AGENCY FOR HEALTHCARE RESEARCH AND QUALITY

AHRQ

Optimizing Data Visualization to Improve Care

Presented by:
Richelle J. Koopman, M.D., M.S.
Gabriela Schmajuk, M.D., M.S.
Daniel C. Malone, B.S. Pharmacy, Ph.D., FAMCP

Moderated by:
Roland Gamache, Ph.D., M.B.A., FAMIA
Agency for Healthcare Research and Quality

October 19, 2022

Agenda

- Welcome and Introductions
- Presentations
- Q&A Session With Presenters
- Instructions for Obtaining CME Credits

Note: You will be notified by email once the slides and recording are available.

Presenter and Moderator Disclosures

Richelle J. Koopman, M.D., M.S.
Presenter

Gabriela Schmajuk, M.D., M.S.
Presenter

Daniel C. Malone, B.S. Pharm, Ph.D.
Presenter

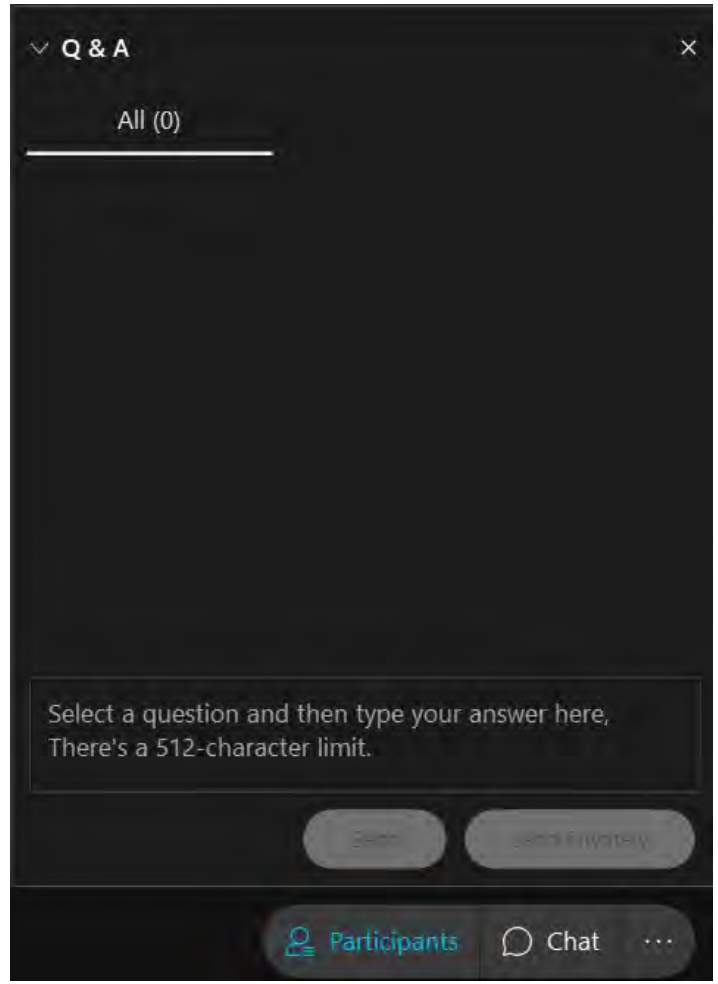
Roland Gamache, Ph.D., M.B.A.
Moderator

This continuing education activity is managed and accredited by AffinityCE, in cooperation with AHRQ and SD Solutions.

- Drs. Richelle J. Koopman, Gabriela Schmajuk, Daniel C. Malone, and Roland Gamache have no relevant financial interests to disclose.
- AffinityCE, SD Solutions, and AHRQ staff, as well as planners and reviewers, have no relevant financial interests to disclose.
- Commercial support was not received for this activity.

How to Submit a Question

- At any time during the presentation, type your question into the “Q&A” section of your WebEx Q&A panel.
- Please address your questions to “All Panelists” in the drop-down menu.
- Please include the presenter’s name or their presentation order number (first, second, or third) with your question.
- Select “Send” to submit your question to the moderator.
- Questions will be read aloud by the moderator.



Learning Objectives

At the conclusion of this webinar, participants should be able to:

1. Describe creation and testing of intuitive health data visualization and explain how the visualization tools lead to better-informed patients and improved care decisions.
2. Describe the development and implementation of an application that displays real-time visualizations of PRO data during clinical encounters for patients with rheumatoid arthritis.
3. Discuss the development and evaluation of a shared decision-making dashboard for presenting individualized risks of harm from a drug-drug interaction.

AGENCY FOR HEALTHCARE RESEARCH AND QUALITY

AHRQ

Data Visualization to Support Hypertension Decision Making

Richelle J. Koopman, M.D., M.S.
Professor and Vice Chair, Jack M. and Winifred S. Colwill Professor
Department of Family and Community Medicine
University of Missouri

Acknowledgements

- This work is supported by **Agency for Healthcare Research and Quality (AHRQ)** grants
  - R01 HS023328 “Optimizing Display of Blood Pressure Data to Support Clinical Decision Making” PI: Koopman
  - R18 HS028579 “Collaboration Oriented Approach to Controlling High blood pressure (COACH)” PIs: Dorr, Koopman

  The content is solely the responsibility of the author and does not represent the official views of AHRQ

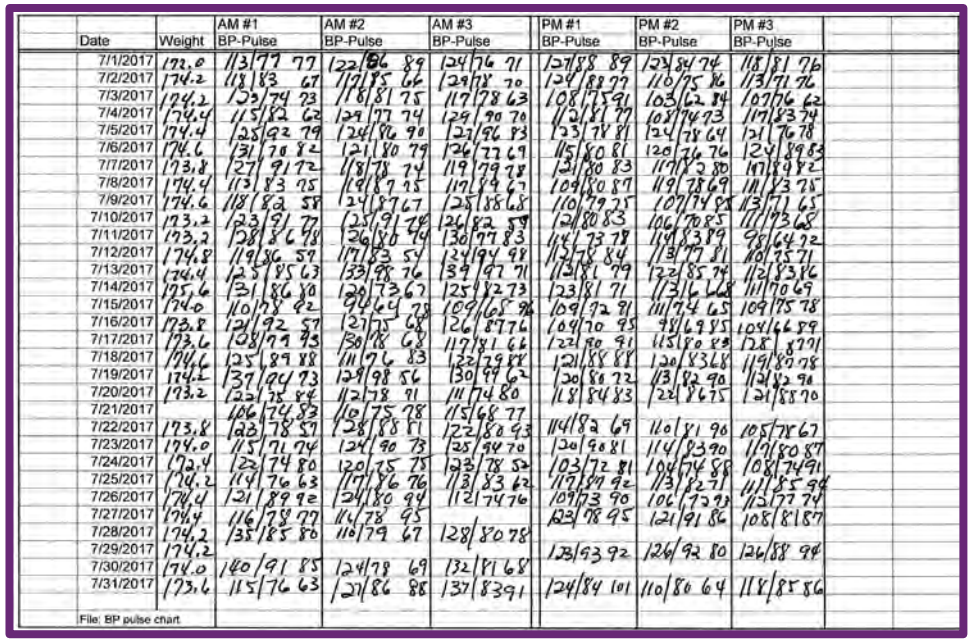
- No conflicts to declare

Learning Objectives

- Describe creation and testing of intuitive health data visualization
- Explore challenges in representing patient-generated health data
- Explain how visualization tools lead to better-informed patients and improved care decisions

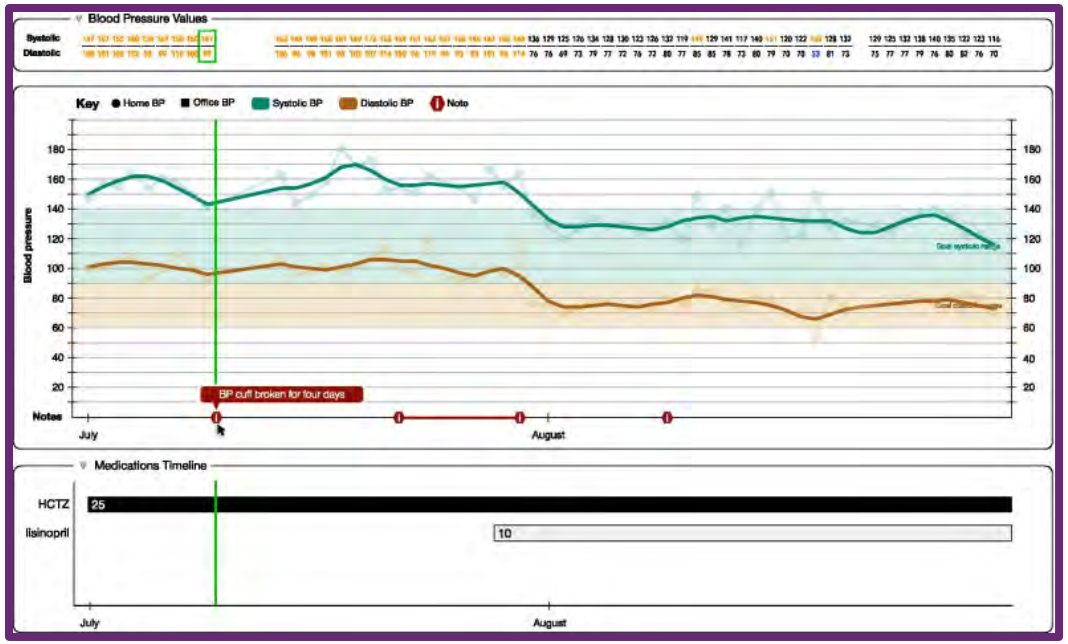
The Problem and The Solution

- The problem: Incorporate patient-generated home BP data into clinical workflow
- The solution: EHR data visualization of home bp data entered via the patient portal



Date	Weight	AM #1 BP-Pulse	AM #2 BP-Pulse	AM #3 BP-Pulse	PM #1 BP-Pulse	PM #2 BP-Pulse	PM #3 BP-Pulse
7/1/2017	172.0	113/77 77	122/86 89	124/76 71	127/88 89	123/84 74	118/81 76
7/2/2017	174.2	118/83 67	117/85 66	129/78 70	124/88 77	110/75 86	113/71 76
7/3/2017	174.2	123/74 73	118/81 75	117/78 63	108/75 91	103/62 84	107/76 62
7/4/2017	174.4	115/82 62	129/77 74	129/90 70	112/81 77	108/74 73	117/83 74
7/5/2017	174.4	128/92 79	124/86 90	127/96 83	123/78 81	124/78 64	121/76 78
7/6/2017	174.6	131/70 82	121/80 79	126/77 69	115/80 81	120/76 76	124/89 85
7/7/2017	173.8	127/91 72	118/78 74	119/79 78	131/80 83	117/72 80	117/84 82
7/8/2017	174.4	113/83 75	118/87 78	117/84 67	109/80 87	119/78 69	111/83 75
7/9/2017	174.6	118/82 58	124/87 67	128/88 68	110/79 75	107/74 88	113/71 65
7/10/2017	173.2	123/91 77	125/91 78	124/82 59	121/80 83	106/70 85	111/73 68
7/11/2017	173.2	128/86 78	126/80 74	130/77 83	114/73 78	114/83 89	98/64 72
7/12/2017	174.8	119/86 59	117/83 54	124/94 98	113/78 84	113/77 81	101/75 71
7/13/2017	174.4	125/85 63	133/88 76	139/97 71	112/81 79	122/85 74	112/83 86
7/14/2017	175.6	131/86 80	120/73 67	125/82 73	123/81 71	113/76 68	111/70 69
7/15/2017	174.0	110/78 82	94/64 78	109/68 96	109/72 91	111/74 65	109/75 78
7/16/2017	173.8	121/92 57	127/75 68	126/87 76	109/70 95	98/69 85	104/66 89
7/17/2017	173.6	108/79 93	130/88 69	119/81 66	122/90 91	115/80 89	128/87 91
7/18/2017	174.6	125/89 88	111/76 83	122/79 88	121/88 88	120/83 68	119/80 78
7/19/2017	174.2	137/94 93	129/98 86	130/99 62	120/80 72	113/82 90	112/82 90
7/20/2017	173.2	122/75 84	112/78 91	111/74 80	118/84 83	122/86 75	121/88 70
7/21/2017		106/74 83	110/75 78	115/68 77			
7/22/2017	173.8	123/78 57	128/88 81	122/80 93	114/82 69	110/81 90	105/78 67
7/23/2017	174.0	115/71 74	124/90 73	125/94 70	120/90 81	114/83 90	117/80 87
7/24/2017	172.4	123/74 80	120/75 75	123/78 52	103/72 81	104/74 88	108/74 91
7/25/2017	174.2	114/76 63	117/86 76	113/83 62	117/89 92	113/82 71	111/85 94
7/26/2017	174.4	121/89 92	124/80 94	112/74 76	109/73 90	106/73 93	112/77 74
7/27/2017	174.4	116/78 77	114/78 93		123/98 95	121/91 86	108/81 87
7/28/2017	174.2	135/85 80	110/79 67	128/80 78			
7/29/2017	174.2				128/93 92	126/92 80	126/88 94
7/30/2017	174.0	140/91 85	124/78 69	132/81 68			
7/31/2017	173.6	115/76 63	121/86 88	137/83 91	124/84 101	110/80 64	118/85 86

File: BP pulse chart



Our Multidisciplinary Team

Richelle Koopman, M.D., M.S., U Missouri
Family Physician Researcher

Victoria Shaffer Ph.D., MU, U Missouri
Quantitative Psychologist, Decision Scientist

Jeffery L. Belden M.D., U Missouri
Family Physician Usability Expert

Pete Wegier Ph.D., U Toronto
Quantitative Psychologist, Decision Scientist

Shannon M. Canfield Ph.D., M.P.H., U Missouri
Patient Engagement, Social Work

Linsey M. Steege Ph.D., U Wisconsin
Human Factors Engineering

Mihail Popescu Ph.D., U Missouri
Computer Science and Informatics

Deborah Cohen, Ph.D., OHSU
Family Medicine, Conversation Analysis

Akshay Jain, Ph.D., U Missouri
Computer Science Engineering

K.D. Valentine Ph.D., Harvard
Quantitative Psychologist, Decision Scientist

Nuha Wareg, M.P.H., U Missouri
Family Medicine

Tamar Wyte-Lake, D.P.T, M.P.H., OHSU
Family Medicine

Jennifer Hall, M.P.H., OHSU
Family Medicine

Sean Duan M.S., U Missouri
Psychology

Sonal Patil M.D., M.S.P.H., U Missouri
Family Physician Researcher

Mike LeFevre M.D., M.S.P.H., U Missouri
Family Physician, former member of JNC 8

Our Methods by Objective

Overarching iterative human-centered design process beginning April 2015

- Determine patient/physician information needs
  - 10 focus groups and key informant interviews
  - n =16 patients, n = 24 FM/GIM physicians, and n = 1 CMIO
- Assess effect of form of data visualization on patient risk perception
  - 6 online experiments each with n = 50-75 people with hypertension, US national sample
- Assess interaction of health literacy, numeracy, and graph literacy with form of data visualization
  - 1 large online experiment, n = 1079

Our Methods by Objective

- Explore use of fuzzy logic and linguistic summarization of data
  - Data experiments with patient home blood pressure data, n = 40 patients with 90 days of data
- Pair blood pressure data visualization with medication timeline
  - Usability task analysis, n = 21 physicians

EHR Implementation, phased July 2018 – May 2019

- Examine effect of implemented data visualization on physician-patient communication about hypertension
  - Video recordings including screen capture of 89 patient visits with 15 physicians with conversation analysis

Visualization Design: Our Team's Principles

1. Design for primary care setting
2. Design for shared decision making
   - Patient information needs and comprehension
   - Physician information needs and workflow
3. Intuitive design
4. Cognizant of how data visualization can affect decision making

What will people expect to see?

