medication reconciliation fits into my workflow†	3 (2–4)	47.2
Medication reconciliation makes me do extra work	3 (2–4)	48.7
Medication reconciliation makes me take on more responsibilities	4 (3–4)	52.3
I believe I have a routine way of identifying medication discrepancies†	4 (3–4)	53.1
I know the processes for managing medication discrepancies†	4 (3–4)	59.0
Implementation Climate Subscale	23 (20–27)	
Our hospital executives have expressed a commitment to the medication reconciliation	4 (3–4)	55.3
My department/service leadership stresses the importance of satisfying medication reconciliation to achieve national performance measures	4 (3–4)	62.2
My manager/supervisor has emphasised the importance of reconciling medications	4 (3–4)	61.8
Our local clinical leadership has acted to remove obstacles encountered in our medication reconciliation process	3 (3–4)	31.7
A peer in my role that is new to our facility receives education about the process of medication reconciliation	3 (3–4)	40.0
In our facility there are no incentives for reconciling medications with the patient†	3 (3–4)	41.5
I have the resources that I need to address identified medication discrepancies	3 (3–4)	47.1

Higher scores are favourable for values and climate scales. lower scores are favourable for the workflow scale (table created by the authors; BMJ has permission to reproduce).

*Agreement frequency includes respondents who specified ‘agree’ or ‘strongly Agree’ for each item.

†Items reverse scored.

Table 4 Questionnaire item responses for distribution phase

Questionnaire item	Median (IQR)	Agreement* (%)
Workflow Compatibility Subscale	20 (17–23)	
Medication reconciliation requires a lot of mental effort	3 (2–4)	46.6
It is difficult to identify significant medication discrepancies	3 (2–4)	28.1
Medication reconciliation fits into my workflow†	4 (3–4)	56.1
Medication reconciliation makes me do extra work	3 (2–4)	42.7
Medication reconciliation makes me take on more responsibilities	3 (2–4)	46.5
I believe I have a routine way of identifying medication discrepancies†	4 (3–4)	54.8
I know the processes for managing medication discrepancies†	4 (3–4)	59.0
User Values Compatibility Subscale	27 (23–30)	
Compared with other tasks, reconciling medications during an encounter makes the biggest contribution to patient safety	4 (3–4)	66.1
I believe it is crucial to review every single medication with the patient or caregiver during the interview.	4 (3–5)	74.7
My time is best spent with the patient correcting and updating all prescriptions	3 (2–4)	36.7
It is not important for me to reconcile medication discrepancies associated with prescriptions written by other providers†	2 (1–2)	4.8
It is crucial that I review all recently expired and discontinued prescriptions with the patient	4 (3–4)	69.7
It is important for the patient to complete a medication review at every single encounter	4 (3–4)	68.6
It is crucial for the patient to leave every encounter or hospitalisation with an updated list in hand of all medications	4 (4–5)	79.6
Implementation Climate Subscale	23 (20–27)	
Our hospital executives have expressed a commitment to the medication reconciliation	4 (3–4)	54.5
My department/service leadership stresses the importance of satisfying medication reconciliation to achieve national performance measures	4 (3–4)	60.5
My manager/supervisor has emphasised the importance of reconciling medications	4 (3–4)	58.9
Our local clinical leadership has acted to remove obstacles encountered in our medication reconciliation process	3 (3–4)	32.3
A peer in my role that is new to our facility receives education about the process of medication reconciliation	3 (3–4)	39.9
In our facility there are no incentives for reconciling medications with the patient†	3 (3–4)	41.7
I have the resources that I need to address identified medication discrepancies	4 (3–4)	50.1

Higher scores are favourable for values and climate; lower are favourable for workflow (created by authors; BMJ has permission to reproduce).
 *Agreement frequency includes respondents who specified 'agree' or 'strongly agree' for each item.
 †Items reverse scored.

assistants (30.4 vs 28.0 out of 35, averaged over questionnaire versions; $p < 0.001$).

