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Mapping the Way to Improved Hospital Smoking Cessation Treatment: A Systems Approach with Mixed Methods

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ABSTRACT

Objectives: To generate system insights on patient and provider levers and strategies that must be activated to improve hospital-based smoking cessation treatment.

Design: Mixed methods study including a series of in-depth group model building sessions, which informed the design of an online survey completed by healthcare providers and a structured interview protocol administered at the bedside to patients who smoke.

Setting: Large, tertiary care hospital in the Midwestern United States.

Participants: *Group model building*: 28 healthcare providers and 22 previously-hospitalized patients; *Online survey*: 308 healthcare providers; *Bedside interviews*: 205 hospitalized patients.

Primary and Secondary Outcome Measures: Hypothesis-generating, participatory qualitative methods informed the examination of the following quantitative outcomes: patient interest versus provider perception of patient interest in smoking cessation and treatment; patient-reported receipt versus provider-reported offering of inpatient smoking cessation interventions; and priority ratings of importance and feasibility of strategies to improve treatment.

Results: *System insights* included patients frequently leaving the floor to smoke, which created major workflow disruption. *Leverage points* included interventions to reduce withdrawal symptoms, and *action ideas* included nurse-driven protocols for timely administration of nicotine replacement therapy. Quantitative data corroborated system insights; for instance, 80% of providers reported that patients frequently leave the floor to smoke, leading to safety risks, missed assessments, and inefficient use of staff time. Patients reported significantly lower rates of receiving any smoking cessation interventions, as compared to provider reports (mean diff=17.4%-33.7%, p<.001). Although 92% of providers cited patient interest as a key barrier, only 4% of patients indicated no interest in quitting or reducing smoking.

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Conclusions: Engaging hospital providers and patients in participatory approaches to develop an implementation strategy revealed discrepant perceptions of patient interest and frequency of hospital-based treatment for smoking. These findings spurred adoption of standardized point-of-care treatment for cigarette smoking, which remains highly prevalent yet undertreated among hospitalized patients.

STRENGTHS AND LIMITATIONS

- Using a systems science lens, this study integrated multiple data sources to inform more systematic provision of smoking cessation treatment practices in hospital settings.
- This study featured a rigorous mixed methods approach whereby hypothesis-generating qualitative data informed the design of quantitative instruments and guided interpretation of resulting quantitative data.
- The use of participatory approaches to engage healthcare provider and patient stakeholders identified provider and patient levers to be activated in a robust implementation strategy.
- Despite having many similarities to other healthcare systems in the nation, study findings are based in one large tertiary care hospital system in the Midwestern United States.

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INTRODUCTION

Cigarette smoking remains the leading cause of preventable death worldwide.[1–4] National efforts directed at reducing tobacco use have contributed to a decline in the proportion of combustible cigarette smokers.[5,6] However, smoking prevalence remains high among those entering hospital settings, presenting an opportune time to promote cessation.[7–9]

Despite the existence of effective, FDA-approved medications for smoking cessation—including nicotine replacement therapy, varenicline, and bupropion[10–12]—which can be combined with brief counseling for optimal success,[13] these treatments remain underutilized in inpatient settings.[14–16] In our hospital, only 18-24% of patients who smoke received smoking cessation pharmacotherapy during hospitalization from 2010 to 2016.[9] Further, these medications were often prescribed inconsistently between admitting services and sub-demographic groups in our hospital. For instance, African Americans were 35% less likely than European Americans to receive smoking cessation pharmacotherapies during their hospital stay, which highlights concerning inequalities in hospital prescribing practices.[9]

These treatment gaps and disparities emerge as a result of a complex, dynamic system of care. To develop actionable strategies, we explored the underlying system structure producing these gaps and incorporated multiple stakeholder perspectives and data sources.[17–20] Engaging with a set of patient and healthcare provider stakeholders, we identified optimal leverage points to yield consistent delivery of inpatient smoking cessation care.

Study purpose

The goal of the study was to understand determinants of treatment underutilization for inpatients who smoke and inform the development of stakeholder-supported strategies for improving smoking cessation treatment delivery in the inpatient setting. Building on our robust,

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validated electronic health record data demonstrating suboptimal smoking cessation pharmacotherapy prescription practices,[9] this study integrated multiple data sources to inform more systematic provision of smoking cessation treatment practices in hospital settings.

METHODS

This mixed methods study integrated qualitative and quantitative data sources including in-depth group model building sessions with healthcare providers and patients,[20,21] followed by an online survey with healthcare providers and bedside interviews with patients.

Phase I: Group model building (qualitative work)

Participants and procedures

Participants were recruited from Barnes-Jewish Hospital (BJH), a large tertiary care hospital. We engaged two participant populations: (1) BJH employees including physicians, nurses, and support staff with patient contact and (2) patients who had recently received care at BJH and who self-identified as current smokers at the time of their most recent hospital admission. To recruit providers, we requested program directors and nursing supervisors of a diverse set of service lines to distribute recruitment materials to employees who may be eligible to participate. To recruit patients who had been previously hospitalized at BJH, we distributed a recruitment email through a research participant registry to potentially eligible individuals who smoke, posted a Facebook advertisement on the registry fan page listing, and hung printed flyers in the hospital. Those interested in participating were screened using a standardized telephone script.

We engaged 50 stakeholders in five group model building sessions comprised of patients (2 sessions, n=22), nurses, social workers, and case managers (1 session, n=14), nurse practitioners, hospitalists, and pharmacists (1 session, n=6), and resident physicians (1 session,

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n=8). We then reconvened a select group of participants from the initial sessions with representation across all provider groups to synthesize perspectives and refine the stakeholder-generated model (1 session, n=16). Patients and providers stemmed from a wide variety of hospital service lines, including cardiology, general surgery, internal medicine, obstetrics, oncology, and psychiatry. Sessions were conducted between late October 2017 and early February 2018.

Planning, conduct, and analysis of the series of sessions was led by a Core Modeling Team, including the principal investigator, BJH nursing partner, and two experts in group model building and community-based system dynamics. Each group model building session utilized a Facilitation Team, which included the *conveners/closers* (principal investigator and nursing partner), *primary modeler* (lead expert in group model building), *facilitators* (~2 support experts in group model building), and *note takers* (~2 additional team members). The group model building team used scripts,[22] or a pre-defined set of exercises and behaviors, to provide a semi-structured environment for stakeholder groups to model a typical sequence of clinical decision points with regard to ordering and administering smoking cessation pharmacotherapy and offering counseling in the hospital. Participants were asked to identify factors that determine the likelihood of offering smoking cessation pharmacotherapy and counseling, the likelihood of patients accepting pharmacotherapy and counseling, sources of decision-making, and workflow barriers. Participants were then asked to prioritize the identified factors and position them as intervening variables within the modeled sequence of events.

Mixed methods analytic approach

We used an exploratory sequential design in which qualitative data from the group model building sessions informed the design of the quantitative online survey and patient bedside

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interviews.[23] The qualitative data were hypothesis-generating to further guide the development of the quantitative measures and interpretation of the resulting quantitative data.

Phase II: Online survey (quantitative and qualitative)

Participants and procedures

We recruited healthcare providers to complete an anonymous 10 minute online survey by emailing a cover letter and survey link to administrative contact persons, program directors, and nursing staff who then distributed the email through their networks. Participants of the online survey included 308 providers (112 physicians, 196 nurses) from BJH with direct inpatient contact. Participants were located across a wide range of service lines, with internal medicine (46%) and general surgery (22%) being the most highly represented. Of physicians, 79% were resident physicians, and 21% were hospitalists. Of nurses, 47% were staff nurses, 30% nurse practitioners, and 23% other types of nurses. Nurses and physicians were asked about their current smoking cessation treatment practices—namely the use of the "5A's": *Ask* about tobacco use, *Advise* to quit smoking, *Assess* readiness for quit attempt, *Assist* with medication and counseling options, and *Arrange* follow-up contact or referral,[24–26] barriers to using these practices, perceived patient interest in various smoking cessation resources during an inpatient stay, perceived importance and feasibility of various potential strategies to improve practices, and the frequency of workflow and safety issues related to hospitalized patient smoking. The online survey remained open from late February 2018 to late March 2018.

Phase III: Bedside interviews (quantitative)

Participants and procedures

We recruited hospitalized patients to complete a structured 5-minute interview at the bedside. We obtained reports daily during the month of May 2018 from the hospital electronic

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health record to identify potentially eligible patients and conducted all interviews during this time period. Participants of the bedside interviews included 205 inpatients who were categorized by electronic health record as current smokers and nearing hospital discharge. Reflecting the underlying population of patients who were current smokers during this time frame, participants were more often male (56%) and Caucasian (59%), with a median age of 54 (*M*=50.25; *SD*=15.22). On average, participants smoked 14.0 cigarettes per day and had stayed in the hospital for 4.5 days within a variety of admitting services, including internal medicine (38%), surgery (23%), oncology (13%), cardiology (12%), neurology (7%), and orthopedics (5%). Patients were asked about their smoking behaviors, the smoking cessation care they had received during their current inpatient stay, interest in and experience with attempting to quit smoking, and the importance of various potential strategies to improve practices.

Patient and public involvement

During participant recruitment, patients were able to identify other potentially eligible individuals who smoke to be screened for enrollment. Through the participatory group model building sessions, patients generated key system insights that informed the research questions and outcome measures to be assessed in the subsequent online survey for healthcare providers and bedside interview protocol for patients. For instance, patients expressed significant frustration regarding being asked repeatedly about their smoking behaviors without being offered any help to quit smoking during their hospital stay. As a result, the research team prioritized questions in the quantitative instruments to assess the frequency of patient- and provider-reported delivery of smoking cessation interventions, as well as patient and provider reports of patient interest in receiving smoking cessation treatment while hospitalized. This research reflects a key step in developing a system-level intervention; therefore, patient input is contributory to ongoing

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research and practice improvements. We plan to disseminate results of this study to patients and other participants by presenting findings at local symposia and conferences that are well attended by patients, patient advocates, healthcare providers, and the broader community. We will also present these findings during healthcare provider training workshops, whereby patients benefit through improved quality of smoking cessation care in the hospital.