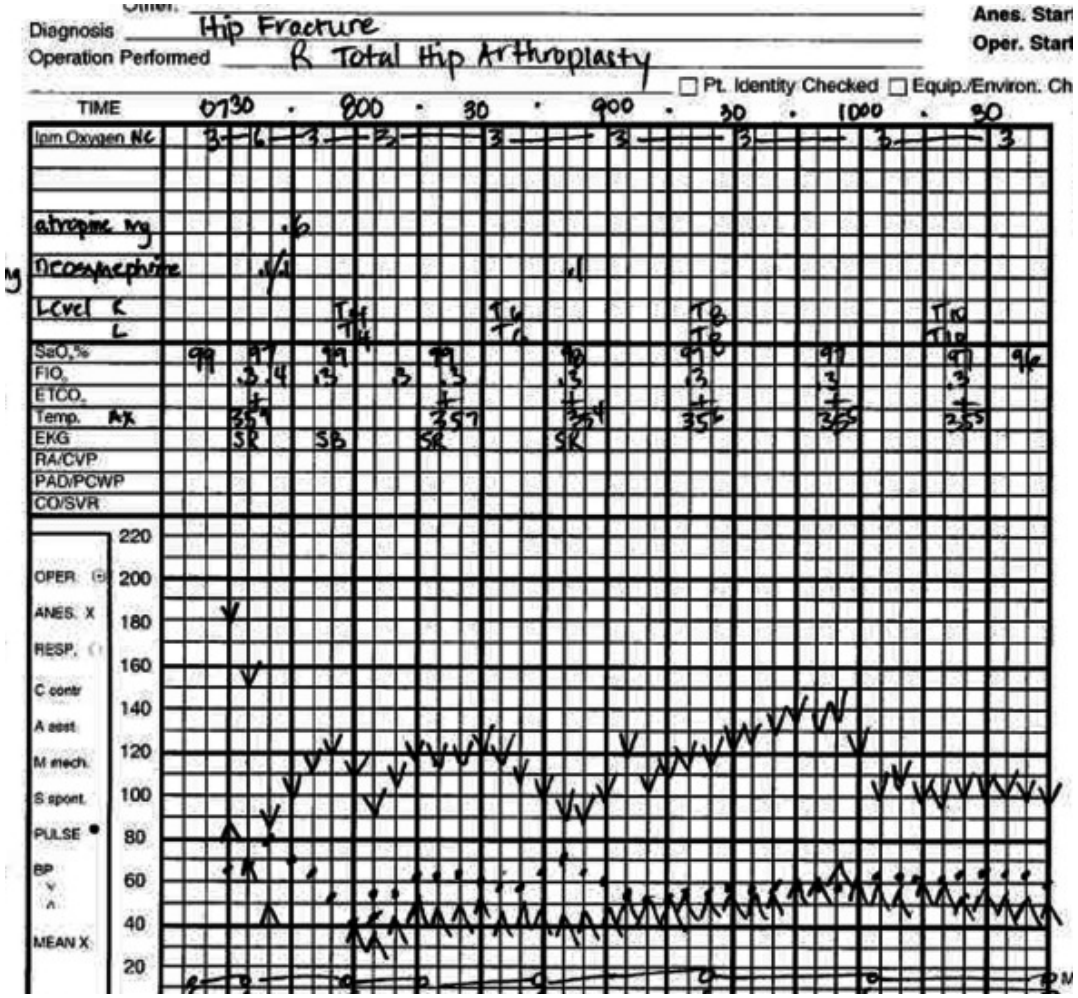
What will help them with their work?

Fang J, Alderman MH, Keenan NL, Ayala C, Croft JB. Hypertension Control at Physicians' Offices in the United States. *Am J Hypertens.* 2008;21(2):136-142

Design for Primary Care Setting – NOT Primary Care Example

Typical anesthesia intra-operative display

Caret and inverted caret, include heart rate and other data



Wegier P, Belden JL, Canfield SM, et al. Home blood pressure data visualization for the management of hypertension: using human factors and design principles. BMC Medical Informatics and Decision Making. 2021;21(1):235.

Principle: Design for Primary Care Setting

Information Need	Design Element
Systolic and diastolic data	Two-line graphs, Color to differentiate
Clinic and home data	Different symbols, same graph, same line
See the raw data numbers	Stack with values
Effect of medications on blood pressure	Stack graph with medication timeline
Understand goal ranges	Shaded goal ranges, default setting
Emphasize out of range values	Color, symbols (both rejected)
Customizable goal ranges	Radio buttons vs. manual entry
Patient burden of entry	Automated data upload
Understand data variability relative to control	LOWESS smoothing line
Contextual life event data	Annotations

Koopman RJ, Canfield SM, Belden JL, et al. Home blood pressure data visualization for the management of hypertension: designing for patient and physician information needs. BMC Medical Informatics and Decision Making. 2020;20(1):195.

Iterating Based on Patient-Physician Needs

From our ideas to what they need

Early Design: Representing Both Home and Clinic Blood Pressure

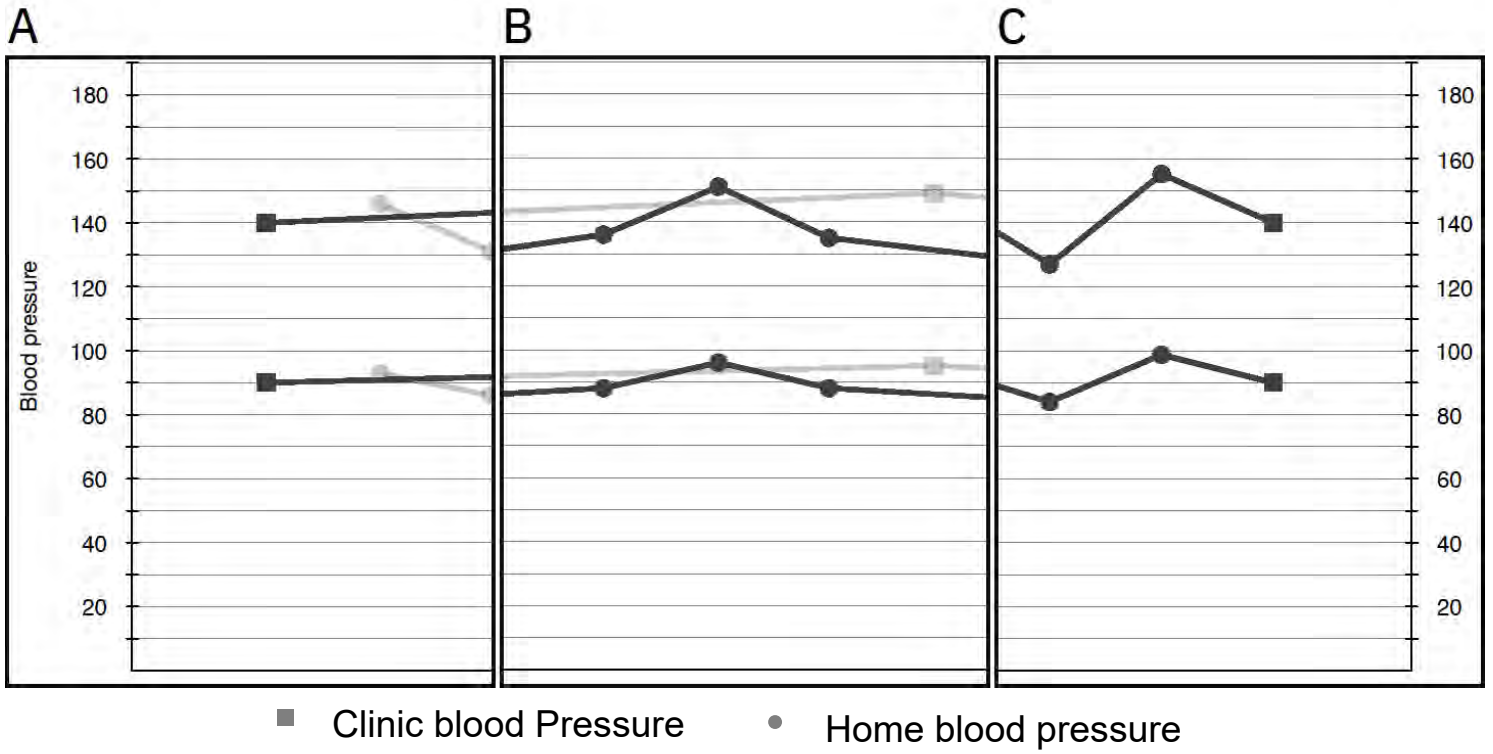


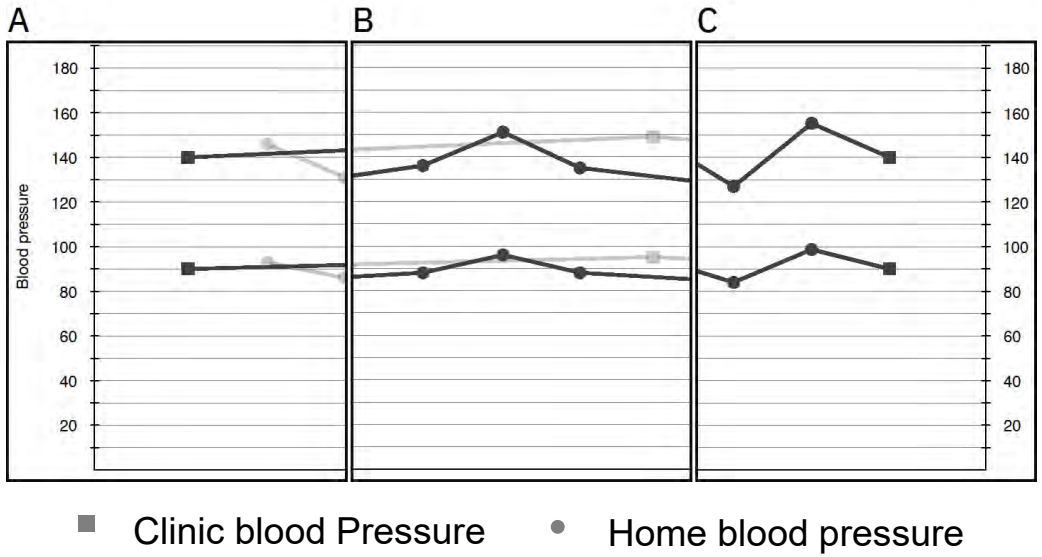
Fig. A and B: Toggle between clinic and home (vivid/soft)

☑ Fig. C: Both on same line, different symbols

Wegier P, Belden JL, Canfield SM, et al. Home blood pressure data visualization for the management of hypertension: using human factors and design principles. BMC Medical Informatics and Decision Making. 2021;21(1):235.

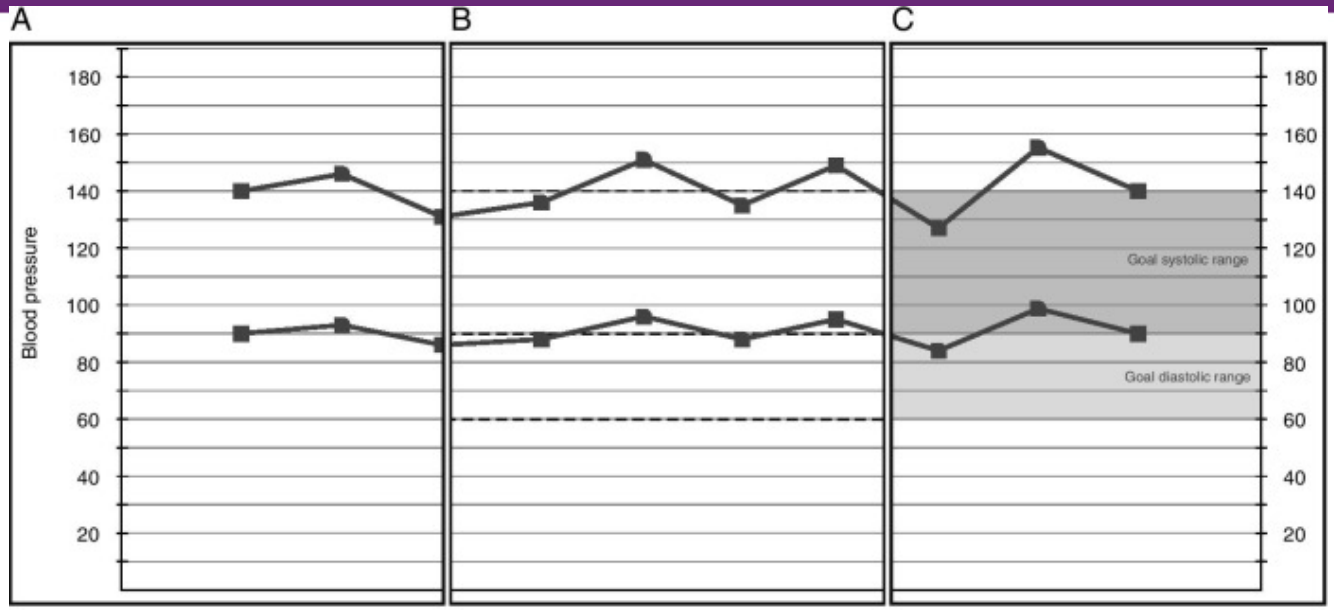
Early Design Decisions

- 2-Line graph form with systolic and diastolic in same graph space
- Lines continuous despite gaps in data
- Y axis remains constant despite no values below 80 mm Hg
- Home blood pressure given equal weight to clinic blood pressure
- Experimented with open vs. closed data points for home blood pressures depending if home monitor had been validated



Wegier P, Belden JL, Canfield SM, et al. Home blood pressure data visualization for the management of hypertension: using human factors and design principles. BMC Medical Informatics and Decision Making. 2021;21(1):235.

Goal Ranges



Design Decisions

- Patients and physicians strongly desired indicators of goal
- Capitalizes on pre-attentive attributes of color and enclosure to simplify visual processing – easier to see that data is “in” or “out” of range
- Color – we thought that people might want to print these graphs, so we designed in grayscale, a decision we would quickly abandon

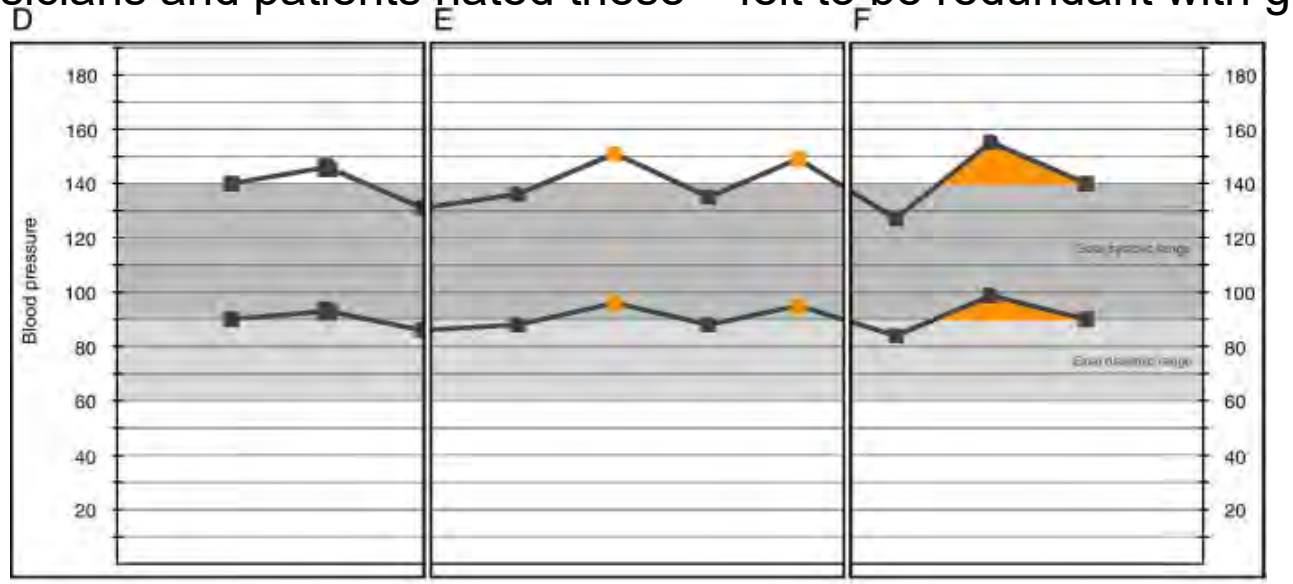
Wegier P, Belden JL, Canfield SM, et al. Home blood pressure data visualization for the management of hypertension: using human factors and design principles. BMC Medical Informatics and Decision Making. 2021;21(1):235.