Staff perceptions of MR processes and workflow

Respondents seemed to struggle to align MR processes with current workflow. About 90% of respondents believed MR was burdensome; the mean score was about 20 out of 35 (table 2), representing typical scores of 3 per item (ie, neutral valence). The validation phase workflow compatibility scale sums were rescaled by 7/8 to correct for change in scale maximum value between versions.

Nearly half of respondents believed MR requires a lot of mental effort, and roughly 75% had difficulty identifying important discrepancies at the point of care. About half of respondents believed MR processes increased their workload and added to their responsibilities. Emergency care staff reported the highest perception of burden (21.7 for emergency care vs 20.0 for non-emergency

care; $p < 0.001$), whereas outpatient and domiciliary staff reported the lowest (18.7 for either vs 20.3 for neither; $p < 0.001$).

Respondents could choose multiple work areas as their main work area, but 95% of respondents chose just a single area. Thus, responses were non-overlapping in nearly all cases. For example, only 20 out of 8704 respondents identified emergency care *and* either outpatient or domiciliary care as their main work areas.

Staff attitudes towards MR implementation climate

Respondents harboured mixed feelings about the implementation climate. They tended to agree that hospital executives supported MR programmes and that clinical leadership promoted MR to achieve quality targets. Averaged over questionnaire versions, 60.2% agreed or strongly agreed with at least two of the first three items in

the implementation climate scale (see also tables 3 and 4).

However, over 40% of respondents did not believe they were suitably incentivised to participate in MR work. Only about 30% agreed leadership removed implementation obstacles, and less than half (47%) believed they had sufficient resources. The most negative views were expressed by younger staff (22.2 for less than 30 vs 23.3 for over 30; $p < 0.001$) and those with less tenure (22.9 for five or less years vs 23.8 for 20 or more years; $p < 0.001$).

DISCUSSION

Principal findings

In this MR readiness assessment, we examined staff perceptions and attitudes about MR before deploying an MR toolkit during an enterprise-wide QI campaign. By surveying a cross-section of clinical and administrative personnel in the largest US healthcare system, we were able to assemble a detailed portrait of staff concerns and organisational challenges facing MR implementation and dissemination. Typically, sustained improvement in MR processes and clinical outcomes is contingent on a combination of decision support technologies, a strong organisational climate and a schematised workflow.^{16 19 24 28}

Unfortunately, our findings indicate that VA clinicians struggle with resource and technology gaps. They cited concerns over workflow compatibility and institutional support—including resources, time and leadership prioritisation. Approximately one-third of respondents did not think their time was well-spent reconciling medications, most thought it added to their workload and three-quarters had difficulty identifying important discrepancies at the point of care. The VA boasts a very mature information-technology infrastructure that includes a Health Information Management Systems Society stage 7 EHR and an electronic pharmaceutical supply-chain management system. Therefore, challenges identified in our study population are likely greater in community settings worldwide.³⁷

To our knowledge, this is the largest survey published looking at the sociotechnical mediators of MR. Our findings are generally concordant with results from other studies examining barriers.^{13 26 38–41} High-reliability MR requires more than rote checklists, boilerplate language, or modal dialogue boxes.⁴² There must be an organisational and individual commitment to detecting discrepancies, identifying root causes and closing gaps.⁸ Our results indicate that many clinicians neither feel incentivised nor are given the resources to be successful.

Comparison to the literature and implication of findings

Respondent concerns over the mental workload and challenge of identifying important discrepancies may indicate a need for better EHR-based tools to collect, analyse, display and document discrepancies.^{43 44} A systematic review by Marien *et al* identified specific MR tools used during hospital admission, discharge and ambulatory

clinic visits.²⁴ These include (1) automated data retrieval, (2) side-by-side list displays, (3) point-and-click selection controls, (4) duration of therapy and refill displays, (5) context-sensitive decision support, (6) automated task documentation and (7) the ability to sort medications by class or disease. Prescription data interoperability and regional health information exchange can also provide a more complete picture of prescribing activity within a community.⁴⁵

While clinicians need these capabilities to limit cognitive load and improve performance, many features are unavailable or poorly implemented in commercial EHRs.^{16 43 46–48} We believe next-generation tools should incorporate better visualisations, predictive analytics and artificial intelligence. They should also engage patients and leverage direct-to-consumer technologies such as online portals, smartphone applications and automated pill organisers.