RESULTS

Phase I: Group model building

System insights

Based on factors prioritized by participants during group model building, the research team generated a multilevel (i.e., individual, hospital, community, policy) understanding, referred to as system insights, that characterized the observed treatment underutilization. These insights included *provider* reports of patients frequently leaving the floor to smoke, which created major workflow problems and enhanced provider receptivity to solutions framed to address "nicotine withdrawal" rather than "cessation". *Providers* also reported a lack of awareness of resources, and enthusiasm balanced with concerns about time, while *patients* reported infrequent receipt of smoking cessation support and preferences for non-judgmental communication (see Table 1).

Potential leverage points

With these system insights providing the appropriate frame, the modeling group then identified potential leverage points to target for action. Potential leverage points to address provider-reported insights included interventions framed as solutions to reduce nicotine withdrawal and subsequent workflow problems, education and decision support, and a standardized approach to smoking cessation treatment. Potential leverage points to address

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patient-reported insights included transparency of patient interest and use of treatment and patient-provider rapport through more supportive cessation messaging (see Table 1).

Action ideas

Finally, stakeholders used these potential leverage points as the frame for nominating potential concrete solutions and then prioritizing them on perceived importance and feasibility in the hospital setting. Action ideas to address provider-reported insights and leverage points included implementing nurse-driven protocols for timely administration of inpatient nicotine replacement therapy, using an assortment of provider training approaches, designing electronic health records to support point-of-care decisions, and offering point-of-care advice, medication, and links to outpatient counseling. Action ideas to address patient-reported insights and leverage points included generating provider feedback, developing cessation plans for discharge, offering help to every patient who smokes, and revamping hospital signage for more positive messaging (see Table 1). These system insights, potential leverage points, and action ideas were then examined more closely in the subsequent online survey with providers and bedside interviews with patients.

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Table 1. Linking stakeholder-generated system insights with potential leverage points and action ideas

Viewpoint	System Insights	Potential Leverage Points	Action Ideas	Representative Quote
Provider	Patients frequently leave the floor to smoke, which creates major workflow problems; as a result, providers are more compelled by "reducing nicotine withdrawal" rather than "cessation" efforts	Interventions to reduce nicotine withdrawal symptoms and framing solutions around nicotine replacement and workflow to foster provider engagement	Use nurse-driven protocols to ensure that readily accessible nicotine replacement therapy can be provided to inpatients with little delay	"*People go down to smoke and they miss meds and even appointments which is so frustrating.*" – [Staff nurse]
Provider	Providers lack awareness of existing cessation resources to connect patients at discharge, which negatively impacts their willingness to provide inpatient smoking cessation care	Education and decision support	Use continuing medical education, roving in-services, quick reference tools, and brief videos to train providers on how to implement existing and effective treatments Design electronic health record modules to support point-of-care treatment decision	"*I would like to know more about free or low-cost smoking cessation treatment centers to which I can refer my patients…if there was some way they could get [medications] at low cost along with smoking cessation therapy, I think that would be beneficial.*" – [Resident physician]
Provider	Enthusiasm to improve inpatient smoking cessation is balanced by concern about demands and limited time	Standardized and coordinated approach to smoking cessation treatment	Provide point-of-care brief advice, opt-out medication, and discharge links to community resources, including quit-line counseling, to every patient who smokes	"*Most of us would love to help them quit smoking, but it is time consuming…thereby making it feel very much like extra work and easily dropped when busy.*" – [Resident physician]
Patient	Patients are often asked about their smoking but very rarely assisted with cessation	Transparency regarding patient interest in and use of treatment	Give providers feedback on individual and aggregate rates of offering smoking cessation treatment, as well as patient interest and engagement with cessation support Develop cessation plan for discharge	"*I'm so tired of being asked if I'm a smoker without being offered help to quit. It seems like they are only asking so that they can check a box and move on."* – [Patient]
Patient	Patients are more compelled by positive and non-judgmental communication	Patient-provider rapport through more supportive cessation messaging	Ask every patient who smokes if they would like help to quit smoking Revamp hospital signage to incorporate positive messaging on smoking cessation	"*The more respect staff gives, the more honest the conversation is, and the more likely I will be to accept treatment.*" – [Patient]

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Phase II: Healthcare provider online survey

Qualitative data

Open-ended responses from the provider sample were useful in expanding further upon the group model building data. Key representative quotes are included in Table 1 to reinforce themes from the group model building sessions.

Quantitative data

Rates of smoking cessation practice varied substantially across the 5A's, with the majority of providers indicating regular completion of *Ask* (88%), *Advise* (79%), *Assess* (62%), and *Assist* (63%), with lower rates for *Arrange* (24%). Additionally, 64% of providers reported that they often-to-always encourage use of medication (e.g., nicotine replacement therapy, varenicline) with patients for smoking cessation.

The most commonly cited barriers to providing treatment were patient lack of interest (92%) and compliance (92%), followed by lack of awareness of existing community resources for patient referral (72%) and lack of time (71%).

Approximately 80% of providers reported that patients often or very often leave the floor to smoke and that this frequently leads to patients posing a safety risk (75% reported often or very often), assessments being missed (51% reported often or very often), and staff time used to escort patients off the floor (42% reported often or very often).

The strategies rated as most important for improving smoking cessation treatment at the hospital were also the ones rated as most feasible. These top strategies included asking every patient who smokes if they want help (86% endorsed as very or extremely important; 77% endorsed as very or extremely feasible), offering brief advice to every patient who smokes (65% endorsed as very or extremely important; 56% endorsed as very or extremely feasible), and

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offering medication to every patient who smokes (62% endorsed as very or extremely important; 52% endorsed as very or extremely feasible).

Phase III: Patient bedside interviews

Table 2 highlights high levels of patient smoking cessation interest and attempts. In particular, nearly three-fourths (73%) were interested in quitting now, and nearly all (96%) were interested in quitting or smoking less. Most patients (59%) had tried quitting in the past year. Nearly two-thirds (65%) had ever used e-cigarettes, and 12% currently used them.

Table 2. High patient demand to quit smoking

Variables	**Patients No. (%)**
Interested in quitting now	146/200 (73)
Interested in quitting now or later	188/202 (93)
Interested in quitting now or later or smoking less	193/202 (96)
Past year quit attempt	118/201 (59)
Ever used e-cigarettes	131/202 (65)
Currently used e-cigarettes	25/202 (12)

Patient-reported receipt of 5A's smoking cessation practices were examined in relation to provider reports using summary independent-sample t-test analyses (see Figure 1). Although patients reported rates similar to providers on *Ask* (mean diff= -1.4%; p=0.653), they reported much lower rates of receiving *Advise* (mean diff= -27.5%; p<.001), *Assess* (mean diff= -33.7%; p<.001), *Assist* (mean diff= -19.2%; p<.001), and *Arrange* (mean diff= -17.4%; p<.001) steps, as well as being provided with medication to quit smoking during their inpatient stay (mean diff= -35.0%; p<.001; see Figure 2). Additionally, in contrast to 92% of providers citing patient interest as a key barrier to smoking cessation treatment, only 4% of patients indicated no interest in

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quitting at some point or smoking less, and only 27% of patients indicated no interest in quitting now.

Nearly one-third (31%) of patients reported that they had left the floor to go smoke during their hospital stay, and nearly two-thirds of those who left did so multiple times per day. Overall, receipt of inpatient smoking cessation medication was not significantly associated with leaving the floor to smoke (p=.331). However, among patients who left, those who did not receive smoking cessation medications were more likely to report leaving multiple times per day than those who received medications, controlling for cigarettes per day and length of stay (OR=3.3, p=.036).

Patients were well-aligned with providers regarding perceived importance of potential strategies to improve smoking cessation treatment in the hospital (see Figure 3). The most highly rated strategies were to ask every patient who smokes if they want help (76% endorsed as very or extremely important), offer medication to every patient who smokes (67%), and offer brief advice to every patient who smokes (58%).

DISCUSSION

Healthcare providers reported that patient smoking during a hospitalization created significant workflow issues for hospital staff. Despite low current rates of smoking cessation pharmacotherapy prescribing, we found high patient demand to quit smoking. Provider-reported barriers centered on a perceived lack of patient interest, time, and awareness of existing resources; these barriers reflect aspects of motivation, opportunity, and capability, which have been identified as key determinants of behavioral change and fruitful targets for intervention.[27,28] Importantly, providers were much more receptive to and compelled by approaches to prevent the chain of events involving nicotine withdrawal, patients leaving the

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floor to smoke, and workflow problems than approaches framed as promoting smoking cessation among hospitalized patients. This finding has significant implications for approaches to engaging hospital providers in the treatment of inpatients who smoke.

Interestingly, based on patient reports, receipt of nicotine replacement therapy was not associated with whether or not patients left the floor to smoke at least once; however, patients receiving nicotine replacement therapy were more likely to have only left the floor to smoke once. Therefore, it is possible that patients may have been receiving nicotine replacement therapy *in response to* leaving the floor to smoke (e.g., missing patient prompts the provider to offer treatment for nicotine withdrawal), thereby reducing the likelihood that patients subsequently left due to nicotine withdrawal during their hospital stay. This hypothesis would require further testing, including an establishment of temporal precedence, to demonstrate risk of patient smoking before and after receiving nicotine replacement therapy in the hospital setting.

Regarding points of (mis)alignment between patient and provider perceptions, both groups reported high rates of asking patients whether or not they smoke. However, patients reported much lower rates of receiving any smoking cessation support and much higher levels of interest in cessation, as compared to provider reports. This finding replicates recent research in mental health settings,[24] and was corroborated by qualitative data, which characterized the patient perception that providers frequently ask about smoking behaviors yet no actions result from these inquiries. Improved alignment of perceptions could benefit patient-provider rapport and increase acceptance of smoking cessation treatments when offered—opportunities which were all raised by patients during group model building discussions.