Belden JL, Patel J, Lowrance N, Plaisant C, Koopman RJ, Moore JL, Snyder TR, Sonin J. Inspired EHRs: Designing for Clinicians. 2014. Ebook available at InspiredEHRs.org

Emphasize Outliers?

Design Decisions

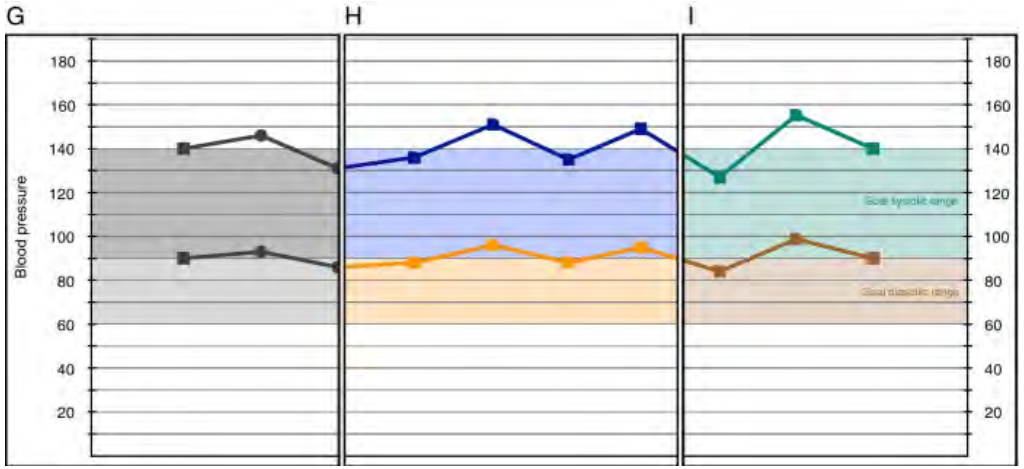
- Experimented with color to emphasize outliers – used an "alarm" color
- Perhaps increase emotional salience for the viewer?
- Physicians and patients hated these – felt to be redundant with goal ranges



"It [orange squares] doesn't seem to clarify anything… I can see that [orange fill means out of range]. I don't need the orange."— Round 1, Patient 17

Wegier P, Belden JL, Canfield SM, et al. Home blood pressure data visualization for the management of hypertension: using human factors and design principles. BMC Medical Informatics and Decision Making. 2021;21(1):235.

Color



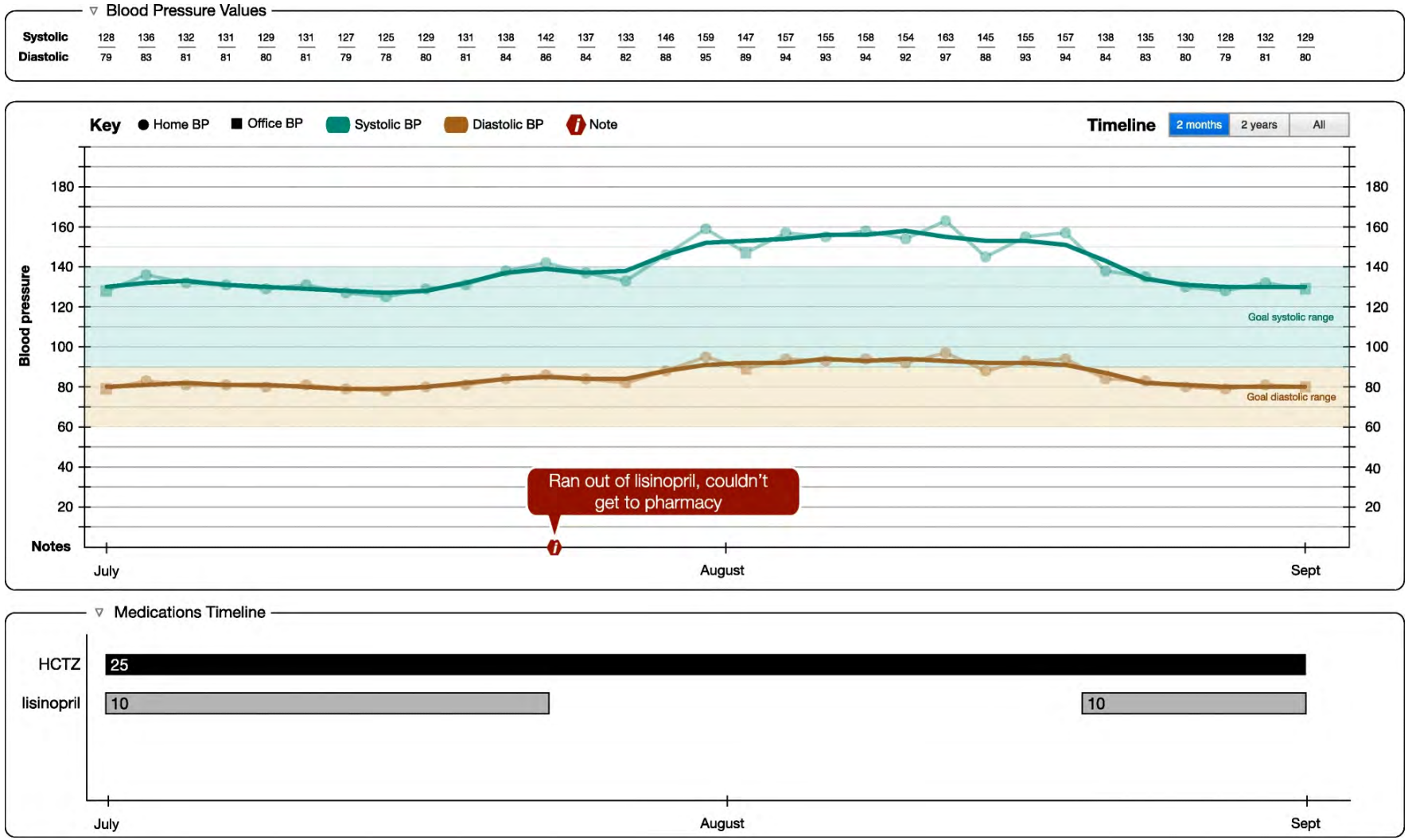
Design Decisions

- When diastolic is high, it strays into the systolic goal band → abandon gray scale, use distinct colors, data point and corresponding goal band in same color
- When used effectively, color informs, and even calms the user
- Color provides context for the user using a pre-attentive attribute
- Original choice of blue/orange conflicted with the EHR color scheme for normal (blue) and out of range (orange) data, implemented design is mint and cocoa

Wegier P, Belden JL, Canfield SM, et al. Home blood pressure data visualization for the management of hypertension: using human factors and design principles. BMC Medical Informatics and Decision Making. 2021;21(1):235.

Belden JL, Patel J, Lowrance N, Plaisant C, Koopman RJ, Moore JL, Snyder TR, Sonin J. Inspired EHRs: Designing for Clinicians. 2014. Ebook available at InspiredEHRs.org

Intuitive Design, Inference

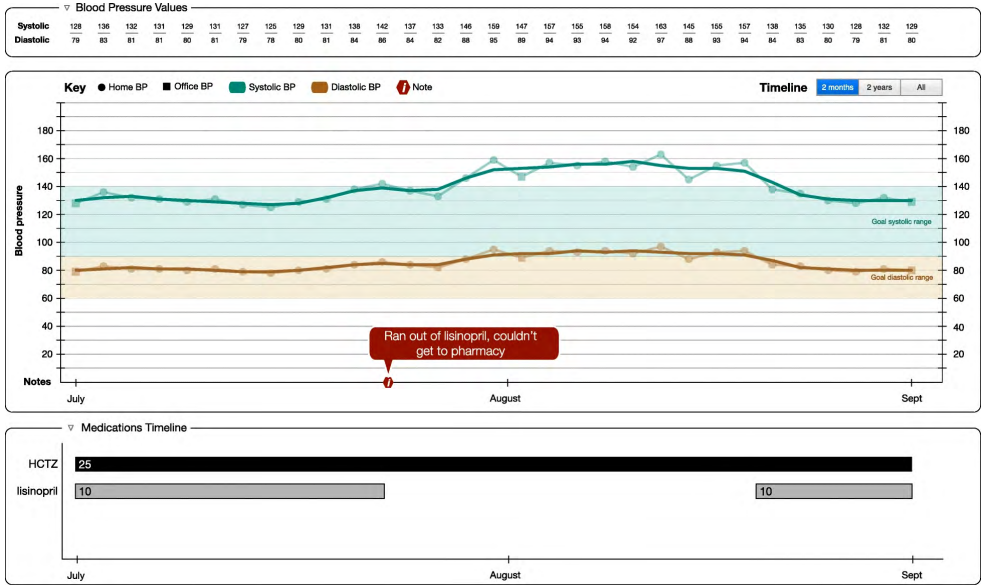


Koopman RJ, Canfield SM, Belden JL, et al. Home blood pressure data visualization for the management of hypertension: designing for patient and physician information needs. BMC Medical Informatics and Decision Making. 2020;20(1):195.

Intuitive Design, Inference

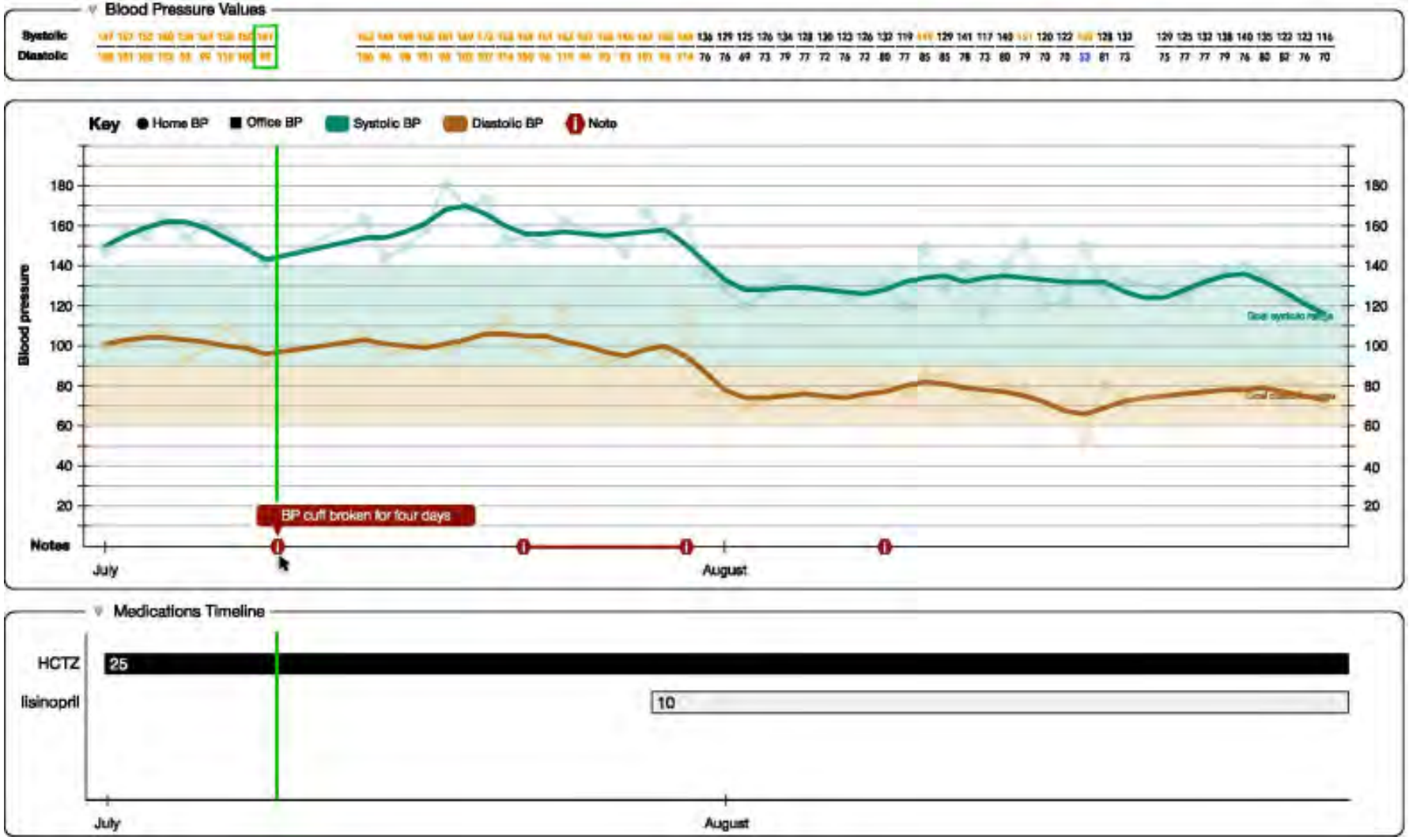
"I mean, it's doing great … [and then this person] quits taking the medication, it's just out of control."

Patient, Design Round 5



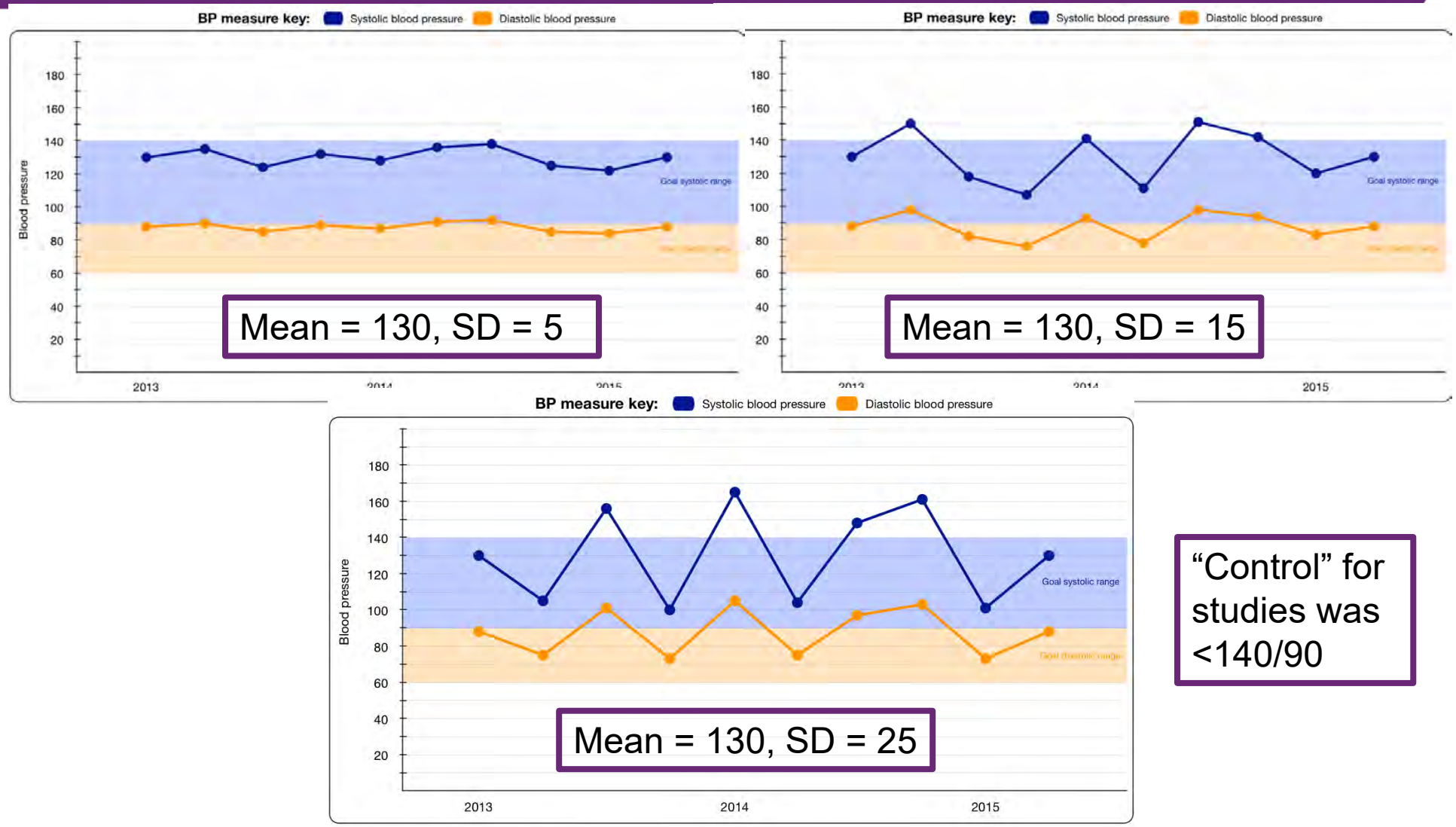
Koopman RJ, Canfield SM, Belden JL, et al. Home blood pressure data visualization for the management of hypertension: designing for patient and physician information needs. BMC Medical Informatics and Decision Making. 2020;20(1):195.

