RESEARCH LETTER

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Artificial intelligence for venous thromboembolism prophylaxis: Clinician perspectives

1 | INTRODUCTION

Hospital-associated venous thromboembolism (VTE) is a major public health challenge, and while thromboprophylaxis is known to be effective, it remains misused [1]. Clinicians face enormous complexity when determining who should receive thromboprophylaxis. To better understand current practices around VTE prophylaxis in adult hospitalized patients, we previously surveyed 607 clinicians across the United States between 2021 and 2022 [2]. Overall, 48% of respondents reported patients at their institution are not on appropriate VTE prophylaxis almost all the time. The majority reported that technology such as artificial intelligence (AI) may help improve rates of appropriate prophylaxis. However, only 35% reported using existing risk assessment models (RAMs); 68% reported using their own clinical assessment instead. Therefore, we invited survey respondents to participate in focus groups to better understand how they approach VTE prophylaxis, with a focus on their perspectives regarding using AI decision support.

2 | METHODS

Research assistants emailed respondents to our national survey who had reported willingness to participate in a focus group on VTE prophylaxis. Additional participants were recruited through snowball sampling. Participants received $50 as incentive.

One of 2 researchers (B.D.L. and A.P.) led all focus groups using a semistructured interview guide (Supplementary Appendix 1) that was developed based on initial survey findings and a literature review [3–6]. VTE was defined as including deep vein thromboses and pulmonary embolisms. AI was defined broadly as computer algorithms that can assist clinicians in making decisions in order to not bias participants who may have had prior interactions with a specific AI tool.

A researcher (B.D.L.) analyzed 3 randomly selected transcripts to derive themes for an initial codebook, which was reviewed by other members of the research team (M.S. and R.P.). Initial coding was both deductive and inductive and followed Braun and Clarke's methods for thematic analysis [7]. Two researchers (B.D.L. and S.Z.) then independently coded all transcripts, iteratively updating the codebook (Supplementary Appendix 2), reviewing discrepancies, and recoding until consensus was achieved. We followed COnsolidated criteria for REporting Qualitative research (COREQ) guidelines for qualitative research (Supplementary Appendix 3). Participants were interviewed until thematic saturation was achieved.

This study was deemed exempt by The Beth Israel Deaconess Medical Center Institutional Review Board.

3 | RESULTS

Of 174 respondents (29% of the 607 who participated in the initial survey) who expressed interest in participating, 33 clinicians from across the United States attended a focus group (Supplementary Figure S4 shows participant flow, and Table 1 shows sample characteristics). The median age was 37 years (range 21-70), and most identified as female and described their role as Doctor of Medicine or Osteopathic Medicine (64%). Focus group participants were more likely than overall survey participants to specialize in hematology (46% vs 21%; $P = .001$) and less likely to specialize in hospital medicine (33% vs 52%; $P = .04$). The groups did not differ with respect to age, gender identity, clinical role, trainee status, practice setting, or other specialty.

Clinicians described 3 themes (Table 2) regarding VTE prophylaxis in adult hospitalized patients: (1) a "default" approach to prophylaxis, (2) disparate views on RAMs, and (3) lack of assessment for VTE prophylaxis at discharge.

Many participants described giving patients VTE prophylaxis "by default": "The majority of patients should get some form of VTE prophylaxis, and really you have to justify why the patient doesn't receive it." Participants looked for bleeding risks as reasons to not provide prophylaxis. While some participants perceived underutilization of VTE prophylaxis at their institution, more described overuse. Participants acknowledged the value of RAMs, but most reported not using one. A few cited lack of standardization, and many described

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TABLE 1 Demographics of focus group participants.

Demographic	N = 33 n (%)
Age	
<40 y	18 (58.1)
40 y or older	13 (41.9)
Gender	
Female	18 (54.5)
Clinical role	
Doctor of Medicine or Doctor of Osteopathic Medicine	21 (63.6)
Pharmacist	8 (24.2)
Registered nurse	3 (9.1)
Advanced practice provider *specified as a nurse practitioner or physician assistant*	1 (3.0)
Training status	
In training	12 (36.4)
Clinical focus[a]	
Hematology	15 (45.5)
Hospital medicine	11 (33.3)
Oncology	5 (15.2)
Critical care	5 (15.2)
Practice setting[a]	
Academic hospital	25 (75.8)
Community hospital	8 (24.2)

[a]Respondents could select more than one, thus, totals may sum to greater than 100%.

them as cumbersome. Several suggested that an ideal model would weigh both bleeding and clotting risk.