Finally, patients and providers agreed that the most important strategies were to ask every patient who smokes if they want help and offer medication and brief advice to every patient who

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smokes. Providers also found these to be the most feasible potential strategies, despite the patient reports that these were not frequently occurring. While seen as feasible, providers may perceive the need for a hospital-wide program that expects, supports, and reinforces the practice of offering treatment to every patient who smokes. As noted in a recent systematic review,[28] standardized implementation of this type of opt-out program that leverages lighter-touch point-of-care support may in fact ease provider burden and workflow. In addition, the alignment between patients and providers in ratings of importance and feasibility give additional credence to the viability of implementing these proposed strategies in hospital settings.

Limitations of this study include being based in one large tertiary care hospital system in the Midwestern United States. However, there are indications that this hospital system is largely representative of other systems in the nation. For instance, researchers recently found smoking cessation medication rates of 22.3% across 282 U.S. hospitals,[16] nearly identical to our rate of approximately 22% across years 2010-2016.

CONCLUSION

Our findings have led our hospital to adopt standardized, lighter-touch yet higher-reach approaches to smoking cessation treatment, supported by provider feedback and simplified decision support and enabled through the electronic health record system.[7,19,29,30] The potential leverage points we identified point to the following specific strategies:

1. *Create a standardized and coordinated approach to smoking cessation treatment*: Provide point-of-care brief advice, opt-out medication, and discharge links to community resources, including quit-line counseling, to every patient who smokes;
2. *Foster provider engagement by identifying and framing interventions as solutions to reduce nicotine withdrawal and subsequent workflow problems related to patients*

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leaving the floor to smoke: Use nurse-driven protocols to ensure that readily accessible nicotine replacement therapy can be provided to inpatients with little delay;

3. *Offer positive, supportive, and non-judgmental messaging to patients*: Revamp hospital signage to incorporate positive messaging on smoking cessation;
4. *Improve awareness, knowledge, self-efficacy, and attitudes*: Use continuing medical education, roving in-services, and quick reference tools to train providers on existing and effective treatments and how to implement them;
5. *Increase transparency regarding patient interest in and use of treatment*: Give providers feedback on ongoing performance and aggregate rates of patient-reported readiness to quit and engagement with quit-line counseling to foster awareness and accountability.

Engaging hospital stakeholders through a process of self-identification of approaches to addressable problems presents opportunities to fit high-leverage challenges with sustainable, contextually-appropriate solutions. Findings from this study inform engagement with healthcare provider and patient stakeholders in the development and implementation of proposed strategies to facilitate consistent delivery of smoking cessation treatment practices in the hospital setting.

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CONTRIBUTORS

ATR, L-SC, and LJB conceptualized and designed the study. ATR and DP led participant recruitment and data collection. EB led the group model building sessions and synthesis of qualitative data. ATR analyzed the qualitative and quantitative data and drafted the initial manuscript. ATR, DP, EB, L-SC, and LJB contributed to manuscript revisions and approved the final manuscript.

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COMPETING INTERESTS

LJB is listed as an inventor on Issued U.S. Patent 8,080,371, "Markers for Addiction" covering the use of certain SNPs in determining the diagnosis, prognosis, and treatment of addiction. The other authors have no financial disclosures.

ETHICS APPROVAL

This study was approved by an institutional review board in the Human Research Protection Office at Washington University in St. Louis (IRB ID: 201703162).

DATA SHARING

Additional data may be available by emailing aramsey@wustl.edu.

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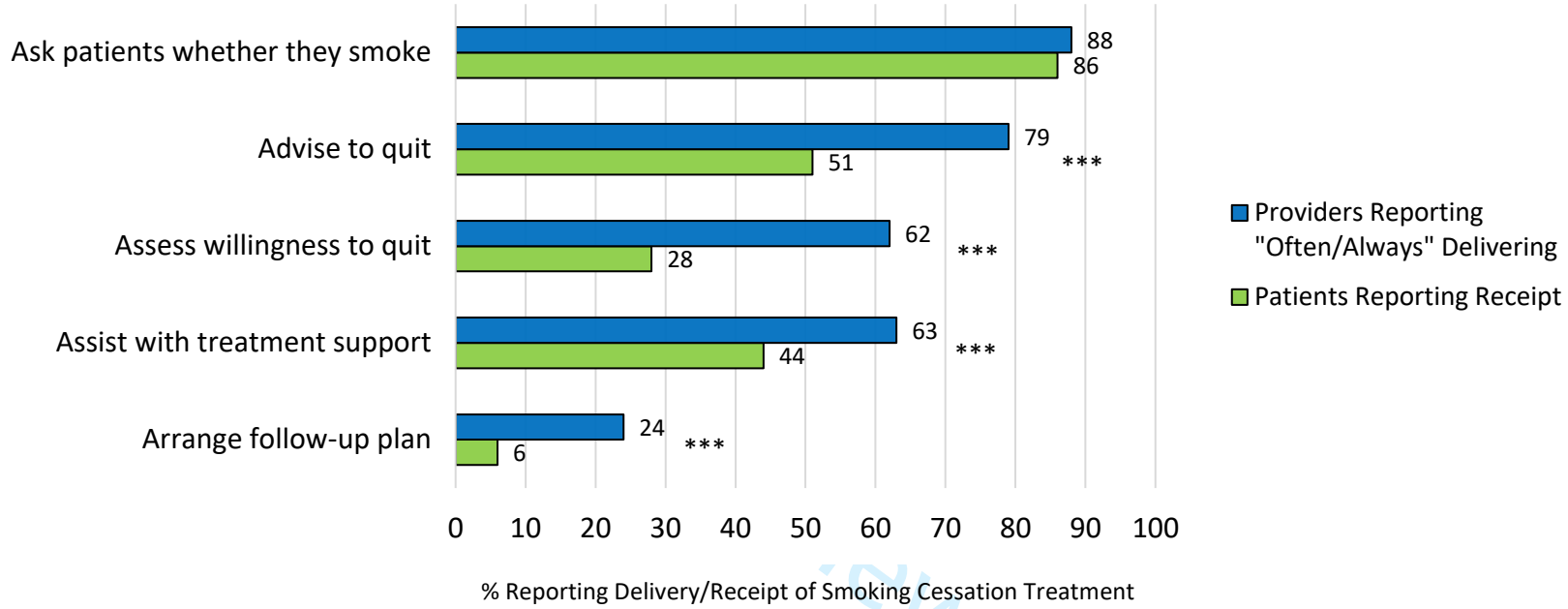
Figure 1. Providers and patients report discrepant rates of inpatient smoking cessation treatment



*** $p < .001$

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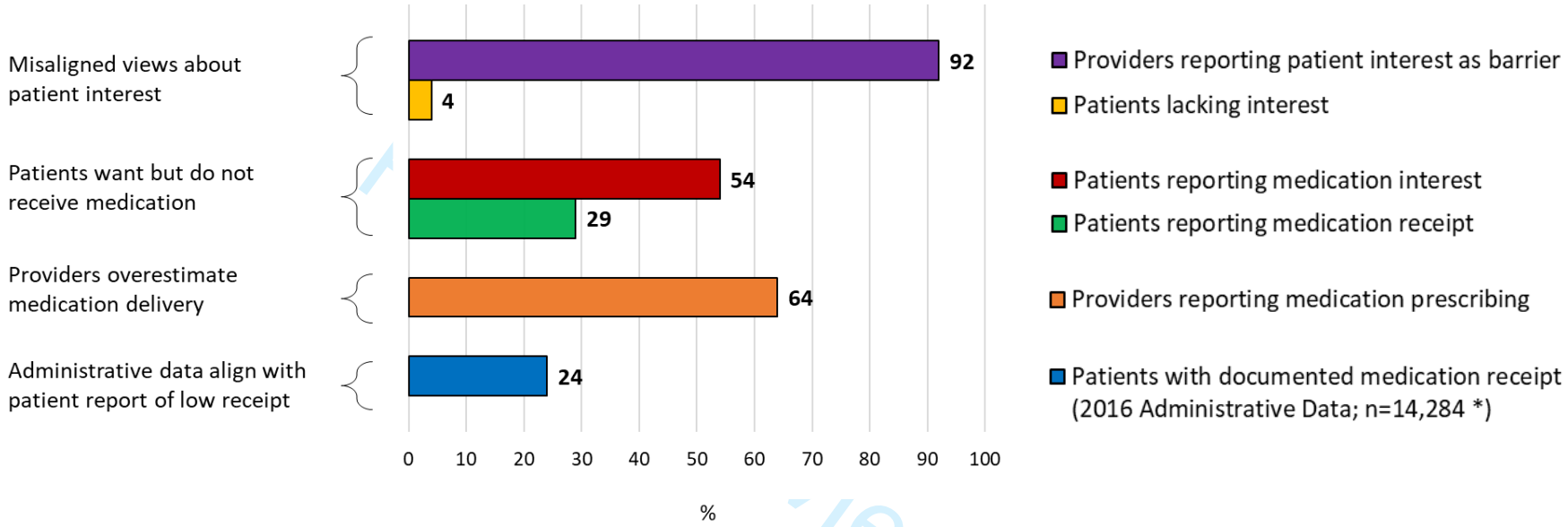
Figure 2. Despite high interest, fewer patients receive pharmacologic cessation treatment than indicated by providers



* Adapted from Srivastava et al., 2018 [9]