Smoothing Line



Wegier P, Belden JL, Canfield SM, et al. Home blood pressure data visualization for the management of hypertension: using human factors and design principles. BMC Medical Informatics and Decision Making. 2021;21(1):235.

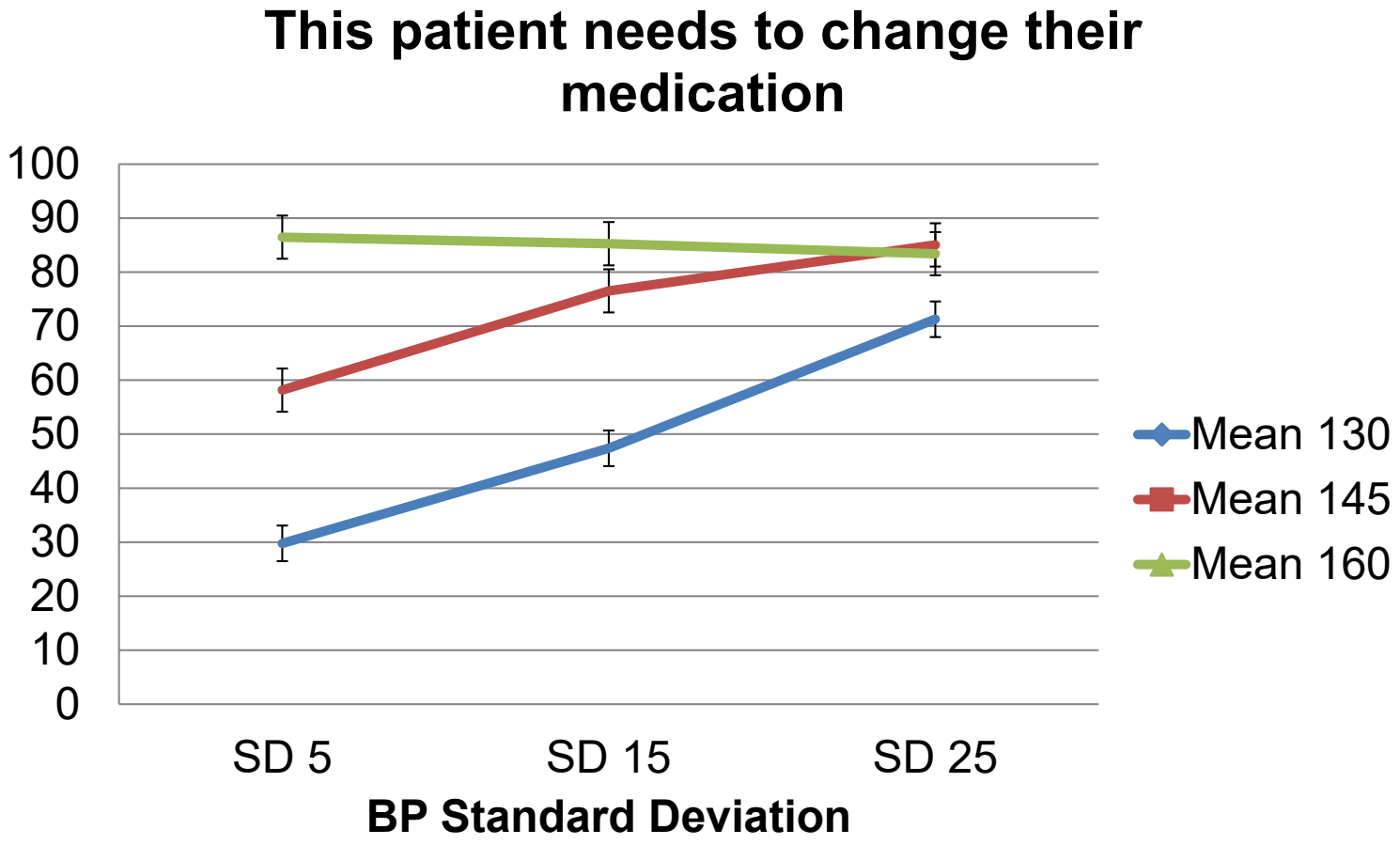
Effect of Variability on Judgment of Control



"Control" for studies was <140/90

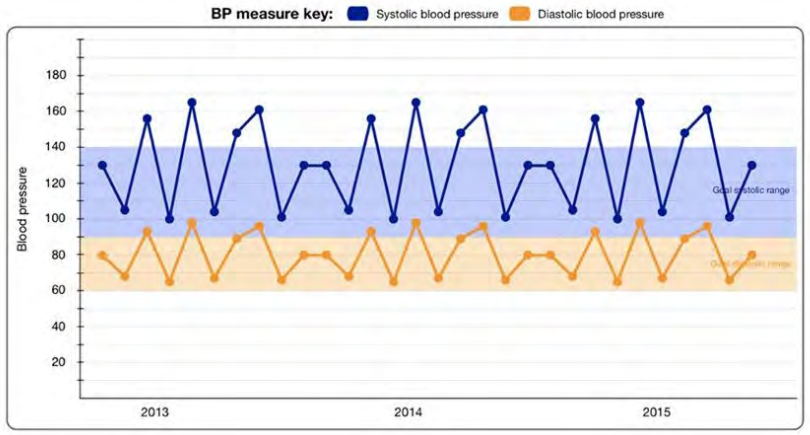
Shaffer VA, Wegier P, Valentine KD, Belden JL, Canfield SM, Patil SJ, Popescu M, Steege LM, Jain A, Koopman RJ. Patient Judgments about Hypertension Control: The Role of Variability, Trends, and Outliers in Blood Pressure Data. Journal of Medical Internet Research, 2019;21(3):e11366. DOI: 10.2196/11366. PMID: 30912759

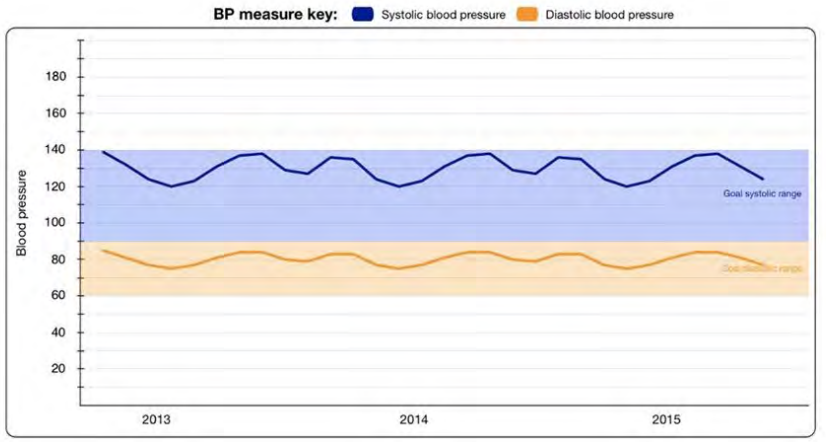
Effect of Variability on Judgment of Control



Shaffer VA, Wegier P, Valentine KD, Belden JL, Canfield SM, Patil SJ, Popescu M, Steege LM, Jain A, Koopman RJ. Patient Judgments about Hypertension Control: The Role of Variability, Trends, and Outliers in Blood Pressure Data. Journal of Medical Internet Research, 2019;21(3):e11366. DOI: 10.2196/11366. PMID: 30912759

Smoothing the Data



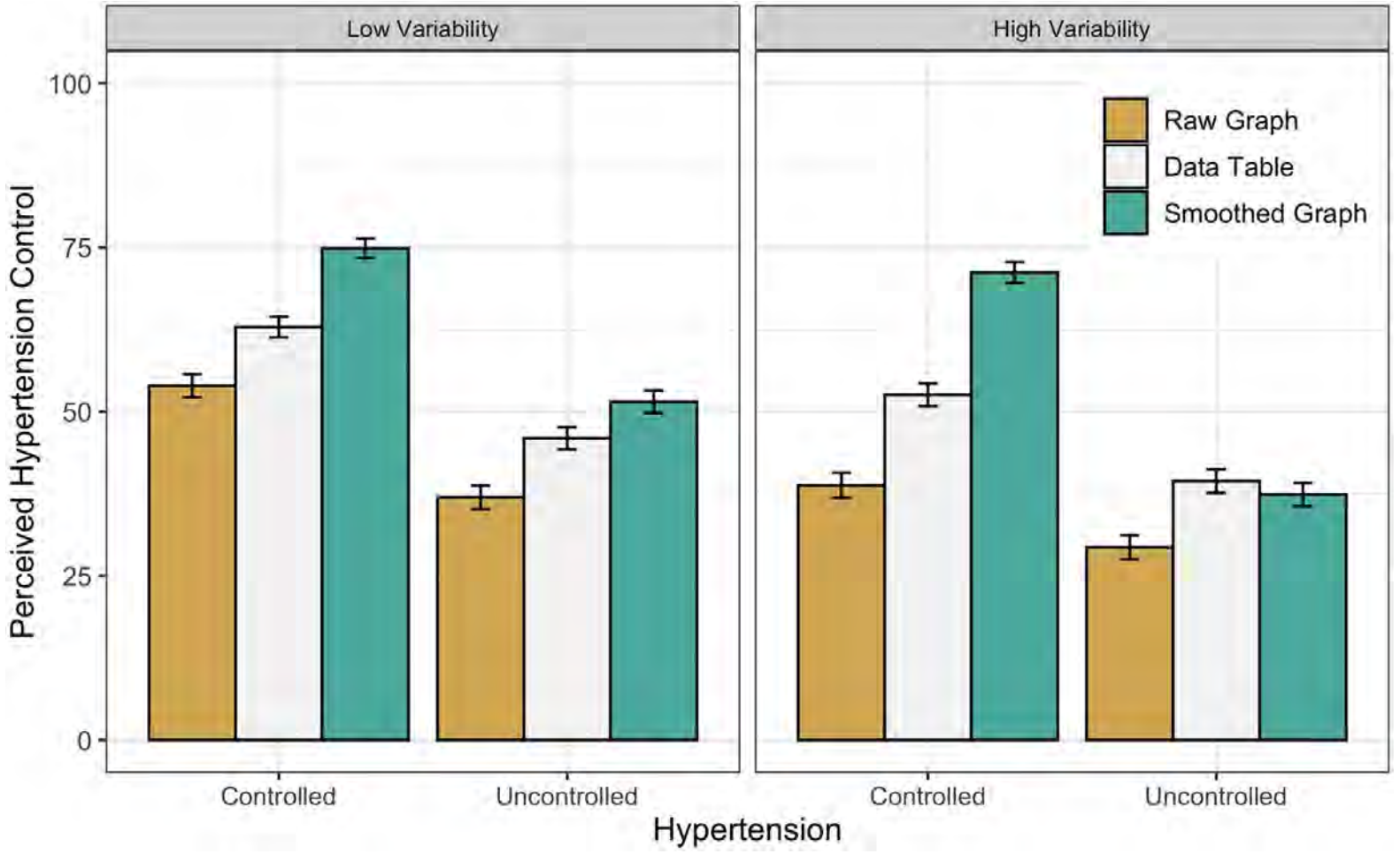


- LOWESS Smoothing Algorithm
- Variability is a potential distraction in judging control
- Evidence to value BP mean >> BP variability
- Smoothed data acceptable to physicians and patients, many wanted to see both raw and smoothed data

Shaffer VA, Wegier P, Valentine KD, Duan S, Canfield SM, Belden JL Steege LM, Patil SJ, Popescu M, Koopman RJ, Patient judgments about hypertension control: the role of patient numeracy and graph literacy, Journal of the American Medical Informatics Association, 2022.

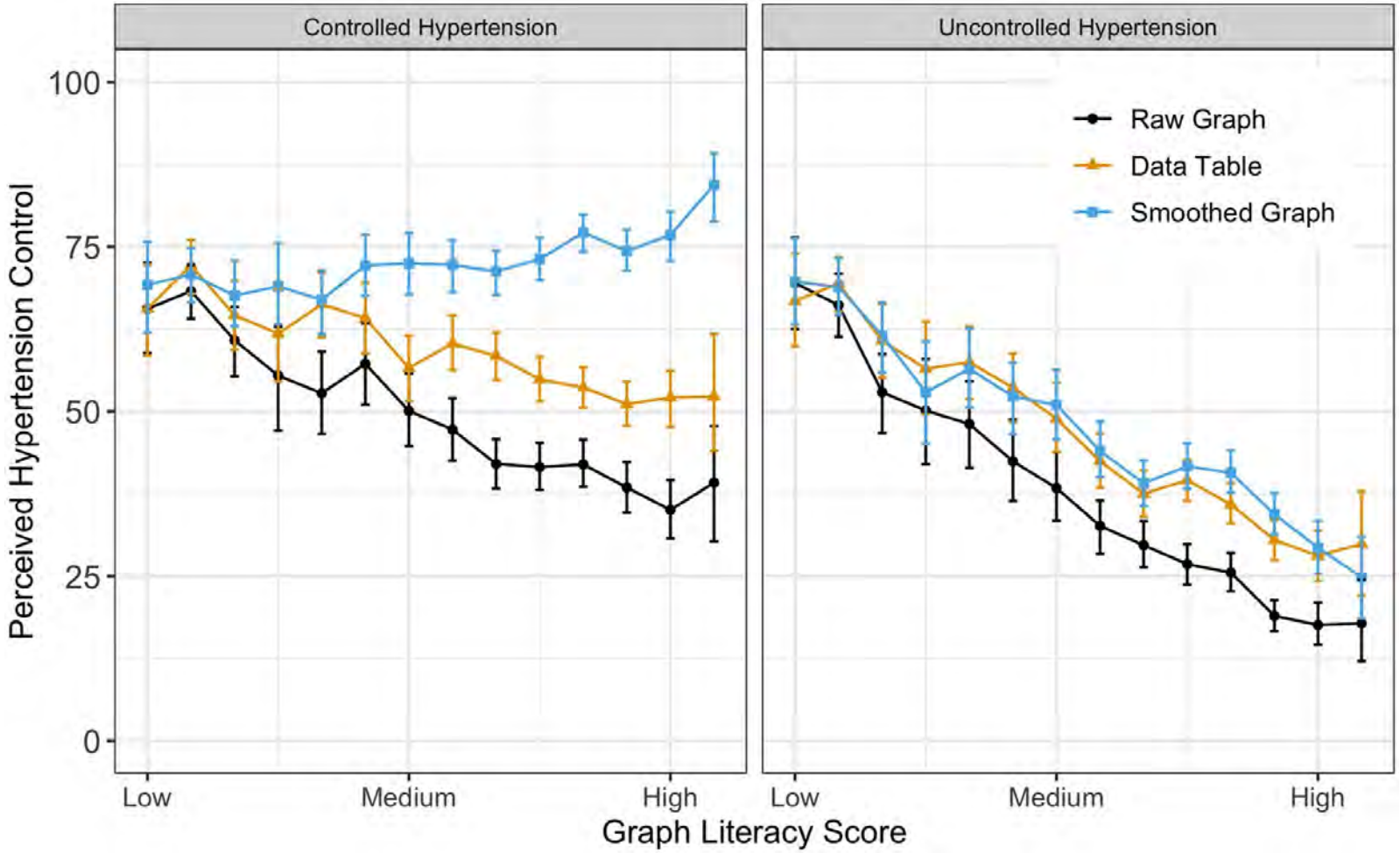
Hansen TW, Thijs L, Li Y, et al. Prognostic value of reading-to-reading blood pressure variability over 24 hours in 8938 subjects from 11 populations. Hypertension 2010; 55 (4): 1049–57.