User values compatibility scores in our study were lower among physicians and physician assistants compared with nurses and pharmacists. While it is difficult to know if one group felt more or less responsible for MR tasks, the literature indicates nurses, physicians and pharmacists often disagree over delegation of medication management responsibilities.⁴⁰ For example, compared with nurses and pharmacists, physicians tend to prioritise other tasks in a resource-constrained setting.²⁶ Therefore, it is crucial for organisational leaders to identify local champions, sponsor human factors evaluations and identify dedicated personnel (eg, pharmacy technicians) based on clinic resources and characteristics.^{8 19 49}

Only a minority of respondents (31%–32%) believed leadership removed obstacles to completing MR and only half (47%–50%) thought they had the resources needed to address discrepancies. These data seem to align with what is known about the workload associated with MR. Compiling medication lists, identifying discrepancies, reconciling medications and managing formulary options is time-consuming, cognitively complex and a potential contributor to burn-out.^{19 20 50} Complex problems demand systems-based solutions. Successful MR programmes require team-based models of care, context-sensitive management pathways, better use of health information exchange and consumer-centred tools to engage patients as active stewards of their own medications.^{46 51}

The MR literature offers some insight into the related failure modes and strategies that might increase a campaign's success. However, it is not yet clear which interventions would have the greatest effect in our organisation. The best interventions need to be precisely matched to local context. Therefore, professionals charged with deploying an MR programme should consider using this questionnaire with a workflow analysis and a qualitative needs assessment to identify failure modes and to anticipate assets required for system-level change.

STRENGTHS AND LIMITATIONS

There are several strengths to our study and findings. First, we were able to survey nearly every VA hospital and clinic in the US and conduct a near 360° angle view of all clinical roles. Second, in designing our questionnaire, we used a theory-based approach reflecting recent concepts from the systems engineering and technology adoption literature. Finally, we used a multistep process to validate our questionnaire. Therefore, we believe the final instrument could be re-used across a broad range of clinical settings and compared with our benchmarks.

This study has several limitations that may have affected our results. Our study design relied on snowball sampling to comply with institutional policies. This may be an important source of respondent bias, since we do not know the actual survey response rates. Second, our questionnaire did not explicitly ask about any MR technologies. Future work should directly measure the usability associated with embedded EHR tools. Third, some of the clinicians surveyed may not be responsible for MR at their facility. This could bias perceptions and values. Fourth, we were unable to recruit equal numbers of nurses, clinicians, pharmacy staff, social workers and administrative staff. The differences in subgroups limited our ability to compare beliefs across these groups. Future work should engage social workers and other groups under-represented in the literature. Finally, we analysed findings from two questionnaire versions—the validation phase questionnaire and the distribution phase questionnaire. While they were very similar in design and wording, we could not combine results. Given the large number of responses, we thought it is best to report findings for both sets.

Conclusions

Our findings can inform MR-related QI initiatives in hospitals and clinics. While prior researchers have reported on the attitudes of physicians and pharmacists, far fewer have studied nurses, social workers and other allied care providers.^{8 9 39 40} This manuscript provides a readiness assessment tool (online supplemental appendices 1 and 2) and a framework to plan and execute an MR change management programme.