Participants discussed that VTE prophylaxis at discharge may be appropriate for high-risk populations. However, the vast majority reported that an assessment at discharge is not part of routine clinical care. Many also shared trepidation around educating about and prescribing VTE prophylaxis at discharge, citing barriers such as insurance coverage, limited health literacy, medication adherence, and safety.

Clinicians described 3 themes regarding the use of AI for VTE prophylaxis: (1) excitement about its potential, (2) concern around transparency, accuracy, and overreliance, and (3) increasing acceptance over time.

"[We could] develop better predictive models," one participant said. Participants described how AI might leverage the vast amounts of data generated in medicine to improve risk stratification of patients. Participants also identified other potential uses, including using AI to review imaging, monitor rates of VTE, and assist with patient education.

Participants brought up the "black box" nature of AI, but several noted that AI models may not be that different from RAMs as long as

they know how the model was trained and how it weighs different variables. Participants voiced concerns about data quality, patient representation, and the possibility of encoding bias. One stated, "These models are only as good as the electronic health record (EHR)," and another suggested the need to standardize how models are assessed. Others worried about the ability of an AI tool to remain accurate over time.

Some participants stated that specific tasks are better suited to humans. "There's an art and a science of medicine," one participant said, "and I think it's important to have both." While some were excited that AI could reduce cognitive burden, most felt strongly that clinicians "press the final button" and voiced concern that AI might "take away critical thinking skills" leading to misses in care. Participants reported that AI might not be accepted by clinicians right away, and the way AI is implemented—considering factors such as user training, integration into the workflow, and ease of use—could build or break trust. Many saw themselves learning to trust AI over time: "I think I'm very evidence-based," one participant said. "I wouldn't be like, no [I won't use it]." Nearly every participant noted their lack of knowledge about AI, and several suggested that clinicians should learn to critique AI tools, given their inevitable impact on medicine.

4 | DISCUSSION

Clinicians participating in 8 focus groups described dissatisfaction with existing RAMs and felt AI may be a promising solution for optimizing VTE prophylaxis. However, they emphasized the need for transparency around AI model development and validation. They also felt that effective implementation strategies are needed, and further studies should consider model deployment in addition to model construct and performance.

The EHR data used to build AI tools are not always reliable, and clinicians will need to be closely involved in model build to ensure errors and biases are not perpetuated [8]. Explainability, which indicates how understandable a model and its inputs and outputs are to humans, is an emerging metric that may allow users to better assess quality. More work needs to be done to standardize how explainability is defined and evaluated, and how it can be incorporated into clinician-facing models [9].

There are limitations to this study. Participants were more likely to be interested in the field of hematology or informatics, which may limit generalizability. Interviews focused on AI broadly, but opinions may differ depending on the specific tool at hand. Participants were invited to anonymize their identity and clinical role to minimize bias and encourage equitable participation. The possibility for one voice to dominate others remained a potential source of bias, though every participant made at least one comment. Anonymization of participants precluded us from linking participants to original survey responses or further analyzing how themes varied across demographics.

Based on our findings, we plan to interview informaticists to explore practical barriers to deployment and validate specific AI tools with clinicians and patients.

TABLE 2 Major themes related to use of thromboprophylaxis and artificial intelligence for informing use.