How Much Does Smoothing Data Affect Judgment of Control?



Shaffer VA, Wegier P, Valentine KD, Duan S, Canfield SM, Belden JL Steege LM, Patil SJ, Popescu M, Koopman RJ, Patient judgments about hypertension control: the role of patient numeracy and graph literacy, Journal of the American Medical Informatics Association, 2022.

What is the Role of Graph Literacy in Judgments of Control?



Shaffer VA, Wegier P, Valentine KD, Duan S, Canfield SM, Belden JL Steege LM, Patil SJ, Popescu M, Koopman RJ, Patient judgments about hypertension control: the role of patient numeracy and graph literacy, Journal of the American Medical Informatics Association, 2022.

Sensemaking

"Neato … It's really just creating a story where you see what the blood pressure was, when the medicine was started, where it changed."

— Physician, Design Round 4

"It shows clearly that when you add the Hydrochlorothiazide … and then when you added the additional Lisinopril, that looks like the combination of those … made the blood pressure come down."

— Patient, Design Round 1

Koopman RJ, Canfield SM, Belden JL, et al. Home blood pressure data visualization for the management of hypertension: designing for patient and physician information needs. BMC Medical Informatics and Decision Making. 2020;20(1):195.

Cohen DJ, Wyte-Lake T, Canfield S, Hall JD, Steege L, Wareg NK, Koopman RJ. Impact of Home Blood Pressure Data Visualization on Hypertension Medical Decision Making in Primary Care. Annals of Family Medicine, July 2022, 20 (4) 305-311

Elevating the Value of Patient-Generated Health Data

- Collecting and seeing their data in the EHR gave patients insights into effects of lifestyle on blood pressure (e.g., one patient told his doctor during a visit that this made him quit smoking)
- By incorporation patient generated data in to our EHR workflow, we:
  - Elevate the importance of these data
  - Honor the patient's effort in collecting the data
  - Signal the patients role as an active partner and co-decision maker in managing their condition

Koopman RJ, Canfield SM, Belden JL, et al. Home blood pressure data visualization for the management of hypertension: designing for patient and physician information needs. BMC Medical Informatics and Decision Making. 2020;20(1):195.

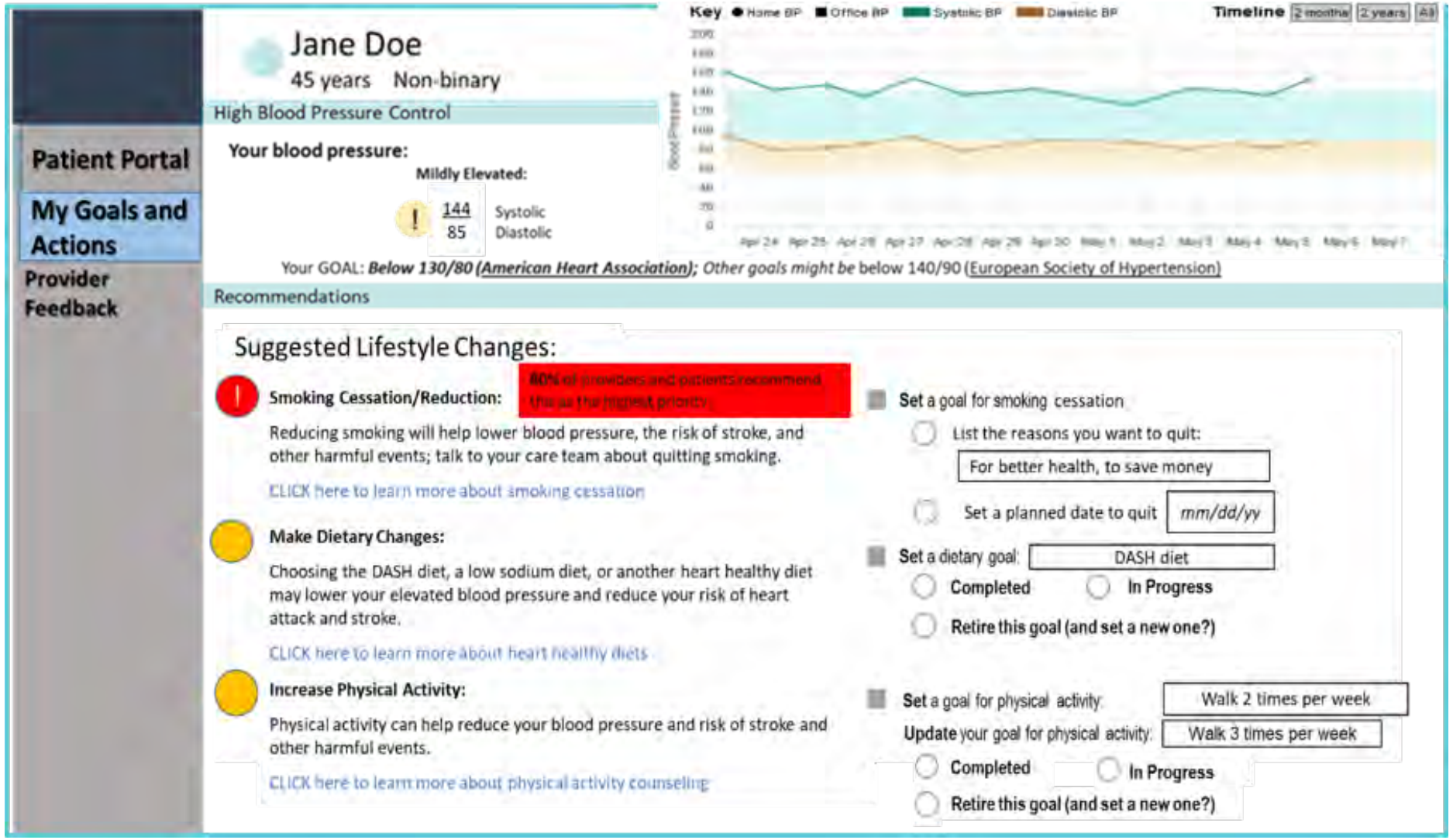
Cohen DJ, Wyte-Lake T, Canfield S, Hall JD, Steege L, Wareg NK, Koopman RJ. Impact of Home Blood Pressure Data Visualization on Hypertension Medical Decision Making in Primary Care. Annals of Family Medicine, July 2022, 20 (4) 305-311

Limitations and Next Steps

- Clinicians exclusively primary care physicians
  - Follow up focus group with advanced practice nurses and care managers yielded similar results
- Implemented in EHR but not patient portal
- Automated upload of patient data
- Determining the flow of home blood pressure data and who manages it
- Logistics of a sustainable practice for using home data in between visits to improve control

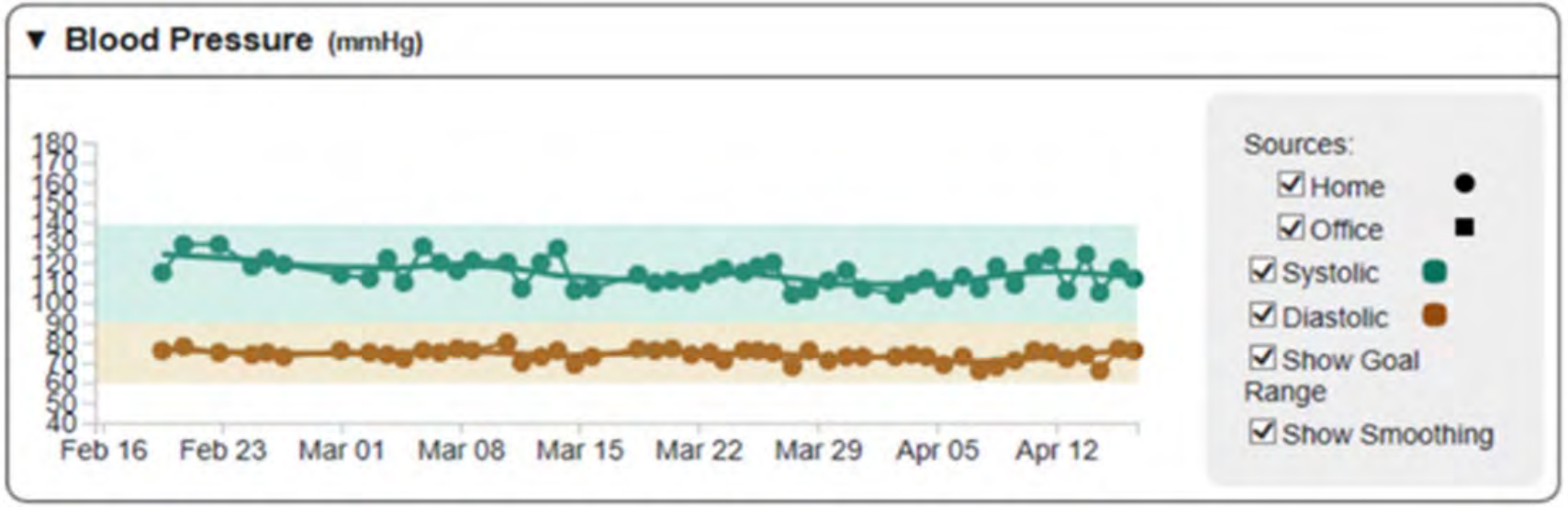
Next: COACH

Collaboration-Oriented Approach to Controlling High blood pressure



Parting Shot:
Pandemic Hypertension Management

April 16, 2020



Telehealth visit with my own patient

Contact Information

Richelle J. Koopman, M.D., M.S.
koopmanr@health.missouri.edu

Health Care
University of Missouri Health System

AGENCY FOR HEALTHCARE RESEARCH AND QUALITY

AHRQ

Building an EHR Application to Display Real-Time Patient-Reported Outcomes Data: Successes and Challenges

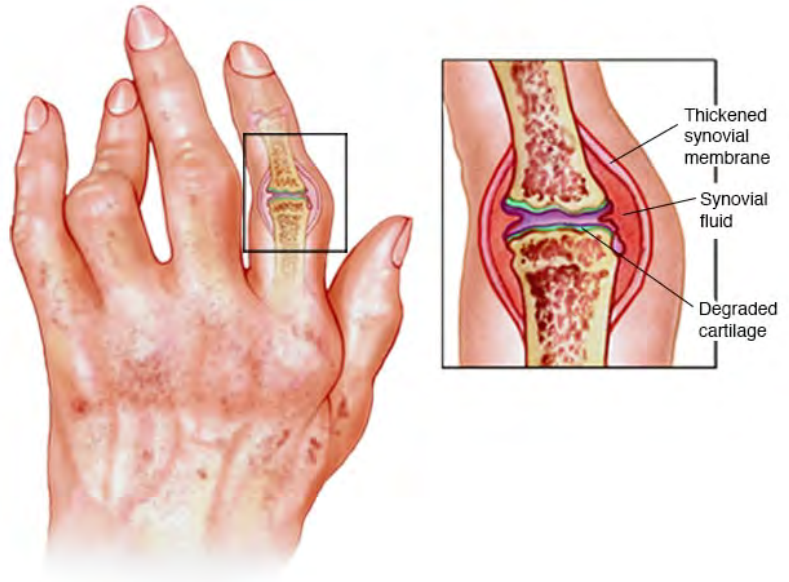
Gabriela Schmajuk, M.D., M.S.
Associate Professor of Rheumatology, Department of Medicine,
University of California, San Francisco
SFVA

Outline

- What is Rheumatoid Arthritis (RA)?
- Tracking disease activity and treating disease
- Human-centered design of a data visualization tool and workflow
- Dashboard implementation
- Stepped-wedge cluster randomized trial
- Successes and challenges

What is Rheumatoid Arthritis (RA)?

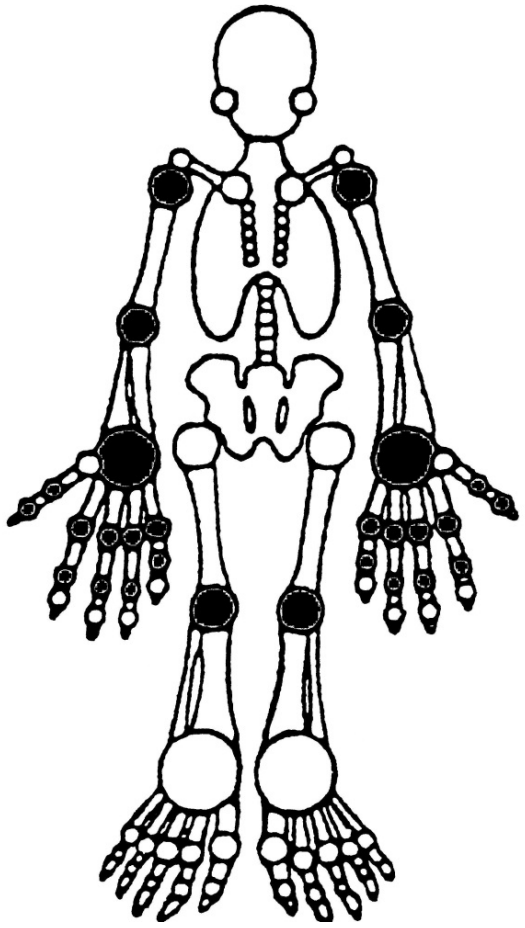
- Chronic inflammatory disease
- Females > males
- Symptoms: Join pain, stiffness, and swelling especially in hands and wrists
- Longstanding active disease: Deformity and loss of function
- Treatment: Immunosuppressants such as methotrexate or biologics (e.g., TNF inhibitors)



© MAYO FOUNDATION FOR MEDICAL EDUCATION AND RESEARCH. ALL RIGHTS RESERVED.

https://www.mayoclinic.org/diseases-conditions/rheumatoid-arthritis/symptoms-causes/syc-20353648

Patient-Reported Outcomes (PROs)



Lack of "objective" outcome measures

↓

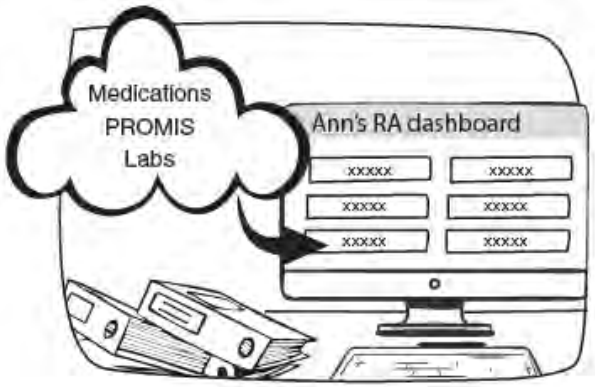
We rely on patient-reported outcomes (PROs)

1. **Disease activity** – Clinical Disease Activity Index (CDAI): Tender joint count + swollen joint count + patient global + physician global
2. **Functional status** – Patient-Reported Outcomes Measurement Information System (PROMIS) physical function: 10 questions about activities of daily living (ADLs) and other daily activities
3. **Pain Score**

Treat-to-Target Approach

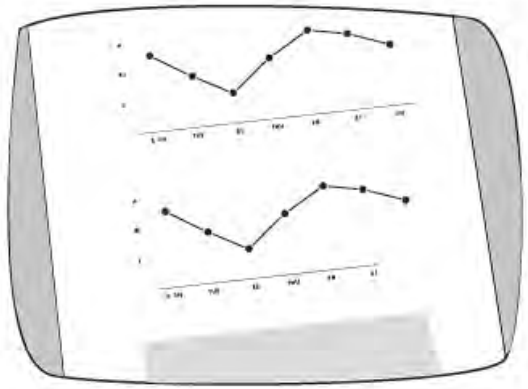
- Persistent, high disease activity is associated with physical damage
- **Treatment philosophy**: "Treat-to-target" based on patient-reported outcomes (disease activity scores)
  - Measure disease activity using a composite measure, at least every 3 months
  - Adjust disease-modifying agents with goal of LOW disease activity or REMISSION (CDAI score < 10)

Data Visualization Tool – Initial Concepts



Pre-visit data is auto-loaded from EHR into Ann's RA dashboard.