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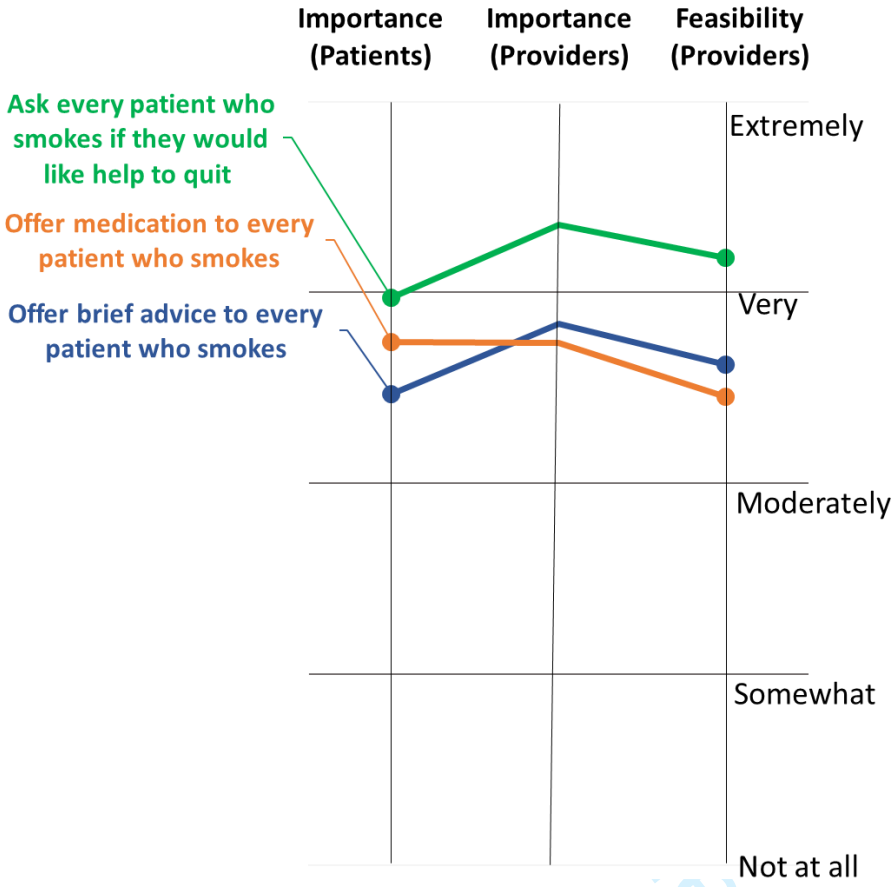
Figure 3. Potential strategies prioritized by importance and feasibility among stakeholders



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Standards for Reporting Qualitative Research (SRQR)

O'Brien B.C., Harris, I.B., Beckman, T.J., Reed, D.A., & Cook, D.A. (2014). Standards for reporting qualitative research: a synthesis of recommendations. *Academic Medicine, 89(9)*, 1245-1251.

No. Topic	Item	Status
Title and abstract		
S1 Title	Concise description of the nature and topic of the study identifying the study as qualitative or indicating the approach (e.g., ethnography, grounded theory) or data collection methods (e.g., interview, focus group) is recommended	Addressed
S2 Abstract	Summary of key elements of the study using the abstract format of the intended publication; typically includes objective, methods, results, and conclusions	Addressed
Introduction		
S3 Problem formulation	Description and significance of the problem/phenomenon studied; review of relevant theory and empirical work; problem statement	Addressed
S4 Purpose or research question	Purpose of the study and specific objectives or questions	Addressed
Methods		
S5 Qualitative approach and research paradigm	Qualitative approach (e.g., ethnography, grounded theory, case study, phenomenology, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g., positivist, constructivist/interpretivist) is also recommended	Addressed
S6 Researcher characteristics and reflexivity	Researchers' characteristics that may influence the research, including personal attributes, qualifications/experience, relationship with participants, assumptions, or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results, or transferability	Addressed
S7 Context	Setting/site and salient contextual factors; rationale	Addressed
S8 Sampling strategy	How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g., sampling saturation); rationale[a]	Addressed
S9 Ethical issues pertaining to human subjects	Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues	Addressed
S10 Data collection methods	Types of data collected; details of data collection procedures including (as appropriate) start and stop dates	Addressed

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	of data collection and analysis, iterative process, triangulation of sources/methods, and modification of procedures in response to evolving study findings; rationale[a]	
S11 Data collection instruments and technologies	Description of instruments (e.g., interview guides, questionnaires) and devices (e.g., audio recorders) used for data collection; if/how the instrument(s) changed over the course of the study	Addressed
S12 Units of study	Number and relevant characteristics of participants, documents, or events included in the study; level of participation (could be reported in results)	Addressed
S13 Data processing	Methods for processing data prior to and during analysis, including transcription, data entry, data management and security, verification of data integrity, data coding, and anonymization/deidentification of excerpts	Addressed
S14 Data analysis	Process by which inferences, themes, etc., were identified and developed, including researchers involved in data analysis; usually references a specific paradigm or approach; rationale[a]	Addressed
S15 Techniques to enhance trustworthiness	Techniques to enhance trustworthiness and credibility of data analysis (e.g., member checking, audit trail, triangulation); rationale[a]	Addressed
Results/Findings		
S16 Synthesis and interpretation	Main findings (e.g., interpretations, inferences, and themes); might include development of a theory or model, or integration with prior research or theory	Addressed
S17 Links to empirical data	Evidence (e.g., quotes, field notes, text excerpts, photographs) to substantiate analytic findings	Addressed
Discussion		
S18 Integration with prior work, implications, transferability, and contribution(s) to the field	Short summary of main findings; explanation of how findings and conclusions connect to, support, elaborate on, or challenge conclusions of earlier scholarship; discussion of scope of application/generalizability; identification of unique contribution(s) to scholarship in a discipline or field	Addressed
S19 Limitations	Trustworthiness and limitations of findings	Addressed
Other		
S20 Conflicts of interest	Potential sources of influence or perceived influence on study conduct and conclusions; how these were managed	Addressed
S21 Funding	Sources of funding and other support; role of funders in data collection, interpretation, and reporting	Addressed

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Leverage Points to Improve Smoking Cessation Treatment in a Large Tertiary Care Hospital: A Systems-Based Mixed Methods Study

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Leverage Points to Improve Smoking Cessation Treatment in a Large Tertiary Care Hospital: A Systems-Based Mixed Methods Study

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ABSTRACT

Objectives: To generate system insights on patient and provider levers and strategies that must be activated to improve hospital-based smoking cessation treatment.

Design: Mixed methods study including a series of in-depth group model building sessions, which informed the design of an online survey completed by healthcare providers and a structured interview protocol administered at the bedside to patients who smoke.

Setting: Large, tertiary care hospital in the Midwestern United States.

Participants: *Group model building*: 28 healthcare providers and 22 previously-hospitalized patients; *Online survey*: 308 healthcare providers; *Bedside interviews*: 205 hospitalized patients.

Primary and Secondary Outcome Measures: Hypothesis-generating, participatory qualitative methods informed the examination of the following quantitative outcomes: patient interest versus provider perception of patient interest in smoking cessation and treatment; patient-reported receipt versus provider-reported offering of inpatient smoking cessation interventions; and priority ratings of importance and feasibility of strategies to improve treatment.

Results: *System insights* included patients frequently leaving the floor to smoke, which created major workflow disruption. *Leverage points* included interventions to reduce withdrawal symptoms, and *action ideas* included nurse-driven protocols for timely administration of nicotine replacement therapy. Quantitative data corroborated system insights; for instance, 80% of providers reported that patients frequently leave the floor to smoke, leading to safety risks, missed assessments, and inefficient use of staff time. Patients reported significantly lower rates of receiving any smoking cessation interventions, as compared to provider reports (mean diff=17.4%-33.7%, p<.001). Although 92% of providers cited patient interest as a key barrier, only 4% of patients indicated no interest in quitting or reducing smoking.

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Conclusions: Engaging hospital providers and patients in participatory approaches to develop an implementation strategy revealed discrepant perceptions of patient interest and frequency of hospital-based treatment for smoking. These findings spurred adoption of standardized point-of-care treatment for cigarette smoking, which remains highly prevalent yet undertreated among hospitalized patients.

STRENGTHS AND LIMITATIONS

- Using a systems science lens, this study integrated multiple data sources to inform more systematic provision of smoking cessation treatment practices in hospital settings.
- This study featured a rigorous mixed methods approach whereby hypothesis-generating qualitative data informed the design of quantitative instruments and guided interpretation of resulting quantitative data.
- The use of participatory approaches to engage healthcare provider and patient stakeholders identified provider and patient levers to be activated in a robust implementation strategy.
- Despite having many similarities to other healthcare systems in the nation, study findings are based in one large tertiary care hospital system in the Midwestern United States.

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INTRODUCTION

Cigarette smoking remains the leading cause of preventable death worldwide.(1–4) National efforts directed at reducing tobacco use have contributed to a decline in the proportion of combustible cigarette smokers.(5,6) However, smoking prevalence among those entering hospital settings remains much higher than in the general population, as those with chronic conditions have higher prevalence of smoking.(7,8) Hospital settings therefore present an opportune time to promote cessation.(9,10)

Despite the existence of effective, FDA-approved medications for smoking cessation—including nicotine replacement therapy, varenicline, and bupropion(11–13)—which can be combined with brief counseling for optimal success,(14) these treatments remain underutilized in inpatient settings.(15–17) In our hospital, only 18-24% of patients who smoke received smoking cessation pharmacotherapy during hospitalization from 2010 to 2016.(8) Further, these medications were often prescribed inconsistently between admitting services and sub-demographic groups in our hospital. For instance, African Americans were 35% less likely than European Americans to receive smoking cessation pharmacotherapies during their hospital stay, which highlights concerning inequalities in hospital prescribing practices.(8) Similar patterns were found in a study of smoking cessation pharmacotherapy rates among smokers hospitalized for an acute cardiac condition across 282 U.S. hospitals; the median treatment rate was 22.3% and even lower among minority racial/ethnic groups.(17) Treatment rates across these hospitals were also highly variable, suggesting that hospitals may be using, with varying levels of success, different strategies to implement inpatient smoking cessation treatment programs.

These treatment gaps and disparities indicate suboptimal care, as inpatient smoking cessation pharmacotherapy in combination with post-discharge treatment has been shown in

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meta-analyses to improve quit rates and is now considered the standard of care by Joint Commission.(10,15) Nevertheless, these treatment gaps and disparities signal that the implementation of smoking cessation treatment approaches remains a formidable challenge in hospital settings. Currently, it is not clear which patient and provider levers and strategies must be activated to improve smoking cessation treatment in hospital settings. Additionally, there is inadequate guidance on the best system-level implementation strategies to use to improve treatment delivery for hospitalized patients who smoke. The healthcare system requires pragmatic evidence to increase the likelihood that other hospitals use strategies that were robustly supported by rigorous yet relevant data and decrease the likelihood that hospitals use strategies without robust support. However, obtaining pragmatic, rigorous, and relevant data may require novel uses of methods including more participatory, stakeholder-engaged approaches that integrate diverse types of data to gain a better understanding of the system-level gaps in care, high-leverage target areas to focus change efforts, and specific strategies that can improve the treatment of patients who smoke. This study uses a systems science lens that integrates multiple data sources to inform more systematic provision of smoking cessation treatment practices in hospital settings, thereby using a novel approach to address a thorny problem that has challenged healthcare systems for decades.