Author affiliations

¹Department of Medical Informatics, The University of Oklahoma-Tulsa, Tulsa, Oklahoma, USA

²School of Health Information Science, University of Victoria, Victoria, British Columbia, Canada

³US Department of Veterans Affairs, Office of Nursing Services, Washington, DC, USA

⁴US Department of Veterans Affairs, Office of Human Factors Engineering, Washington, DC, USA

⁵School of Medicine, Vanderbilt University Medical Center, Nashville, Tennessee, USA

⁶Office of Specialty Care Services, Veterans Health Administration, Washington, DC, USA

⁷Specialty Care Services, Prescription Drug Monitoring Program, Veterans Health Administration, Washington, DC, USA

⁸BioStatistics & Design Program, Oregon Health & Science University, Portland, Oregon, USA

Acknowledgements We acknowledge the contributions of Maureen Layden, MD MPH, and Eric Spahn, PharmD with VA Pharmacy Benefits Management (PBM) for their valuable suggestions on survey instrument design and distribution.

Contributors BL contributed to the study design, data analysis and manuscript draft and revision. He accepts full responsibility for the work and/or the conduct of the study. He had access to the data, and controlled the decision to publish. VLC contributed to the study design, questionnaire distribution, project management and data analysis. She reviewed the manuscript. KA contributed to the study design, data analysis and manuscript development. AM contributed to study design and data analysis. She reviewed the manuscript. AR-A contributed to study design, questionnaire distribution and project management. She reviewed the manuscript. NG contributed to study design, questionnaire distribution and project management. She reviewed the manuscript. JW contributed to study design, data analysis and manuscript draft and revision.

Funding The VA National Center for Patient Safety (NCPS) funded portions of this work (no award/grant number). The authors also wish to acknowledge the generous support from the Portland Division of Research & Development, the VHA Chief Business Office, the Portland Center to improve Veteran Involvement in Care (CIVIC), the VA Veterans' Engineering Resource Center (VERC), and the Oregon Clinical and Translational Research Institute (OCTRI).

Competing interests None declared.

Patient and public involvement The Portland VA Medical Center Office of Research & Development reviewed this work and determined the project to be non-research operations and quality improvement work. The VA Office of Personnel Management also reviewed and approved this work. There was no patient or public involvement in this work.

Patient consent for publication Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. Not applicable.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iDs

Blake Lesselroth <http://orcid.org/0000-0001-6170-7964>

Kathleen Adams <http://orcid.org/0000-0003-4224-038X>

REFERENCES

- 1 Bruce Bayley K, Savitz LA, Maddalone T, *et al*. Evaluation of patient care interventions and recommendations by a transitional care pharmacist. *Ther Clin Risk Manag* 2007;3:695.
- 2 Varkey P, Resar RK. Medication reconciliation implementation in an academic center. *Am J Med Qual* 2006;21:293–5.
- 3 Bayoumi I, Howard M, Holbrook AM, *et al*. Interventions to improve medication reconciliation in primary care. *Ann Pharmacother* 2009;43:1667–75.
- 4 Aspden P, Wolcott J, Bootman JL. Preventing medication errors. *Institute of Medicine. Of The* 2006;26–45.
- 5 Bond CA, Raehl CL, Franke T. Clinical pharmacy services, hospital pharmacy staffing, and medication errors in United States hospitals. *Pharmacotherapy* 2002;22:134–47.
- 6 Pippins JR, Gandhi TK, Hamann C, *et al*. Classifying and predicting errors of inpatient medication reconciliation. *J Gen Intern Med* 2008;23:1414–22.