During Ann's visit, Dr. Gomez updates EHR with data from her exam, such as swollen and tender joints. This data updates her dashboard.



Dr. Gomez and Ann look at all of her data together and discuss progress, medications, treatment, lifestyle and goals.

App Development Roadmap

Develop

- Using principles of human-centered design, patient and clinician stakeholders helped design an EHR-based tool to support shared decision making for RA patients
- **Key features requested**: trajectories of disease activity, functional status, medications and labs, ability to print and share with family and other doctors

Build

- Technical team embedded in our health system built an application that would pull information directly from the EHR
- **Key features built:** pulls historical and real-time data from EHR for PROs, medications, and labs; user friendly interface designed for low-literacy patients.

Implement

- Risk assessments and regulatory approvals completed
- Pilot testing by users (clinicians and patients) in both sandbox and production environments.

Test

- Pragmatic cluster-randomized trial of the dashboard is underway to assess how its use ay affect shared decision making, patient satisfaction, self-efficacy, medication adherence, and PROs.
- Continued feedback from patients and clinicians through surveys, interviews, and focus groups.

App Development Roadmap

Develop

- Using principles of human-centered design, patient and clinician stakeholders helped design an EHR-based tool to support shared decision making for RA patients
- **Key features requested**: trajectories of disease activity, functional status, medications and labs, ability to print and share with family and other doctors

Build

- Technical team embedded in our health system built an application that would pull information directly from the EHR
- **Key features built:** pulls historical and real-time data from EHR for PROs, medications, and labs; user friendly interface designed for low-literacy patients.

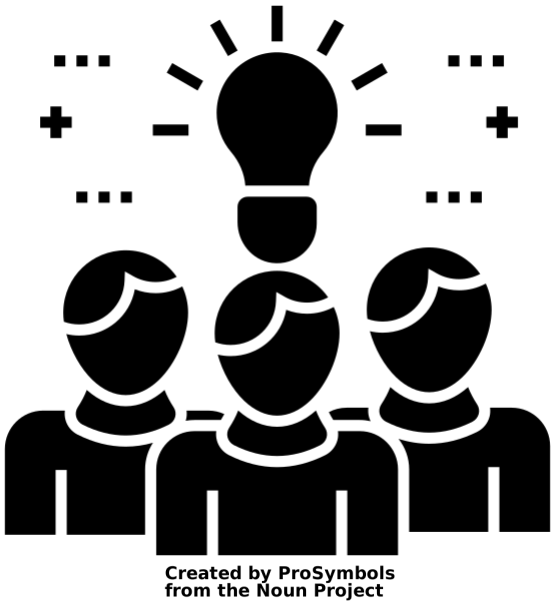
Implement

- Risk assessments and regulatory approvals completed
- Pilot testing by users (clinicians and patients) in both sandbox and production environments.

Test

- Pragmatic cluster-randomized trial of the dashboard is underway to assess how its use ay affect shared decision making, patient satisfaction, self-efficacy, medication adherence, and PROs.
- Continued feedback from patients and clinicians through surveys, interviews, and focus groups.

Human-Centered Design of a Data Visualization Tool

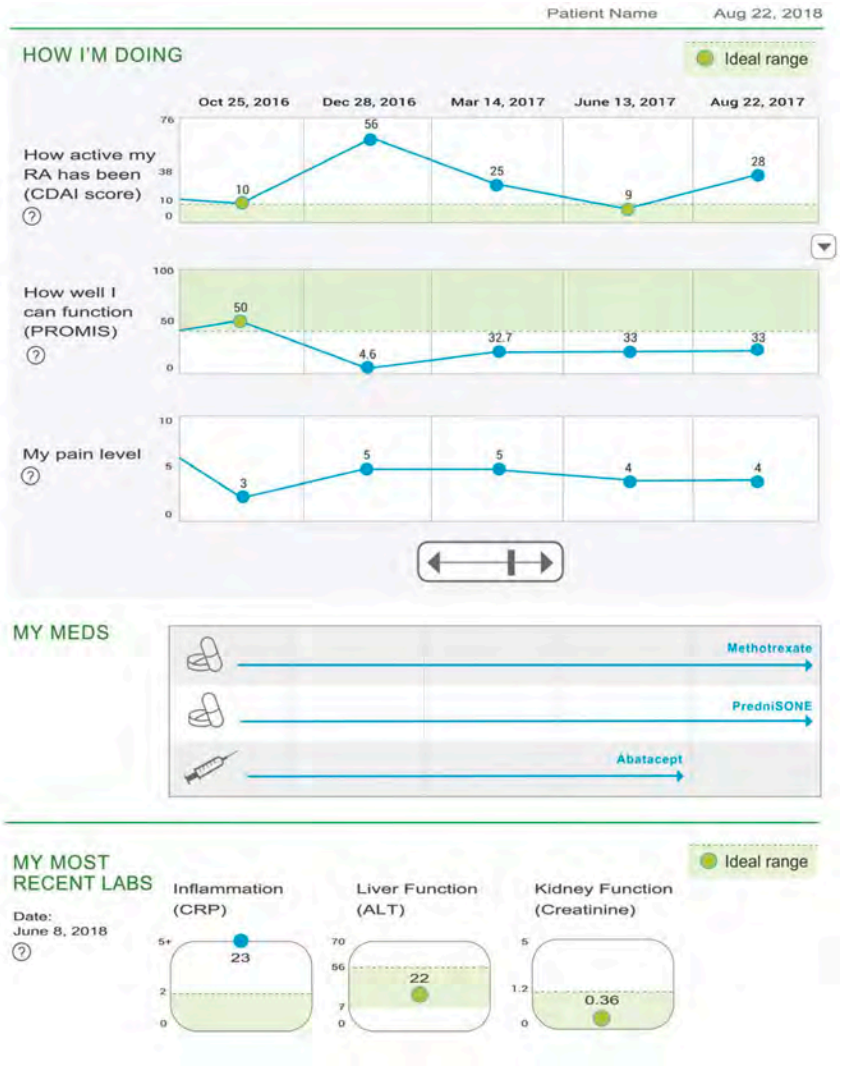


- **Patients**: 20 interviews and 6 focus groups
  - A total of 45 patients from university and county hospitals
  - Adequate and limited health literacy
  - English and Spanish primary languages
- **Clinicians**: 3 focus groups
  - A total of 11 clinicians from university and county hospitals
  - Attendings and fellows, nurse practitioner

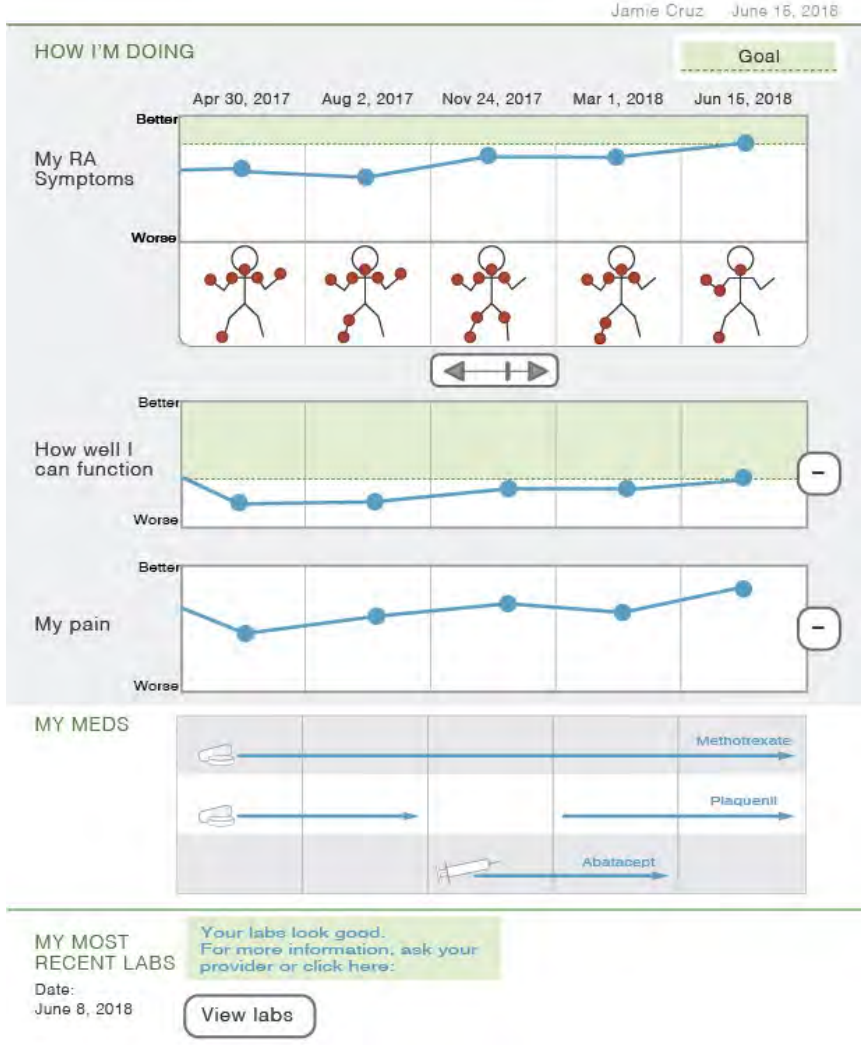
DOI: 10.1111/hex.13057

Human-Centered Design of a Data Visualization Tool

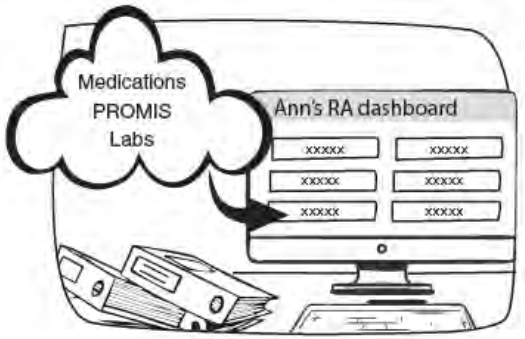
Early version



Final Version

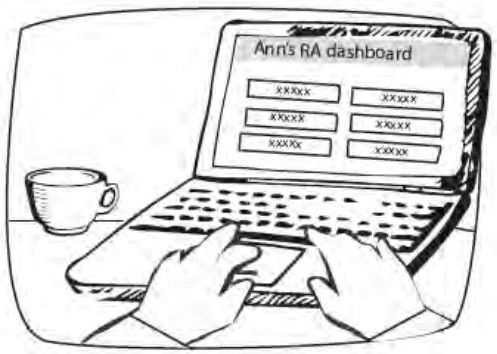


Human-Centered Design of a Data Visualization Tool Workflow

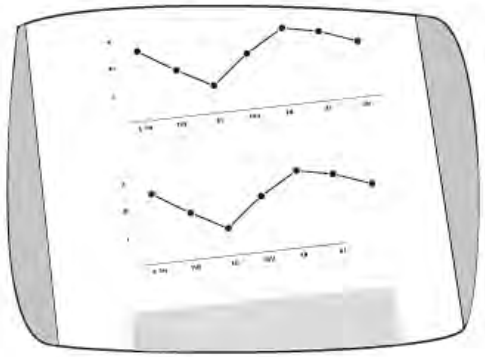


Pre-visit data is auto-loaded from EHR into Ann's RA dashboard.

During Ann's visit, Dr. Gomez updates EHR with data from her exam, such as swollen and tender joints. This data updates her dashboard.



Dr. Gomez launches Ann's dashboard from the RA Navigator in Epic.



Dr. Gomez and Ann look at all of her data together and discuss progress, medications, treatment, lifestyle, and goals.

Ann takes a printout of these options with her, which she can also access later through MyChart.

Later she references the printout when discussing her medication options with her sister.

App Development Roadmap

Develop

- Using principles of human-centered design, patient and clinician stakeholders helped design an EHR-based tool to support shared decision making for RA patients
- **Key features requested**: trajectories of disease activity, functional status, medications and labs, ability to print and share with family and other doctors

Build

- Technical team embedded in our health system built an application that would pull information directly from the EHR
- **Key features built:** pulls historical and real-time data from EHR for PROs, medications, and labs; user friendly interface designed for low-literacy patients.

Implement

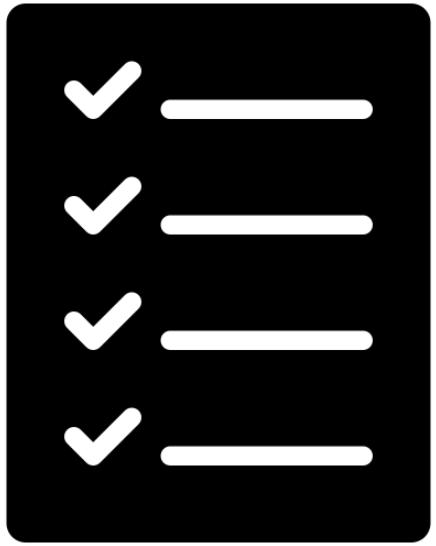
- Risk assessments and regulatory approvals completed
- Pilot testing by users (clinicians and patients) in both sandbox and production environments.

Test

- Pragmatic cluster-randomized trial of the dashboard is underway to assess how its use ay affect shared decision making, patient satisfaction, self-efficacy, medication adherence, and PROs.
- Continued feedback from patients and clinicians through surveys, interviews, and focus groups.

Implementation of the RA PRO Dashboard – Requirements

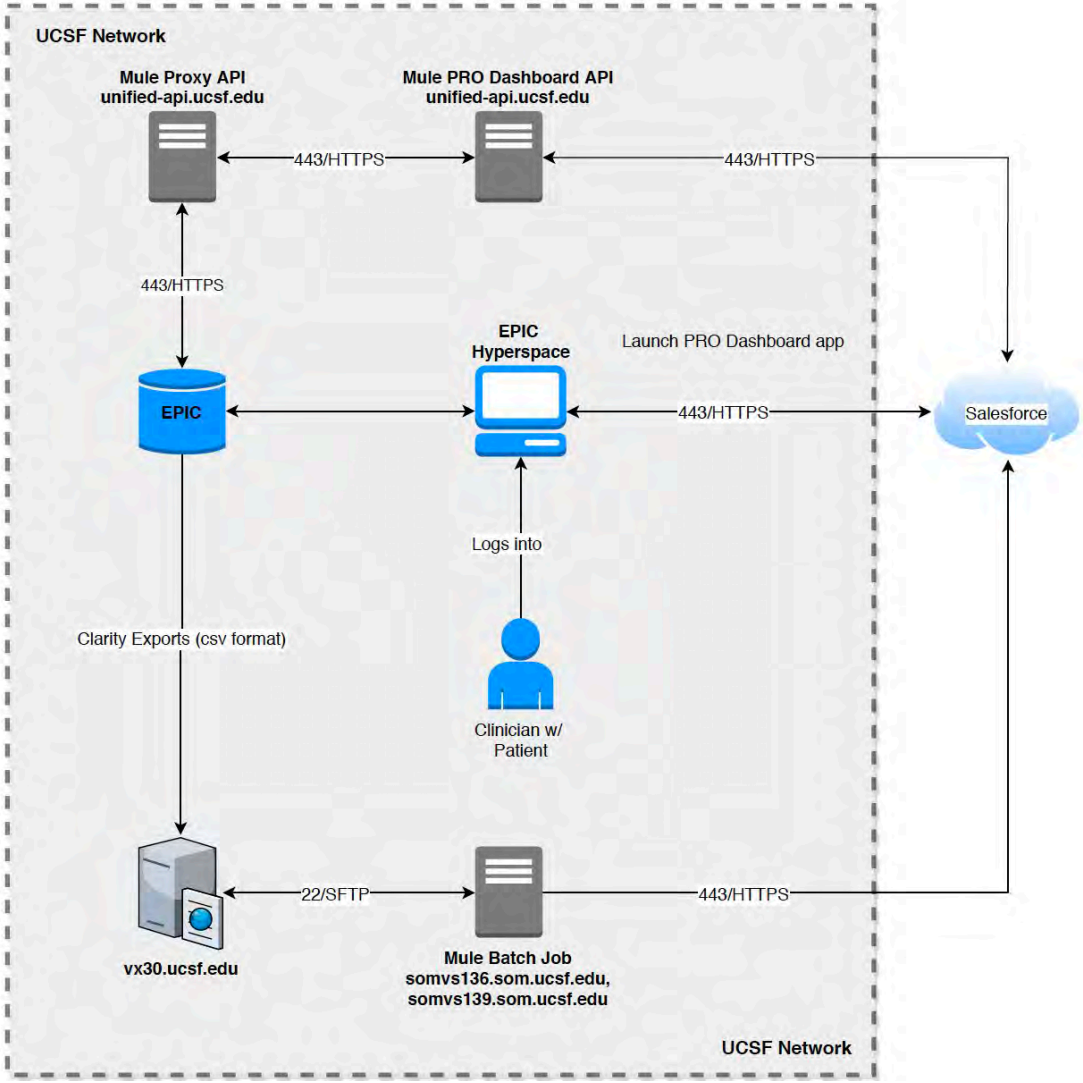
- Historical and real-time data from the EHR including:
  - PROs: CDAI, PROMIS, pain from same day's visit
- Tracking scores over time
- Customizable (toggles and “view” buttons)
- Printable for after-visit review
- Automatic launch within Epic (no separate login process)
- User logs / analytics