Study purpose

The goal of the study was to understand determinants of the treatment gap in hospitalized patients who smoke and inform the development of stakeholder-supported strategies for improving smoking cessation treatment delivery in the inpatient setting. Building on our robust, validated electronic health record data demonstrating suboptimal smoking cessation pharmacotherapy prescription practices,(8) this study integrated multiple data sources to inform

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more systematic provision of smoking cessation treatment practices in hospital settings. To our knowledge, this is the only study to engage with hospital patients and providers in a participatory process to identify the underlying system structure producing the treatment gap, collateral effects of this gap (e.g., impacts on provider workflow), optimal leverage points, and actionable strategies to yield consistent delivery of smoking cessation care in hospital settings.(18–21)

METHODS

This mixed methods study integrated qualitative and quantitative data sources including in-depth group model building sessions with healthcare providers and patients,(21,22) followed by an online survey with healthcare providers and bedside interviews with patients.

Phase I: Group model building with healthcare providers and patients (qualitative work)

Participants and procedures

Participants were recruited from Barnes-Jewish Hospital (BJH), a large tertiary care hospital. We engaged two participant populations: (1) BJH employees including physicians, nurses, and support staff with patient contact and (2) patients who had recently received care at BJH and who self-identified as current smokers at the time of their most recent hospital admission. To recruit healthcare providers, we requested program directors and nursing supervisors of a diverse set of service lines—including general surgery, internal medicine, neurology, oncology, orthopedics, otolaryngology, and psychiatry—to distribute recruitment materials to employees who may be eligible to participate. We excluded participants from the intensive care unit, emergency room, and operating room due to lower relevance of the topic in these acute care settings. We also prioritized our active recruitment efforts within service lines likely to find the topic most relevant for their service delivery; therefore, some hospital services (e.g., plastic surgery, urology) fell outside the scope of our recruitment efforts. To recruit

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patients who had been previously hospitalized at BJH, we distributed a recruitment email through a research participant registry to potentially eligible individuals who smoke, posted a Facebook advertisement on the registry fan page listing, and hung printed flyers in the hospital. Those interested in participating were screened using a standardized telephone script.

We engaged 50 stakeholders in five group model building sessions comprised of patients (2 sessions, n=22), nurses, social workers, and case managers (1 session, n=14), nurse practitioners, hospitalists, and pharmacists (1 session, n=6), and resident physicians (1 session, n=8). Using a standard process for synthesizing the models,(22–24) we then invited all participants in the initial sessions to reconvene for a model review that functioned to present a preliminary synthesis model for critique and refinement of the stakeholder-generated model (1 session, n=16). Patients and providers stemmed from a wide variety of hospital service lines, including cardiology, general surgery, internal medicine, neurology, obstetrics, oncology, orthopedics, otolaryngology, and psychiatry. We received participation from each service line from which we recruited. Sessions were conducted between late October 2017 and early February 2018.

Planning, conduct, and analysis of the series of sessions was led by a Core Modeling Team, including the principal investigator, BJH nursing partner, and two experts in group model building and community-based system dynamics. Each group model building session utilized a Facilitation Team, which included the *conveners/closers* (principal investigator and nursing partner), *primary modeler* (lead expert in group model building), *facilitators* (~2 support experts in group model building), and *note takers* (~2 additional team members). The group model building team used scripts,(23) or a pre-defined set of exercises and behaviors, to provide a semi-structured environment for (1) patient stakeholder groups to model a typical sequence of clinical

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encounters that may or may not result in patients being offered smoking cessation treatment and (2) healthcare provider stakeholder groups to model a typical sequence of clinical decision points with regard to ordering and administering smoking cessation treatment and offering counseling in the hospital. Patient participants were then asked to identify factors that determine the likelihood of being offered and receiving smoking cessation treatment. Similarly, healthcare provider participants were asked to identify factors that determine the likelihood of offering smoking cessation pharmacotherapy and counseling, the likelihood of patients accepting pharmacotherapy and counseling, sources of decision-making, and workflow barriers. All participants were then asked to prioritize the identified factors and position them as intervening variables within the modeled sequence of events.

Mixed methods analytic approach

We used an exploratory sequential design in which qualitative data from the group model building sessions informed the design of the quantitative online survey and patient bedside interviews.(25) The qualitative data were hypothesis-generating to further guide the development of the quantitative measures and interpretation of the resulting quantitative data.

Phase II: Online survey with healthcare providers (quantitative and qualitative)

Participants and procedures

We recruited healthcare providers to complete an anonymous 10 minute online survey by emailing a cover letter and survey link to administrative contact persons, program directors, and nursing staff who then distributed the email through their networks. Participants of the online survey included 308 providers (112 physicians, 196 nurses) from BJH with direct inpatient contact. Participants were located across a wide range of service lines, with internal medicine (46%) and general surgery (22%) being the most highly represented. As in Phase I, we excluded

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participants from the intensive care unit, emergency room, and operating room due to lower relevance of the topic in these acute care settings. Of physicians, 79% were resident physicians, and 21% were hospitalists. Of nurses, 47% were staff nurses, 30% nurse practitioners, and 23% other types of nurses. Nurses and physicians were asked via quantitative assessments about their current smoking cessation treatment practices—namely the use of the "5A's": *Ask* about tobacco use, *Advise* to quit smoking, *Assess* readiness for quit attempt, *Assist* with medication and counseling options, and *Arrange* follow-up contact or referral,(26–28) barriers to using these practices, perceived patient interest in various smoking cessation resources during an inpatient stay, perceived importance and feasibility of various potential strategies to improve practices, and the frequency of workflow and safety issues related to hospitalized patient smoking. Qualitative data were obtained through an open-ended prompt to share "final thoughts or comments on the topic of smoking cessation treatment at BJH." The online survey remained open from late February 2018 to late March 2018.

Phase III: Bedside interviews with patients (quantitative)

Participants and procedures

We recruited hospitalized patients to complete a structured 5-minute interview at the bedside. Whereas patients in Phase I were recruited subsequent to their hospitalization as necessary for convening the group model building sessions, patients recruited in Phase III for the brief individualized interviews were still hospitalized yet nearing discharge. This facilitated accurate recall of events while minimizing the risk of missing patients who had recently been discharged or delaying patients' ability to exit the hospital once discharged. We obtained reports daily during the month of May 2018 from the hospital electronic health record to identify potentially eligible patients and conducted all interviews during this time period. Participants of

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the bedside interviews included 205 inpatients who were categorized by electronic health record as current smokers and nearing hospital discharge. Participants were more often male (56%) and Caucasian (59%), with a median age of 54 (*M*=50.25; *SD*=15.22). These demographics appeared to be very similar to those of the larger population of BJH patients across the hospital who were current smokers during this time frame (May 2018). On average, participants smoked 14.0 cigarettes per day and had stayed in the hospital for 4.5 days within a variety of admitting services, including internal medicine (38%), surgery (23%), oncology (13%), cardiology (12%), neurology (7%), and orthopedics (5%). Based on an existing questionnaire to compare patient and provider reports in a different context,(26) patients were asked about their smoking behaviors (i.e., verification of current smoker status prior to hospital admission, cigarettes per day, frequency of leaving the floor to smoke); ever and current e-cigarette use; smoking cessation care they had received during their current inpatient stay (i.e., receipt of the 5A's: *ask*, *advise*, *assess*, *assist*, *arrange*); interest in quitting smoking now, quitting smoking later, smoking less, and methods to quit smoking (e.g., medications); number of past year quit attempts; and the importance of various potential strategies to improve practices (e.g., offering medication to every patient who smokes).

Statistical analysis approach

Data from the healthcare provider online surveys and patient bedside interviews were first analyzed descriptively via frequencies and means. Patient-reported receipt of 5A's smoking cessation practices were examined in relation to provider reports using summary independent-sample t-test analyses. Multiple linear analyses were conducted to determine associations between medication receipt and the likelihood and frequency of leaving the floor to smoke,

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controlling for cigarettes per day and length of stay. Missing data across variables were minimal (< 2% for healthcare providers and <3% for patients) and handled via pairwise deletion.

Patient and public involvement

During participant recruitment, patients were able to identify other potentially eligible individuals who smoke to be screened for enrollment. Through the participatory group model building sessions, patients generated key system insights that informed the research questions and outcome measures to be assessed in the subsequent online survey for healthcare providers and bedside interview protocol for patients. For instance, patients expressed significant frustration regarding being asked repeatedly about their smoking behaviors without being offered any help to quit smoking during their hospital stay. As a result, the research team prioritized questions in the quantitative instruments to assess the frequency of patient- and provider-reported delivery of smoking cessation interventions, as well as patient and provider reports of patient interest in receiving smoking cessation treatment while hospitalized. This research reflects a key step in developing a system-level intervention; therefore, patient input is contributory to ongoing research and practice improvements. We plan to disseminate results of this study to patients and other participants by presenting findings at local symposia and conferences that are well attended by patients, patient advocates, healthcare providers, and the broader community. We will also present these findings during healthcare provider training workshops, whereby patients benefit through improved quality of smoking cessation care in the hospital.

RESULTS

Phase I: Group model building

System insights – "What factors determine the likelihood that patient smoking will be treated?"

Based on factors prioritized by participants during group model building, the research

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team generated a multilevel (i.e., individual, hospital, community, policy) understanding, referred to as system insights, that characterized the observed undertreatment of patients who smoke. Supplemental File 1 illustrates the intentionally oversimplified backbone structure to which participants were responding and building on with content and context. These insights included *provider* reports of patients frequently leaving the floor to smoke, which created major workflow problems and enhanced provider receptivity to solutions framed to address "nicotine withdrawal" rather than "cessation". A commonly reported scenario involved untreated hospital patients going outside to smoke, leading to missed assessments or procedures, which then prompted nurses to prioritize smoking cessation medications to prevent further workflow disruptions. *Providers* also reported a lack of awareness of resources, and enthusiasm balanced with concerns about time, while *patients* reported infrequent receipt of smoking cessation support and preferences for non-judgmental communication (see Table 1).