Current attitudes and practices regarding VTE prophylaxis in adult hospitalized patients	
VTE prophylaxis is near universal	
Default is to prescribe	"Everyone gets VTE prophylaxis."
Clinicians attempt to identify contraindications	"I give everyone VTE prophylaxis unless they are at high bleeding risk."
Clinicians perceive misuse of VTE prophylaxis	
Gaps with care transitions	"The night team doesn't really want to deal with VTE prophylaxis."
Gaps around procedures	"There are misses around procedures."
RAMs can be helpful but are not commonly used	
RAMs are used for gray areas	"If somebody is borderline, you can use that score."
RAMs are cumbersome to use	"There's too many things going on in the RAM."
Lack of precision	"The tools are not precise enough."
Nonmedical factors can influence VTE prophylaxis	
Electronic decision support	"I use a RAM because it's built into our admission order set."
Patient preference	"Some patients don't want heparin because it's porcine."
Systems level factors	"Our hospital only offers Heparin and Lovenox."
Clinicians do not routinely prescribe VTE prophylaxis at discharge	
Not a routine part of assessment or education	"I don't usually think about VTE prophylaxis at discharge."
May be applicable to some high-risk patient populations	"I prescribe it for some patients, like a cancer patient or a COVID patient."
Not practical to address with patients	"There's already so much to tell them... they'd be overwhelmed."
The potential role of AI in VTE prophylaxis	
Clinicians believe AI holds promise	
AI and similar technologies are promising solutions for VTE prophylaxis	"It could take in multiple variables at a time."
Clinical decision support tools lay the foundation for AI tools	"Other things are black box too."
AI may reduce cognitive load	"It's nice to be allowed to think less."
Clinicians have several concerns around AI	
Concern about lack of explainability and transparency	"I would need to see what data is being factored into that decision and also the weight."
Concern about safety and accuracy	"I worry about model drift and that accuracy will change over time."
Concern about liability	"Who will take on the liability of a machine [that] makes the wrong decision?"
Concern about overreliance	"If someone's looking at an algorithm but without really critically thinking, that's bad."
AI models can supplement but should not replace clinical decision-making	"[Clinicians should] press the final button."
More research is needed	"We need more research to figure out how to incorporate AI into clinical practice."
Clinicians may become more accepting of AI over time	
Acceptance of AI models may take time	"Once you see that data it's really hard to argue against the algorithm."
Implementation strategy may make a difference	"We need buy-in from different stakeholders."
Clinicians perceive a lack of knowledge	"I don't know enough to say much."

AI, artificial intelligence; RAM, risk assessment model; VTE, venous thromboembolism.

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AUTHOR CONTRIBUTIONS

B.D.L., J.I.Z., R.P., and M.S. are responsible for conceptualization and methodology. B.D.L., S.Z., A.P., R.P., and M.S. are responsible for formal analysis and investigation. B.D.L. is responsible for writing the original draft. All authors are responsible for reviewing and editing the manuscript.

DATA AVAILABILITY

The data that support the findings of this study are available on request from the corresponding author.

RELATIONSHIP DISCLOSURE

Barbara D. Lam[1,2]
Sabrina Zerbey[1]
Amanda Pinson[1]
William Robertson[3,4]
Rachel P. Rosovsky[5]
Leslie Lake[4]
Laura E. Dodge[6]
Alys Adamski[7]
Nimia Reyes[7]
Karon Abe[7]
Ioannis S. Vlachos[8]
Jeffrey I. Zwicker[9]
Mara Schonberg[10]
Rushad Patell[1]

[1]Division of Hematology, Department of Medicine, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts, USA
[2]Division of Clinical Informatics, Department of Medicine, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts, USA
[3]Weber State University, Ogden, Utah, USA
[4]National Blood Clot Alliance, Philadelphia, Pennsylvania, USA
[5]Division of Hematology, Department of Medicine, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts, USA
[6]Department of Obstetrics and Gynecology, Beth Israel Deaconess Medical Center, Harvard T.H. Chan School of Public Health Boston, Massachusetts, USA
[7]Division of Blood Disorders, National Center on Birth Defects and Developmental Disabilities, Centers for Disease Control and Prevention, Atlanta, Georgia, USA
[8]Department of Pathology, Cancer Research Institute, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts, USA
[9]Hematology Service, Department of Medicine, Memorial Sloan Kettering Cancer Center, New York City, New York, USA
[10]Division of General Medicine, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts, USA

Handling Editor: Dr Vânia Morelli.

Correspondence
Rushad Patell, Beth Israel Deaconess Medical Center, Harvard Medical School, 330 Brookline Avenue, Boston, MA 02215, USA.
Email: Rpatell@bidmc.harvard.edu

TWITTER

Rachel P. Rosovsky @RosovskyRachel
Jeffrey I. Zwicker @jzbos
Rushad Patell @rushadpatell

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SUPPLEMENTARY MATERIAL

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