Implementation of the RA PRO Dashboard – Regulatory Review

- Institutional Digital Diagnostics and Therapeutics Committee (DD&T) oversees and supports extraction of real-time data from Epic via use of APIs
  - Contracting with an internal technical team streamlined our work with DD&T

Implementation of the RA PRO Dashboard – App Architecture



Dashboard built using Salesforce as a "side-car" application

👍 Development can focus on user interface

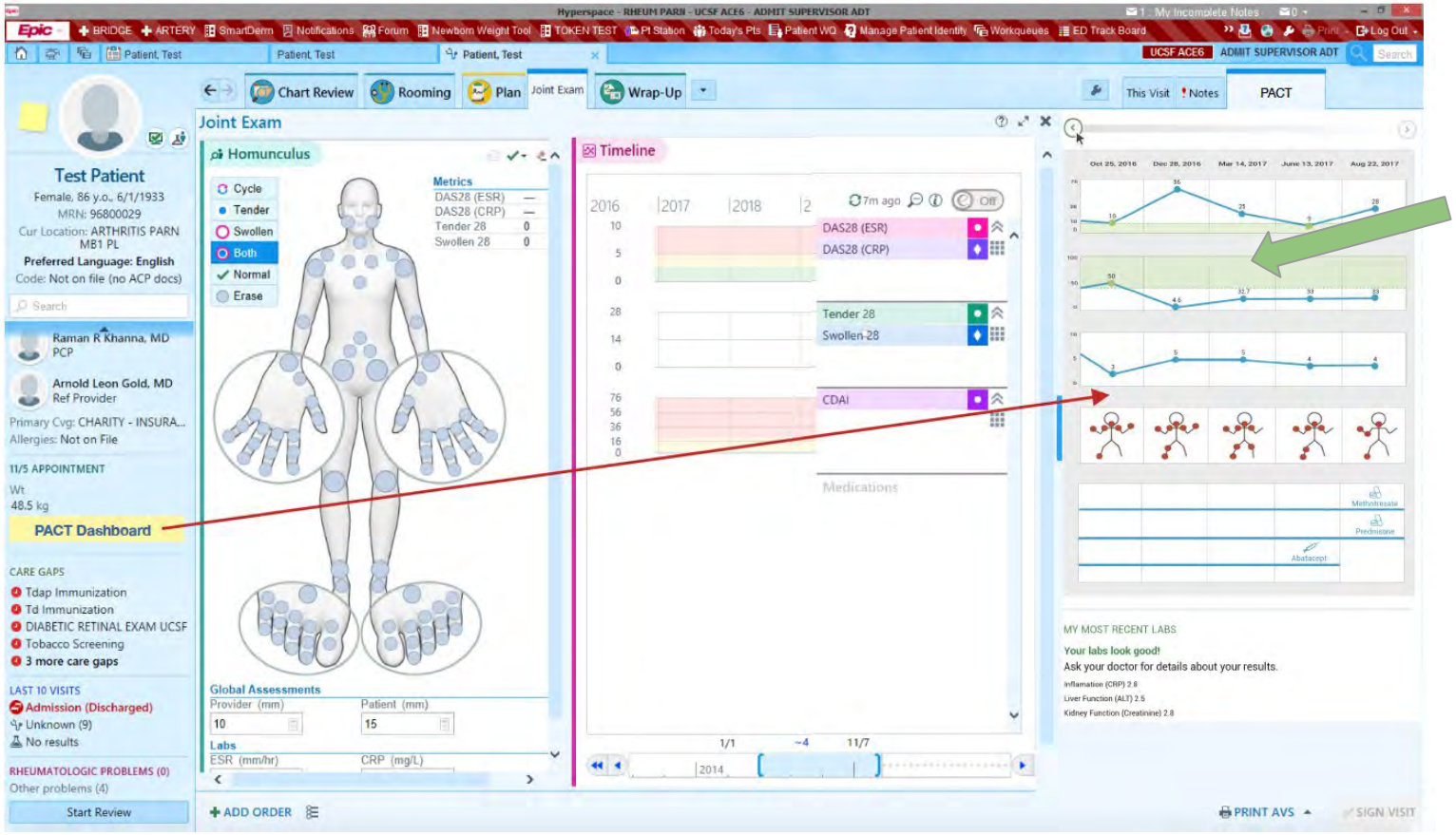
👍 Customization is possible

👍 Designed to pull historical and real-time data

👎 Design requires data flow from multiple sources

👎 Cost to license side-car app

Dashboard Auto-Launch

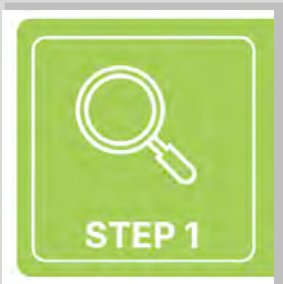


PRO Dashboard will automatically:

1. Open up on Epic for patients with RA.

2. Display CDAI, PROMIS, and pain scores after input during today's visit.

App Development Roadmap



Develop

- Using principles of human-centered design, patient and clinician stakeholders helped design an EHR-based tool to support shared decision making for RA patients
- **Key features requested**: trajectories of disease activity, functional status, medications and labs, ability to print and share with family and other doctors

Build

- Technical team embedded in our health system built an application that would pull information directly from the EHR
- **Key features built:** pulls historical and real-time data from EHR for PROs, medications, and labs; user friendly interface designed for low-literacy patients.

Implement

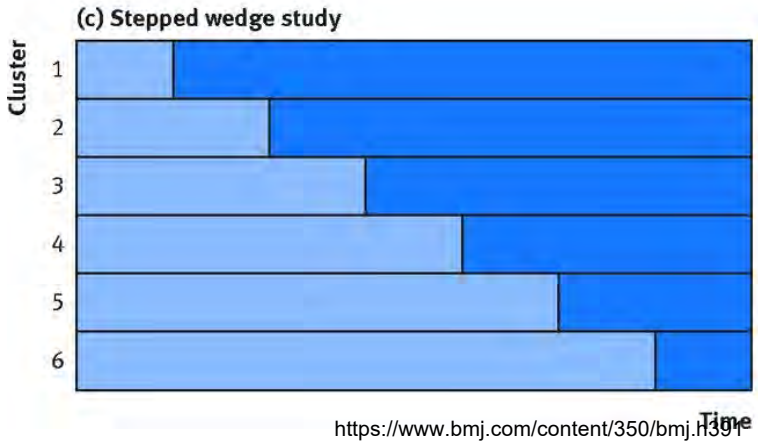
- Risk assessments and regulatory approvals completed
- Pilot testing by users (clinicians and patients) in both sandbox and production environments.

Test

- Pragmatic cluster-randomized trial of the dashboard is underway to assess how its use ay affect shared decision making, patient satisfaction, self-efficacy, medication adherence, and PROs.
- Continued feedback from patients and clinicians through surveys, interviews, and focus groups.

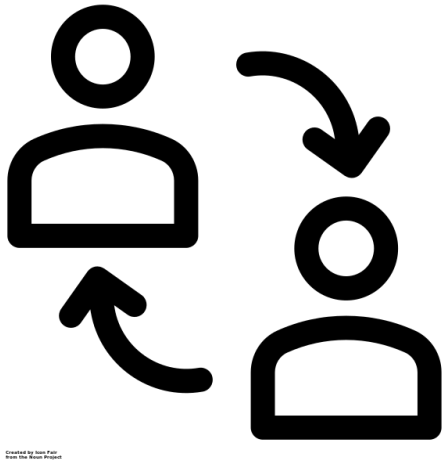
Stepped Wedge Cluster Randomized Trial Design

- **Hypothesis**: The RA PRO dashboard used during clinical encounters will increase patient engagement, foster shared decision making, and improve health outcomes for patients with RA.
- **Design**: Stepped wedge, cluster randomized at clinician level.
- Access is provisioned to clusters of 4-6 clinicians with group and 1:1 training and regular reminders on how to use it during the visit.



https://www.bmj.com/content/350/bmj.h391

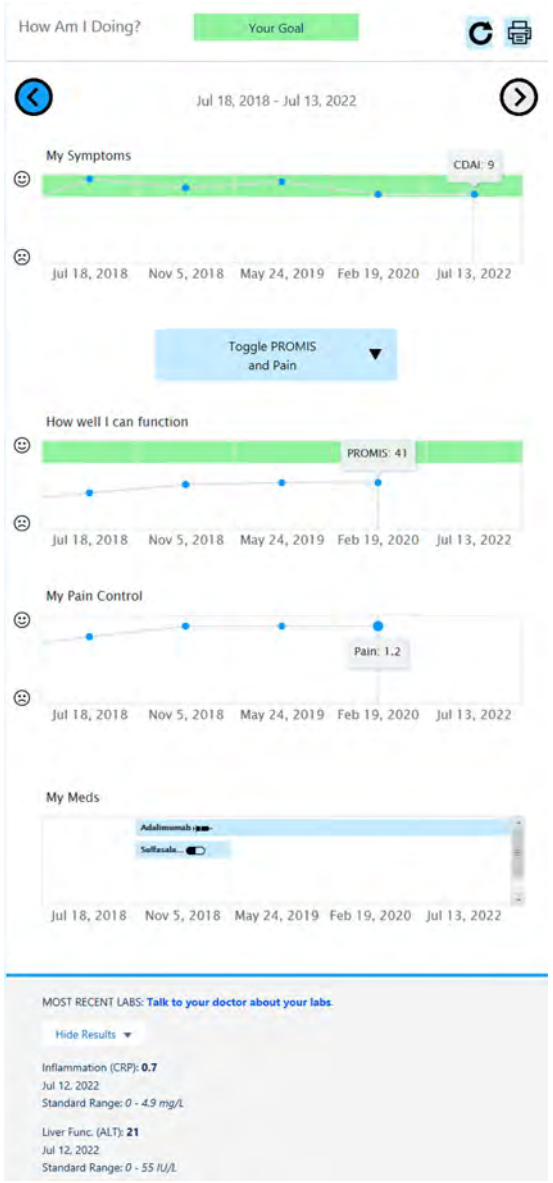
Stepped Wedge Cluster Randomized Trial Outcomes



Will use of the RA PRO dashboard during clinical visits for patients with RA lead to:

- Improvement in **shared decision making** (SURE scale)
- Increased **medication adherence** (patient survey)
- Increased patient **self-efficacy** (PROMIS-symptom management)
- Improvement in **PROs** and/or **disease activity** (CDAI, PROMIS scores)
- Change in **provider satisfaction** (provider survey)

First Patient Impressions



"The dashboard gave me a better understanding of the history of my disease."

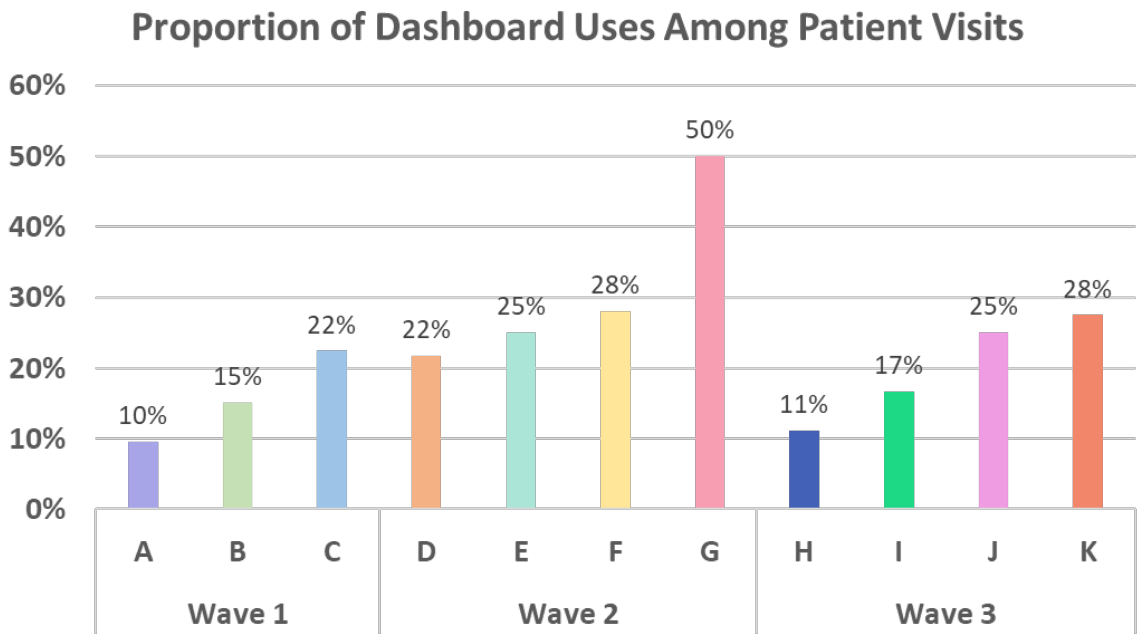
"I'm interested in my disease progression and the discussion that follows with my doctor."

"I appreciate knowing how I'm doing compared to my last visits so I can get a better picture of what's been happening long term."

"I liked seeing that I'm in the green zone."

Clinician Engagement

Provider	Wave	Patient Visits	Activity (minus load out)	Proportion of dashboard uses
A	1	115	11	10%
B	1	205	21	15%
C	1	579	130	22%
D	2	101	22	22%
E	2	8	2	25%
F	2	25	7	28%
G	2	6	3	50%
H	3	18	3	17%
I	3	18	2	11%
J	3	8	2	25%
K	3	80	22	28%



Challenges

Challenge	Example
Technical interruptions	Limited availability of technical team due to COVID
	EHR software upgrades: Broken APIs bring dashboard down; decommissioned tables result in missing data
Major clinical workflow changes	System-wide telehealth explosion: - Assessment of PROs sharply decreased (missing physical exams) - Change in clinic workflow made it harder to identify RA patient visits
Data changes	New sources of data: New PROMIS questionnaire implemented by outside team
	Missing data: Infusions not well-captured via med reconciliation table
Pragmatic trial logistics	Patient recruitment: Clinicians select patients who they think will appreciate the dashboard
	Physician time constraints: clinicians perceive limited time share and discuss dashboard with patients
	Outcomes: Trial participants are generally satisfied and report outstanding adherence, making it difficult to measure change for these outcomes

Lessons Learned

Topic Area	Lessons
Design	Putting patients at the center of application development can yield a well-accepted, usable data visualization tool for PRO; Patient feature requests bring credibility to design choices
	Design process needs to address key features and clinical workflows
Technical build	Collaborating with an internal technical team has unintended benefits – e.g. connection to regulatory committees, awareness of EHR upgrades
Clinic roll-out	*Multiple* clinical champions are needed to encourage other clinicians to use and access the dashboard with patients
	Clinician participatory approach: Regular meetings and discussions with clinicians to address challenges faced when using the dashboard and share possible solutions
Maintenance	Building an EHR-based application that works requires *infrastructure, time, funding, energy* to iterate and maintain: • Continuous, automated checks on data quality • Continuous checks on workflow hiccups • Continuous feedback from frequent users • Ongoing collaboration (daily/weekly) between technical and clinical teams

Thank You!