Potential leverage points – "What targets could lead to major system-level improvements?"

With these system insights providing the appropriate frame, the modeling group then identified potential leverage points to target for action. Leverage points refer to places within a complex system in which a small change can produce large changes in the overall system behavior.(29) Potential leverage points to address provider-reported insights included interventions framed as solutions to reduce nicotine withdrawal and subsequent workflow problems, education and decision support, and a standardized approach to smoking cessation treatment. Potential leverage points to address patient-reported insights included transparency of patient interest and use of treatment and patient-provider rapport through more supportive cessation messaging (see Table 1).

Action ideas – "Which specific strategies appear both highly important and feasible?"

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Finally, stakeholders used these potential leverage points as the frame for nominating potential concrete solutions and then prioritizing them on perceived importance and feasibility in the hospital setting. Providers generated action ideas to address their own provider-reported insights and leverage points, including implementing nurse-driven protocols for timely administration of inpatient nicotine replacement therapy, using an assortment of provider training approaches, designing electronic health records to support point-of-care decisions, and offering point-of-care advice, medication, and links to outpatient counseling. Patients generated action ideas to address their own patient-reported insights and leverage points, including creating provider feedback systems, developing cessation plans for discharge, offering help to every patient who smokes, and revamping hospital signage for more positive messaging (see Table 1). These system insights, potential leverage points, and action ideas were then examined more closely in the subsequent online survey with providers and bedside interviews with patients.

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Table 1. Linking stakeholder-generated system insights with potential leverage points and action ideas

Viewpoint	System Insights	Potential Leverage Points	Action Ideas	Representative Quote
Provider	Patients frequently leave the floor to smoke, which creates major workflow problems; as a result, providers are more compelled by "reducing nicotine withdrawal" rather than "cessation" efforts	Interventions to reduce nicotine withdrawal symptoms and framing solutions around nicotine replacement and workflow to foster provider engagement	Use nurse-driven protocols to ensure that readily accessible nicotine replacement therapy can be provided to inpatients with little delay	"*People go down to smoke and they miss meds and even appointments which is so frustrating.*" – [Staff nurse]
Provider	Providers lack awareness of existing cessation resources to connect patients at discharge, which negatively impacts their willingness to provide inpatient smoking cessation care	Education and decision support	Use continuing medical education, roving in-services, quick reference tools, and brief videos to train providers on how to implement existing and effective treatments Design electronic health record modules to support point-of-care treatment decision	"*I would like to know more about free or low-cost smoking cessation treatment centers to which I can refer my patients…if there was some way they could get [medications] at low cost along with smoking cessation therapy, I think that would be beneficial.*" – [Resident physician]
Provider	Enthusiasm to improve inpatient smoking cessation is balanced by concern about demands and limited time	Standardized and coordinated approach to smoking cessation treatment	Provide point-of-care brief advice, opt-out medication, and discharge links to community resources, including quit-line counseling, to every patient who smokes	"*Most of us would love to help them quit smoking, but it is time consuming…thereby making it feel very much like extra work and easily dropped when busy.*" – [Resident physician]
Patient	Patients are often asked about their smoking but very rarely assisted with cessation	Transparency regarding patient interest in and use of treatment	Give providers feedback on individual and aggregate rates of offering smoking cessation treatment, as well as patient interest and engagement with cessation support Develop cessation plan for discharge	"*I'm so tired of being asked if I'm a smoker without being offered help to quit. It seems like they are only asking so that they can check a box and move on."* – [Patient]
Patient	Patients are more compelled by positive and non-judgmental communication	Patient-provider rapport through more supportive cessation messaging	Ask every patient who smokes if they would like help to quit smoking Revamp hospital signage to incorporate positive messaging on smoking cessation	"*The more respect staff gives, the more honest the conversation is, and the more likely I will be to accept treatment.*" – [Patient]

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Phase II: Healthcare provider online survey

Qualitative data

Open-ended responses from the provider sample were useful in expanding further upon the group model building data. Key representative quotes are included in Table 1 to reinforce themes from the group model building sessions.

Quantitative data

Rates of smoking cessation practice varied substantially across the 5A's, with the majority of providers indicating regular completion of *Ask* (88%), *Advise* (79%), *Assess* (62%), and *Assist* (63%), with lower rates for *Arrange* (24%). Additionally, 64% of providers reported that they often-to-always encourage use of medication (e.g., nicotine replacement therapy, varenicline) with patients for smoking cessation.

The most commonly cited barriers to providing treatment were patient lack of interest (92%) and compliance (92%), followed by lack of awareness of existing community resources for patient referral (72%) and lack of time (71%).

Approximately 80% of providers reported that patients often or very often leave the floor to smoke and that this frequently leads to patients posing a safety risk (75% reported often or very often), assessments being missed (51% reported often or very often), and staff time used to escort patients off the floor (42% reported often or very often).

The strategies rated as most important for improving smoking cessation treatment at the hospital were also the ones rated as most feasible. These top strategies included asking every patient who smokes if they want help (86% endorsed as very or extremely important; 77% endorsed as very or extremely feasible), offering brief advice to every patient who smokes (65% endorsed as very or extremely important; 56% endorsed as very or extremely feasible), and

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offering medication to every patient who smokes (62% endorsed as very or extremely important; 52% endorsed as very or extremely feasible).

Phase III: Patient bedside interviews

Table 2 highlights high levels of patient smoking cessation interest and attempts. In particular, nearly three-fourths (73%) were interested in quitting now, and nearly all (96%) were interested in quitting or smoking less. Most patients (59%) had tried quitting in the past year. Nearly two-thirds (65%) had ever used e-cigarettes, and 12% currently used them.

Table 2. High patient demand to quit smoking

Variables	**Patients No. (%)**
Interested in quitting now	146/200 (73)
Interested in quitting now or later	188/202 (93)
Interested in quitting now or later or smoking less	193/202 (96)
Past year quit attempt	118/201 (59)
Ever used e-cigarettes	131/202 (65)
Currently used e-cigarettes	25/202 (12)

Regarding comparisons between patient and provider reports of the 5A's, patients reported rates similar to providers on *Ask* (mean diff= -1.4%; p=0.653); however, they reported much lower rates of receiving *Advise* (mean diff= -27.5%; p<.001), *Assess* (mean diff= -33.7%; p<.001), *Assist* (mean diff= -19.2%; p<.001), and *Arrange* (mean diff= -17.4%; p<.001) steps (see Figure 1), as well as being provided with medication to quit smoking during their inpatient stay (mean diff= -35.0%; p<.001; see Figure 2). Additionally, in contrast to 92% of providers citing patient interest as a key barrier to smoking cessation treatment, only 4% of patients indicated no interest in quitting at some point or smoking less, and only 27% of patients indicated no interest in quitting now.

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Nearly one-third (31%) of patients reported that they had left the floor to go smoke during their hospital stay, and nearly two-thirds of those who left did so multiple times per day. Overall, receipt of inpatient smoking cessation medication was not significantly associated with leaving the floor to smoke (p=.331). However, among patients who left, those who did not receive smoking cessation medications were more likely to report leaving multiple times per day than those who received medications, controlling for cigarettes per day and length of stay (OR=3.3, p=.036).

Patients were well-aligned with providers regarding perceived importance of potential strategies to improve smoking cessation treatment in the hospital (see Figure 3). The most highly rated strategies were to ask every patient who smokes if they want help (76% endorsed as very or extremely important), offer medication to every patient who smokes (67%), and offer brief advice to every patient who smokes (58%).

DISCUSSION

Extensive research has examined the hospital as a prime setting to engage patients in smoking cessation treatment, as well as effective treatment approaches to employ in hospital settings,(9–14) yet persistent treatment gaps signal formidable implementation challenges.(15–17) This study uniquely employed a systems science lens to frame the implementation challenges and opportunities using a rigorous mixed methods approach to generate system insights, potential leverage points, and specific strategies to improve the treatment of hospitalized patients who smoke. Key contributions of this research include 1) detailing an underutilized participatory, stakeholder-engaged process to yield hypothesis-generating qualitative data that informed the design and interpretation of quantitative data, and 2) a robust set of provider and patient levers to be activated in a multi-component implementation strategy in future research.

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Healthcare providers reported that patient smoking during a hospitalization created significant workflow issues for hospital staff. Despite low current rates of smoking cessation pharmacotherapy prescribing, we found high patient demand to quit smoking. Provider-reported barriers centered on a perceived lack of patient interest, time, and awareness of existing resources; these barriers reflect aspects of motivation, opportunity, and capability, which have been identified as key determinants of behavioral change and fruitful targets for intervention.(30,31)

Despite the wealth of research on inpatient smoking and hospital-based cessation treatment, far fewer studies have focused on potential collateral effects of inpatient smoking and treatment gaps, such as impeded provider workflow characterized by missed assessments and procedures, misuse of staff time, and potential safety concerns, as found in the current study. Importantly, providers were much more receptive to and compelled by approaches to prevent the chain of events involving nicotine withdrawal, patients leaving the floor to smoke, and workflow problems, as opposed to approaches framed as promoting smoking cessation among hospitalized patients. This finding has significant implications for approaches to engaging hospital providers in the treatment of inpatients who smoke.

Whereas previous research found that nearly 1 in 5 smokers admitted to a hospital smoked cigarettes during their hospital stay,(32) the rate was nearly 1 in 3 among smokers sampled in our hospital setting. Interestingly, based on patient reports, receipt of nicotine replacement therapy was not associated with whether or not patients left the floor to smoke at least once; however, patients receiving nicotine replacement therapy were more likely to have only left the floor to smoke once. Therefore, it is possible that patients may have been receiving nicotine replacement therapy *in response to* leaving the floor to smoke (e.g., missing patient

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prompts the provider to offer treatment for nicotine withdrawal), thereby reducing the likelihood that patients subsequently left due to nicotine withdrawal during their hospital stay. This hypothesis would require further testing, including an establishment of temporal precedence, to demonstrate risk of patient smoking before and after receiving nicotine replacement therapy in the hospital setting.