- 7 Wittich CM, Burkle CM, Lanier WL. *Medication errors: an overview for clinicians*, 2014.
- 8 Greenwald JL, Halasyamani L, Greene J, et al. Making inpatient medication reconciliation patient centered, clinically relevant and implementable: a consensus statement on key principles and necessary first steps. *J Hosp Med* 2010;5:477–85.
- 9 Developed through the ASHP Council on Pharmacy Practice and approved by the ASHP Board of Directors on April 13, 2012, and by the ASHP House of Delegates on June 10, 2012. ASHP statement on the pharmacist's role in medication reconciliation. *Am J Health Syst Pharm* 2013;70:453–6.
- 10 Young B. Medication reconciliation matters. *Medsurg Nurs* 2008;17:332.
- 11 The Joint Commission. National Patient Safety Goals 2020. *National Patient Safety Goals 2020*, 2020. Available: <https://www.jointcommission.org/en/standards/national-patient-safety-goals/> [Accessed 1 Aug 2020].
- 12 Midelfort L, Review MR, Reconciliation M, 2020. Available: <http://www.ihl.org/resources/Pages/Tools/MedicationReconciliationReview.aspx> [Accessed 1 Aug 2020].
- 13 Clay BJ, Halasyamani L, Stucky ER, et al. Results of a medication reconciliation survey from the 2006 Society of hospital medicine national meeting. *J Hosp Med* 2008;3:465–72.
- 14 Kwan JL, Lo L, Sampson M, et al. Medication reconciliation during transitions of care as a patient safety strategy: a systematic review. *Ann Intern Med* 2013;158:397–403.
- 15 Lesselroth B, Adams S, Felder R, et al. Using consumer-based kiosk technology to improve and standardize medication reconciliation in a specialty care setting. *Jt Comm J Qual Patient Saf* 2009;35:264–AP1.
- 16 Lesselroth BJ, Adams K, Church VL, et al. Evaluation of multimedia medication reconciliation software: a randomized controlled, single-blind trial to measure diagnostic accuracy for discrepancy detection. *Appl Clin Inform* 2018;9:285–301.
- 17 edLesselroth BJ, Adams K, Tallett S. Naturalistic usability testing of inpatient medication reconciliation software. In: *Building capacity for health informatics in the future*. Amsterdam: IOS Press, 2017: 201–5.
- 18 Lesselroth BJ, Adams K, Tallett S. Usability evaluation of a medication reconciliation and allergy review (MRAR) Kiosk: a methodological approach for analyzing user interactions. In: *Context sensitive health informatics: many places, many users, many contexts, many uses*. Amsterdam: IOS Press, 2015: 61–7.
- 19 Lesselroth BJ, Adams K, Tallett S, et al. Design of admission medication reconciliation technology: a human factors approach to requirements and prototyping. *HERD* 2013;6:30–48.
- 20 Lesselroth BJ, Holahan PJ, Adams K, et al. Primary care provider perceptions and use of a novel medication reconciliation technology. *Inform Prim Care* 2011;19:105–18:105–18.
- 21 Wright TB, Adams K, Church VL. Implementation of a medication reconciliation assistive technology: a qualitative analysis. In: *AMIA annual symposium proceedings*. . American Medical Informatics Association, 2017: 2017. 1802–11.
- 22 Salanitro AH, Osborn CY, Schnipper JL, et al. Effect of patient- and medication-related factors on inpatient medication reconciliation errors. *J Gen Intern Med* 2012;27:924–32.
- 23 Salanitro AH, Kripalani S, Resnic J, et al. Rationale and design of the multicenter medication reconciliation quality improvement study (Marquis). *BMC Health Serv Res* 2013;13:230.
- 24 Marien S, Krug B, Spinewine A. Electronic tools to support medication reconciliation: a systematic review. *J Am Med Inform Assoc* 2017;24:227–40.
- 25 Samarth A, Grant E. *Using health information technology to perform medication reconciliation: findings from the AHRQ health it Portfolio*. Rockville. 5. MD: AHRQ National Resource Center for Health Information Technology, 2010.
- 26 Boockvar KS, Santos SL, Kushniruk A, et al. Medication reconciliation: barriers and facilitators from the perspectives of resident physicians and pharmacists. *J Hosp Med* 2011;6:329–37.
- 27 Poon EG, Blumenfeld B, Hamann C, et al. Design and implementation of an application and associated services to support interdisciplinary medication reconciliation efforts at an integrated healthcare delivery network. *J Am Med Inform Assoc* 2006;13:581–92.