Regarding points of (mis)alignment between patient and provider perceptions, both groups reported high rates of asking patients whether or not they smoke. However, patients reported much lower rates of receiving any smoking cessation support and much higher levels of interest in cessation, as compared to provider reports. This finding replicates recent research in mental health settings,(26) and was corroborated by qualitative data, which characterized the patient perception that providers frequently ask about smoking behaviors yet no actions result from these inquiries. Improved alignment of perceptions could benefit patient-provider rapport and increase acceptance of smoking cessation treatments when offered—opportunities which were all raised by patients during group model building discussions.

Finally, patients and providers agreed that the most important strategies were to ask every patient who smokes if they want help and offer medication and brief advice to every patient who smokes. Providers also found these to be the most feasible potential strategies, despite the patient reports that these were not frequently occurring. While seen as feasible, providers may perceive the need for a hospital-wide program that expects, supports, and reinforces the practice of offering treatment to every patient who smokes. As noted in a recent systematic review,(31) standardized implementation of this type of opt-out program that leverages lighter-touch point-of-care support may in fact ease provider burden and workflow. In addition, the alignment

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between patients and providers in ratings of importance and feasibility give additional credence to the viability of implementing these proposed strategies in hospital settings.

Limitations of this study include being based in one large tertiary care hospital system in the Midwestern United States. However, there are indications that this hospital system is largely representative of other systems in the nation. For instance, researchers recently found smoking cessation medication rates of 22.3% across 282 U.S. hospitals,(17) nearly identical to our rate of approximately 22% across years 2010-2016. In addition, patient recruitment for the group model building sessions was limited to a research participant registry; as a pool of patients who are willing to be contacted about research studies, participants from this registry may differ somewhat from patients at-large. For the online survey, the link was distributed by the primary contacts of hospital divisions, and it was not possible to determine how many healthcare providers received the opportunity to complete the survey. As a result, we were unable to ascertain response rate and therefore cannot rule out the possibility of sampling bias. Finally, patients and providers from psychiatric services may have different perceptions about smoking cessation treatment as compared to other patient and provider groups. However, only two participants from psychiatry were included in the exploratory phase of our study (Phase I) and no participants from psychiatry were included in Phases II and III in which we compared provider and patient reports of treatment (i.e., 5A's) offering and receipt.

CONCLUSION

Our findings have led our hospital to adopt standardized, lighter-touch yet higher-reach approaches to smoking cessation treatment, supported by provider feedback and simplified decision support and enabled through the electronic health record system.(9,20,33,34) Prior reviews and studies frequently highlight the importance of directly targeting hospital systems,

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including integrating key performance indicators into electronic health records, to improve the delivery of hospital smoking cessation care and the sustainability of those improvements.(35) Despite the local system changes, the primary contribution of these findings is in providing generalizable evidence to help other researchers, providers, and hospital administrators to prioritize the use of implementation strategies that were robustly supported across each phase of our mixed methods study. The potential leverage points we identified point to the following specific strategies:

1. *Create a standardized and coordinated approach to smoking cessation treatment*: Provide point-of-care brief advice, opt-out medication, and discharge links to community resources, including quit-line counseling, to every patient who smokes;
2. *Foster provider engagement by identifying and framing interventions as solutions to reduce nicotine withdrawal and subsequent workflow problems related to patients leaving the floor to smoke*: Use nurse-driven protocols to ensure that readily accessible nicotine replacement therapy can be provided to inpatients with little delay;
3. *Offer positive, supportive, and non-judgmental messaging to patients*: Revamp hospital signage to incorporate positive messaging on smoking cessation and focus on boosting confidence and motivation to quit in patients who smoke;(36)
4. *Improve awareness, knowledge, self-efficacy, and attitudes*: Use continuing medical education, roving in-services, and quick reference tools to train providers on existing and effective treatments and how to implement them;
5. *Increase transparency regarding patient interest in and use of treatment*: Give providers feedback on ongoing performance and aggregate rates of patient-reported readiness to quit and engagement with quit-line counseling to foster awareness and accountability.

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Engaging hospital stakeholders through a process of self-identification of approaches to addressable problems presents opportunities to fit high-leverage challenges with sustainable, contextually-appropriate solutions. Findings from this study inform engagement with healthcare provider and patient stakeholders in the development and implementation of proposed strategies to facilitate consistent delivery of smoking cessation treatment practices in the hospital setting.

CONTRIBUTORS

ATR, L-SC, and LJB conceptualized and designed the study. ATR and DP led participant recruitment and data collection. EB led the group model building sessions and synthesis of qualitative data. ATR analyzed the qualitative and quantitative data and drafted the initial manuscript. ATR, DP, EB, L-SC, and LJB contributed to manuscript revisions and approved the final manuscript.

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COMPETING INTERESTS

LJB is listed as an inventor on Issued U.S. Patent 8,080,371, “Markers for Addiction” covering the use of certain SNPs in determining the diagnosis, prognosis, and treatment of addiction. The other authors have no financial disclosures.

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ETHICS APPROVAL

This study was approved by an institutional review board in the Human Research Protection Office at Washington University in St. Louis (IRB ID: 201703162).

DATA SHARING

Additional data may be available by emailing aramsey [at] wustl [dot] edu.

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Figure 1. Providers and patients report discrepant rates of inpatient smoking cessation treatment

Figure 2. Despite high interest, fewer patients receive pharmacologic cessation treatment than indicated by providers

Figure 3. Potential strategies prioritized by importance and feasibility among stakeholders

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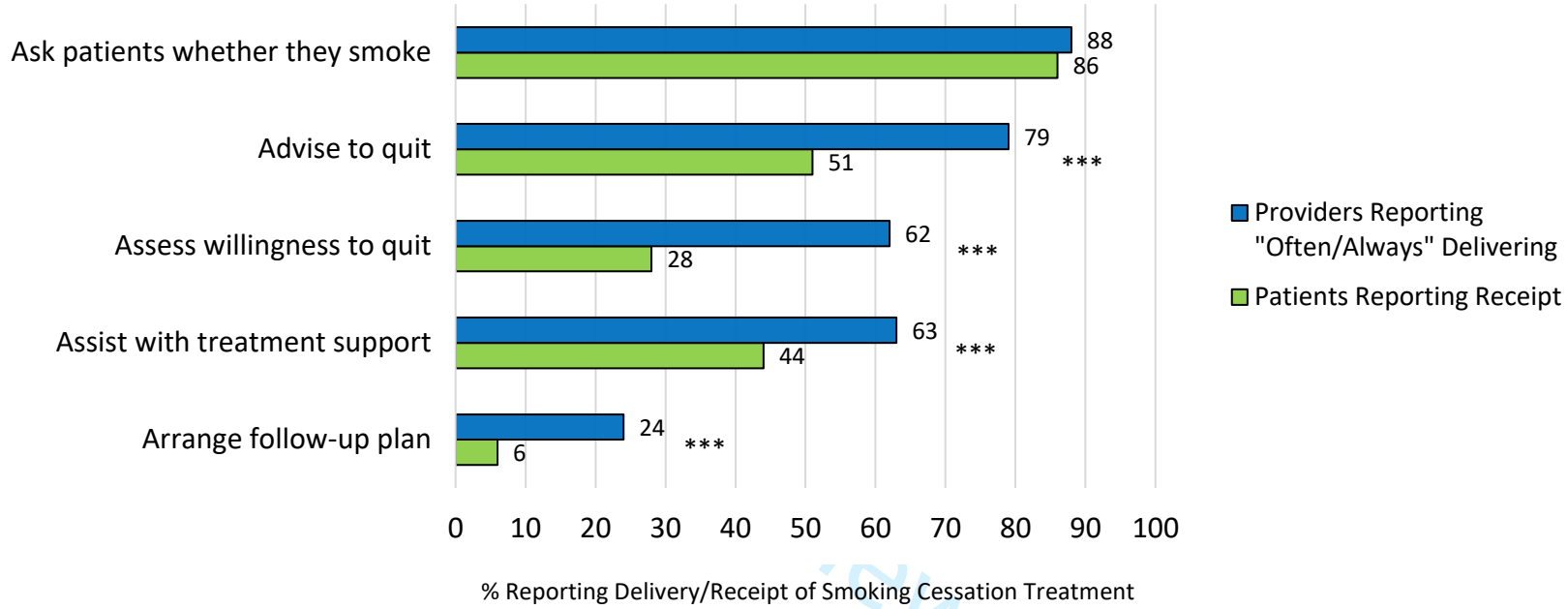
Figure 1. Providers and patients report discrepant rates of inpatient smoking cessation treatment