- 28 Monkman H, Borycki EM, Kushniruk AW, et al. Exploring the contextual and human factors of electronic medication reconciliation research: a scoping review. *Stud Health Technol Inform* 2013;194:166.
- 29 Holahan PJ, Lesselroth BJ, Adams K, et al. Beyond technology acceptance to effective technology use: a parsimonious and actionable model. *J Am Med Inform Assoc* 2015;22:718–29.
- 30 Slattery EL, Voelker CCJ, Nussenbaum B, et al. A practical guide to surveys and questionnaires. *Otolaryngol Head Neck Surg* 2011;144:831–7.
- 31 Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly* 1989;13:319–40.
- 32 Holden RJ, Karsh B-T. The technology acceptance model: its past and its future in health care. *J Biomed Inform* 2010;43:159–72.
- 33 Fowler Jr FJ. *Survey research methods*. Sage publications 2013.
- 34 Harris PA, Taylor R, Minor BL, et al. The REDCap Consortium: building an international community of software platform partners. *J Biomed Inform* 2019;95:103208.
- 35 Harris PA, Taylor R, Thielke R, et al. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform* 2009;42:377–81.
- 36 *Stata Statistical Software* [computer program].. College Station, Texas: StataCorp LLC, 2019.
- 37 Turchin A, Gandhi TK, Coley CM, et al. The use of electronic medication reconciliation to establish the predictors of validity of computerized medication records. *Stud Health Technol Inform* 2007;129:1022–6.
- 38 Wanbon R, Lyder C, Villeneuve E, et al. Medication reconciliation practices in Canadian emergency departments: a national survey. *Can J Hosp Pharm* 2015;68:202.
- 39 Al-Hashar A, Al-Zakwani I, Eriksson T, et al. Whose responsibility is medication reconciliation: physicians, pharmacists or nurses? A survey in an academic tertiary care hospital. *Saudi Pharm J* 2017;25:52–8.
- 40 Lee KP, Hartridge C, Corbett K, et al. "Whose job is it, really?" Physicians', nurses', and pharmacists' perspectives on completing inpatient medication reconciliation. *J Hosp Med* 2015;10:184–6.
- 41 Vogelsmeier A, Pepper GA, Oderda L, et al. Medication reconciliation: a qualitative analysis of clinicians' perceptions. *Res Social Adm Pharm* 2013;9:419–30.
- 42 Leape LL. The checklist conundrum. *N Engl J Med* 2014;370:1063–4.
- 43 Plaisant C, Wu J, Hettinger AZ, et al. Novel user interface design for medication reconciliation: an evaluation of Twinlist. *J Am Med Inform Assoc* 2015;22:340–9.
- 44 Russ AL, Jahn MA, Patel H, et al. Usability evaluation of a medication reconciliation tool: embedding safety probes to assess users' detection of medication discrepancies. *J Biomed Inform* 2018;82:178–86.
- 45 Boockvar KS, Ho W, Pruskowski J, et al. Effect of health information exchange on recognition of medication discrepancies is interrupted when data charges are introduced: results of a cluster-randomized controlled trial. *J Am Med Inform Assoc* 2017;24:1095–101.
- 46 Schnipper JL, Hamann C, Ndumele CD, et al. Effect of an electronic medication reconciliation application and process redesign on potential adverse drug events: a cluster-randomized trial. *Arch Intern Med* 2009;169:771–80.
- 47 Lovins J, Beavers R, Lineberger R. Improving quality, efficiency, and patient/provider satisfaction with electronic medication reconciliation and discharge instructions. *Journal of Hospital Medicine* 2011;6:s121.
- 48 Sherer AP, Cooper JB. 5. electronic medication reconciliation: a new prescription for the medications matching headache. *Heart Lung* 2011;40:372–3.
- 49 Mixon AS, Kripalani S, Stein J, et al. An on-treatment analysis of the Marquis study: interventions to improve inpatient medication reconciliation. *J Hosp Med* 2019;14:614–7.
- 50 Lesselroth BJ, Felder RS, Adams SM, et al. Design and implementation of a medication reconciliation kiosk: the automated patient history intake device (aphid). *J Am Med Inform Assoc* 2009;16:300–4.
- 51 Schnipper JL, Gandhi TK, Wald JS, et al. Effects of an online personal health record on medication accuracy and safety: a cluster-randomized trial. *J Am Med Inform Assoc* 2012;19:728–34.