*** $p < .001$

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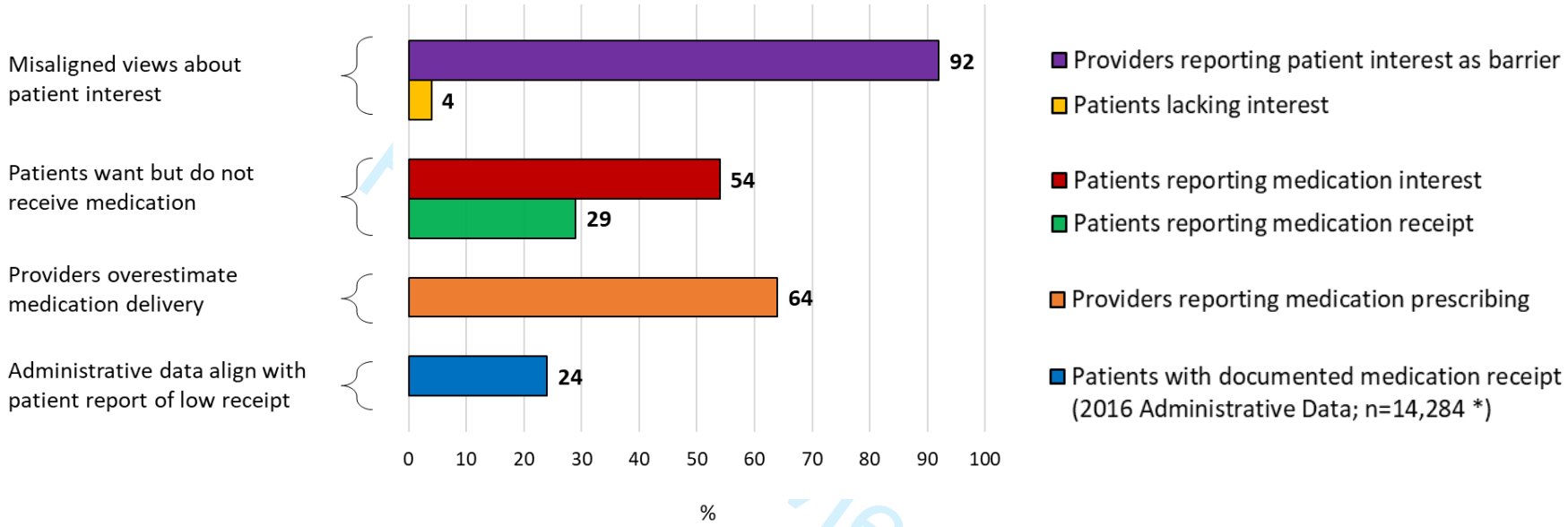
Figure 2. Despite high interest, fewer patients receive pharmacologic cessation treatment than indicated by providers



* Adapted from Srivastava et al., 2018 [9]

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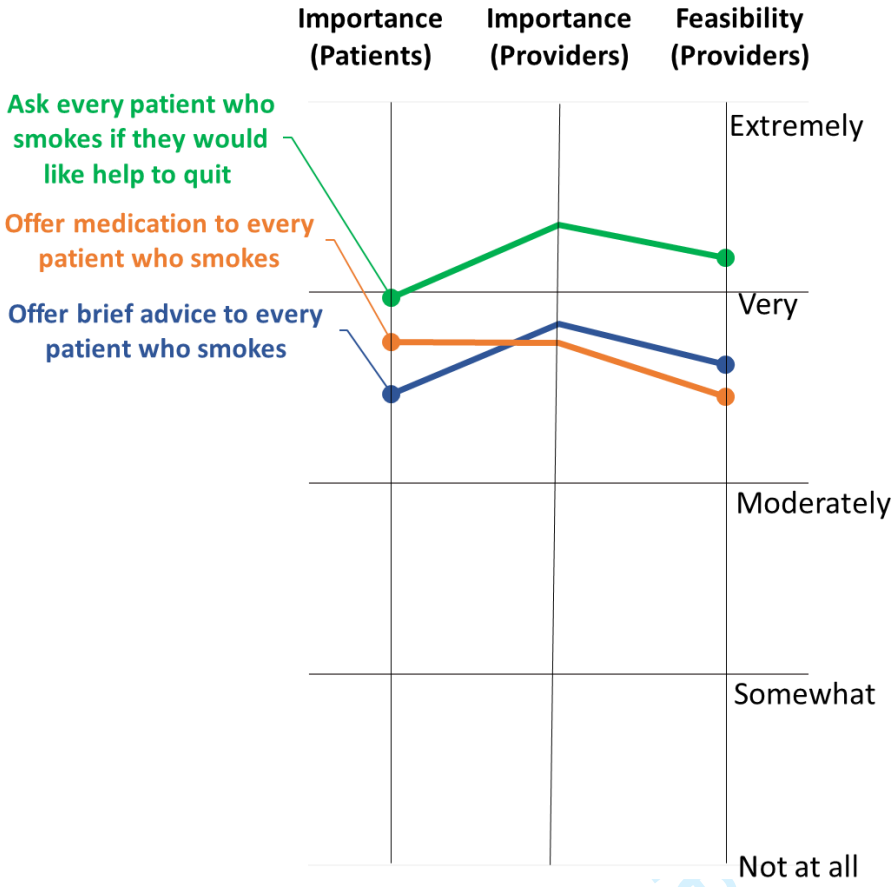
Figure 3. Potential strategies prioritized by importance and feasibility among stakeholders



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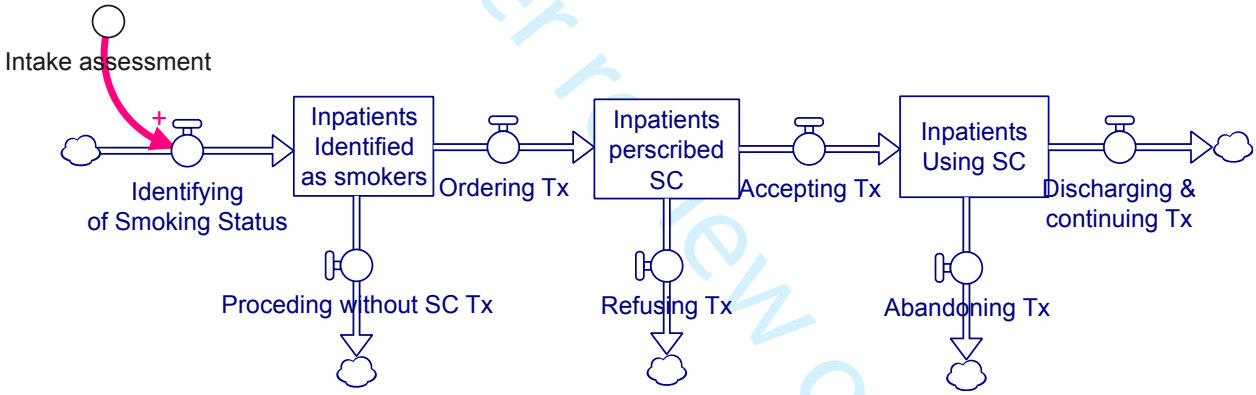
Supplementary File 1. Backbone Structure to Guide the Group Model Building Sessions

Backbone Structure:

Patients who smoke are identified via intake assessment and can either receive an order for treatment or not. Those who are prescribed treatment can accept or refuse it. Those who accept it can either continue or discontinue treatment after discharge.



Sample Semi-Structured Prompt:

"What factors determine the likelihood that a patient's smoking will be treated? ...

... In other words, what barriers might disrupt this process of [a patient who smokes receiving treatment / providing treatment to a patient who smokes]?"

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Standards for Reporting Qualitative Research (SRQR)

O'Brien B.C., Harris, I.B., Beckman, T.J., Reed, D.A., & Cook, D.A. (2014). Standards for reporting qualitative research: a synthesis of recommendations. *Academic Medicine, 89(9)*, 1245-1251.

No. Topic	Item	Status	Page
Title and abstract			
S1 Title	Concise description of the nature and topic of the study identifying the study as qualitative or indicating the approach (e.g., ethnography, grounded theory) or data collection methods (e.g., interview, focus group) is recommended	Addressed	1
S2 Abstract	Summary of key elements of the study using the abstract format of the intended publication; typically includes objective, methods, results, and conclusions	Addressed	2-3
Introduction			
S3 Problem formulation	Description and significance of the problem/phenomenon studied; review of relevant theory and empirical work; problem statement	Addressed	4-5
S4 Purpose or research question	Purpose of the study and specific objectives or questions	Addressed	5-6
Methods			
S5 Qualitative approach and research paradigm	Qualitative approach (e.g., ethnography, grounded theory, case study, phenomenology, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g., positivist, constructivist/interpretivist) is also recommended	Addressed	6-8
S6 Researcher characteristics and reflexivity	Researchers' characteristics that may influence the research, including personal attributes, qualifications/experience, relationship with participants, assumptions, or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results, or transferability	Addressed	7, 11
S7 Context	Setting/site and salient contextual factors; rationale	Addressed	6-9
S8 Sampling strategy	How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g., sampling saturation); rationale[a]	Addressed	6-10
S9 Ethical issues pertaining to human subjects	Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues	Addressed	22-23
S10 Data collection	Types of data collected; details of data collection	Addressed	7-10

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methods	procedures including (as appropriate) start and stop dates of data collection and analysis, iterative process, triangulation of sources/methods, and modification of procedures in response to evolving study findings; rationale[a]		
S11 Data collection instruments and technologies	Description of instruments (e.g., interview guides, questionnaires) and devices (e.g., audio recorders) used for data collection; if/how the instrument(s) changed over the course of the study	Addressed	7-10
S12 Units of study	Number and relevant characteristics of participants, documents, or events included in the study; level of participation (could be reported in results)	Addressed	7-10
S13 Data processing	Methods for processing data prior to and during analysis, including transcription, data entry, data management and security, verification of data integrity, data coding, and anonymization/deidentification of excerpts	Addressed	7,8,10
S14 Data analysis	Process by which inferences, themes, etc., were identified and developed, including researchers involved in data analysis; usually references a specific paradigm or approach; rationale[a]	Addressed	8,10
S15 Techniques to enhance trustworthiness	Techniques to enhance trustworthiness and credibility of data analysis (e.g., member checking, audit trail, triangulation); rationale[a]	Addressed	7,8,10
Results/Findings			
S16 Synthesis and interpretation	Main findings (e.g., interpretations, inferences, and themes); might include development of a theory or model, or integration with prior research or theory	Addressed	11-17
S17 Links to empirical data	Evidence (e.g., quotes, field notes, text excerpts, photographs) to substantiate analytic findings	Addressed	11-17
Discussion			
S18 Integration with prior work, implications, transferability, and contribution(s) to the field	Short summary of main findings; explanation of how findings and conclusions connect to, support, elaborate on, or challenge conclusions of earlier scholarship; discussion of scope of application/generalizability; identification of unique contribution(s) to scholarship in a discipline or field	Addressed	17-22
S19 Limitations	Trustworthiness and limitations of findings	Addressed	20
Other			
S20 Conflicts of interest	Potential sources of influence or perceived influence on study conduct and conclusions; how these were managed	Addressed	22
S21 Funding	Sources of funding and other support; role of funders in data collection, interpretation, and reporting	Addressed	22

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