Quality and Informatics Lab (QUIL)

Contact Information

Gabriela Schmajuk, M.D., M.S.

gabriela.schmajuk@ucsf.edu

UCSF University of California San Francisco

AGENCY FOR HEALTHCARE RESEARCH AND QUALITY

AHRQ

Drug-Drug Interaction Shared Decision Making

Daniel C. Malone, B.S. Pharmacy, Ph.D.
Professor, Department of Pharmacotherapy
University of Utah

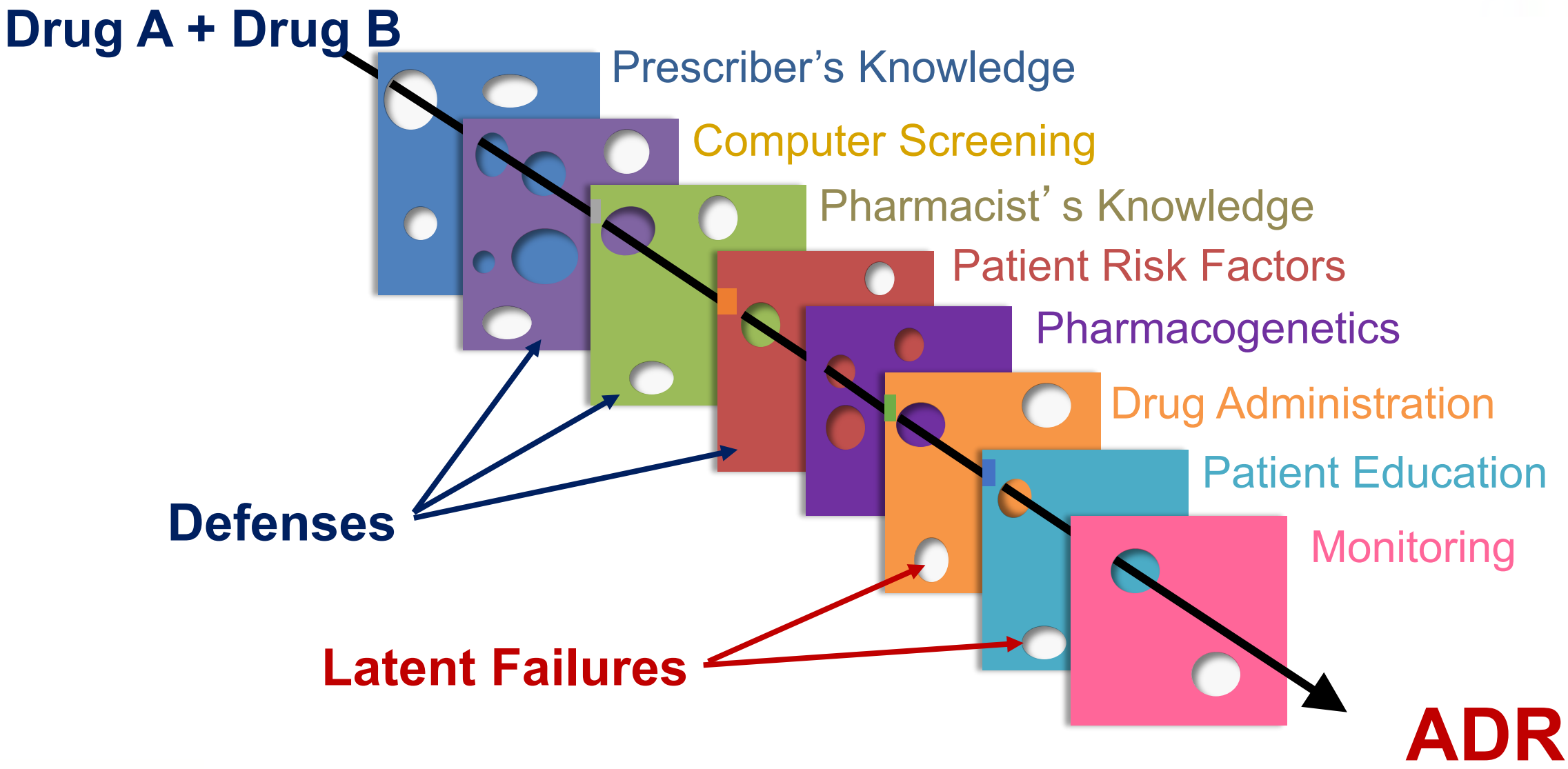
Drug-Drug Interactions (DDIs)

- Preventable adverse events
  - Responsible for 5-14% of adverse drug reactions
  - A major risk factor for hospitalization
  - Occur in 13% of elderly ambulatory patients

- Warfarin – non-steroidal anti-inflammatory drugs (NSAIDs)
  - Increase gastrointestinal bleeding by 2-fold
  - 24% of patients on warfarin receive a prescription for an NSAID
  - Risk can be modified by patient characteristics (e.g., age, previous bleed), type of NSAID, and other medications

1) J Am Geriatr Soc. 2008;56:875-80. 2) JAMA. 2008;300:2867-78. 3) *Thrombosis and Haemostasis* 2020; 120(7): 1066-1074. 4) *Am J Health-Syst Pharm* 2005 62: 1983-1991.

“When The Holes Line Up”

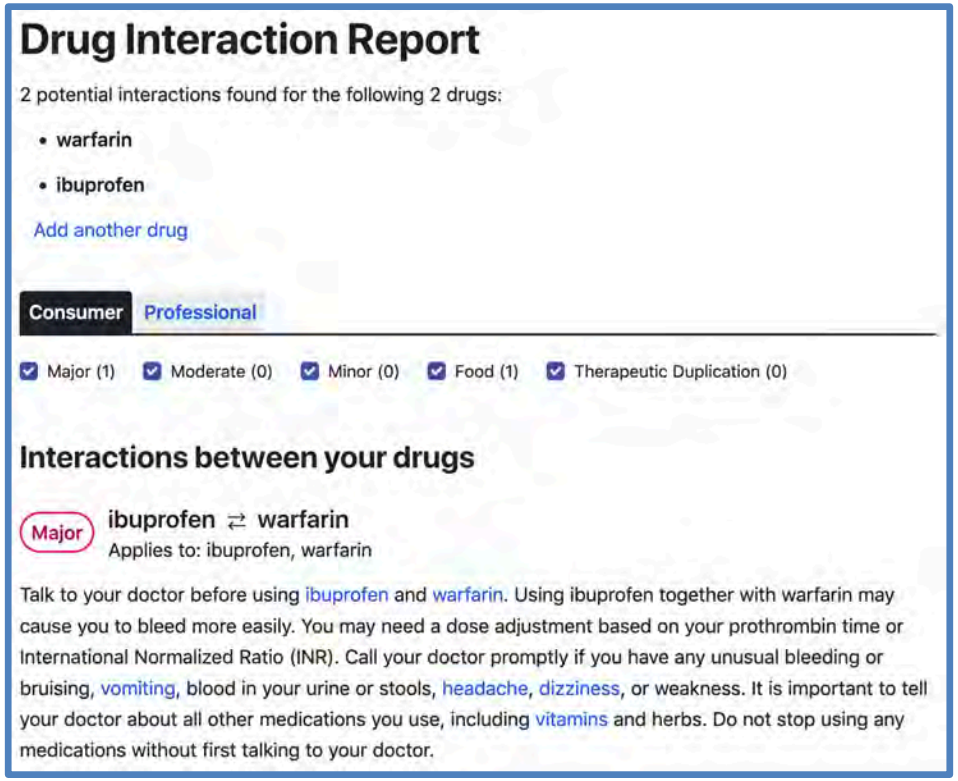


Hansten PD, Horn JR. Modified from: James Reason, Human Error, 1990

DDI Clinical Decision Support and Consumer Information

- **Clinician CDS**
  - No patient characteristics
  - No quantification
  - No patient involvement
  - Easiest resolution is to override
- **> 90% overridden or ignored**

- **Consumer Information**
  - No definitions for risk and limited information



Shared Decision Making

Occurs when a health care provider and a patient work together to make a healthcare decision that is best for the patient.

Treatment options & evidence-based information

Preferences & information about disease

Choice Discussion

Option Discussion

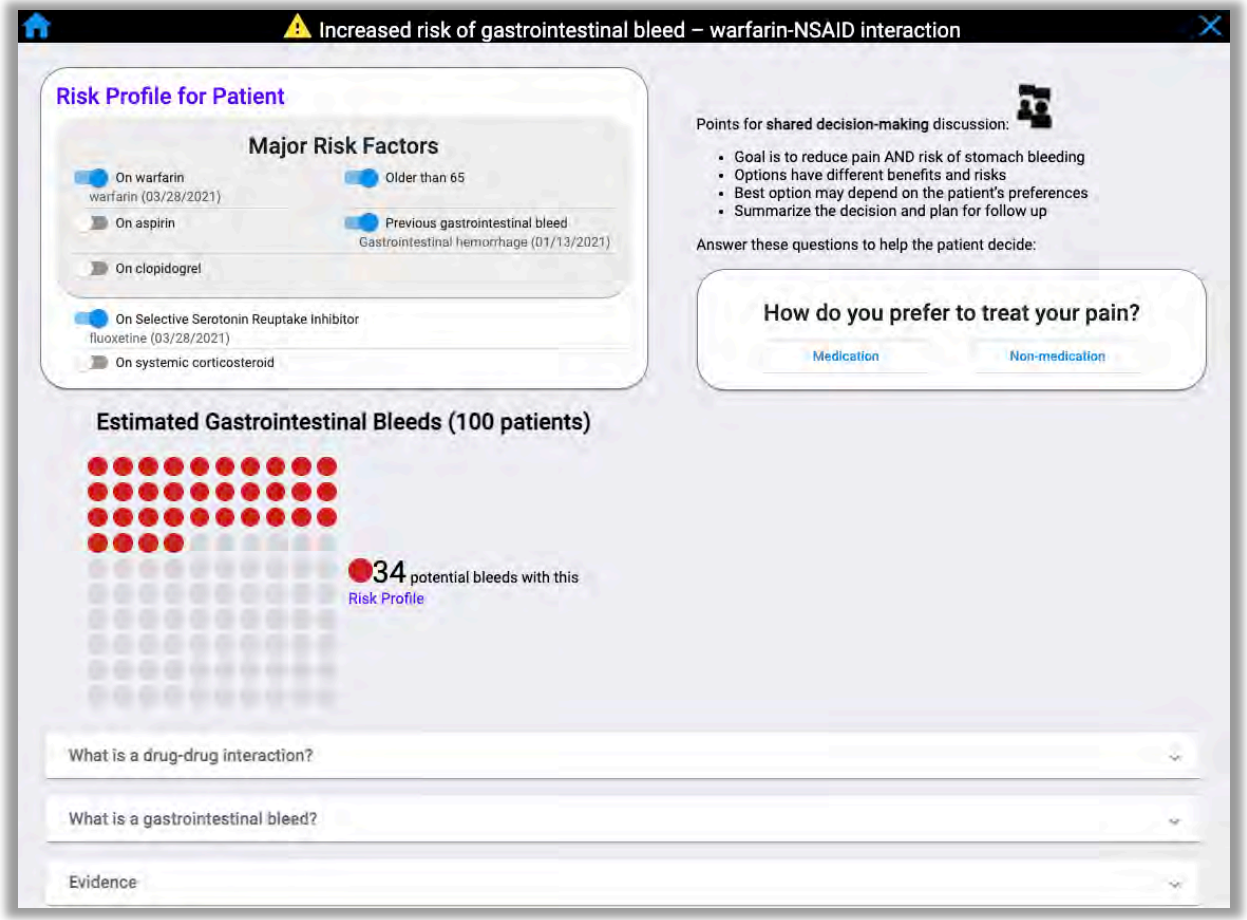
Decision Discussion → Decision

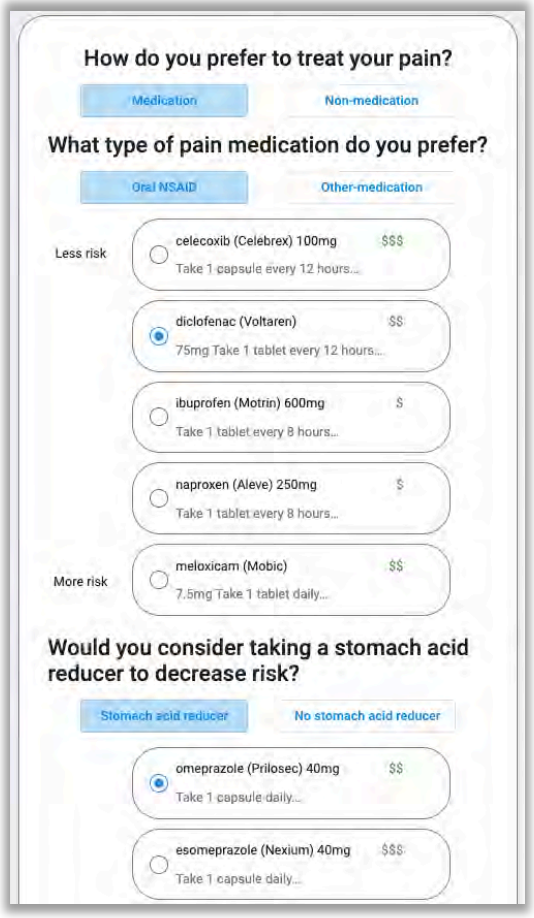
DDInteract

J Gen Intern Med. 2012; 27(10):1361-1367.

Design

- Patient risk factors incorporated at top
- Estimated risk is function of patient risk factors / medications





Design

What is a drug-drug interaction?

- When two or more drugs react with each other and cause unwanted side effects
- Warfarin (Coumadin) and NSAIDS (nonsteroidal anti-inflammatory drugs) increases your risk of stomach bleeding

warfarin ibuprofen

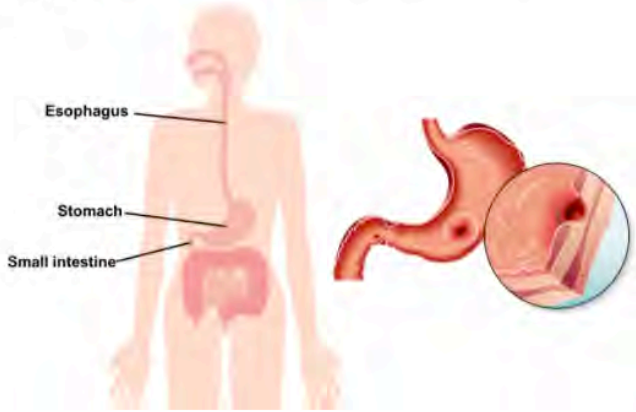
What is a gastrointestinal bleed?

Bleeding that occurs anywhere in the digestive tract, from the esophagus to the rectum.

Symptoms may include:

- Vomiting blood or something that looks like coffee grounds
- Melena: dark and tarry-appearing stools with a distinctive smell
- Feeling weak, light-headed, or woozy
- Rapid heartbeat
- Belly cramps or pain

Parts of your body that are most at risk for bleeding from a drug interaction include:



After Visit Summary

Since you are on warfarin, you have an increased risk of a stomach bleed with adding a nonsteroidal anti-inflammatory drug, such as ibuprofen (Motrin), naproxen (Alieve), or aspirin. After we discussed this risk and treatment options for your pain, we decided to try diclofenac and omeprazole. If you start experiencing symptoms of bleeding, such as coughing up blood, vomit that is bloody or looks like coffee grounds, pink or brown urine, stop taking diclofenac, call our office, and consider going to the emergency room.

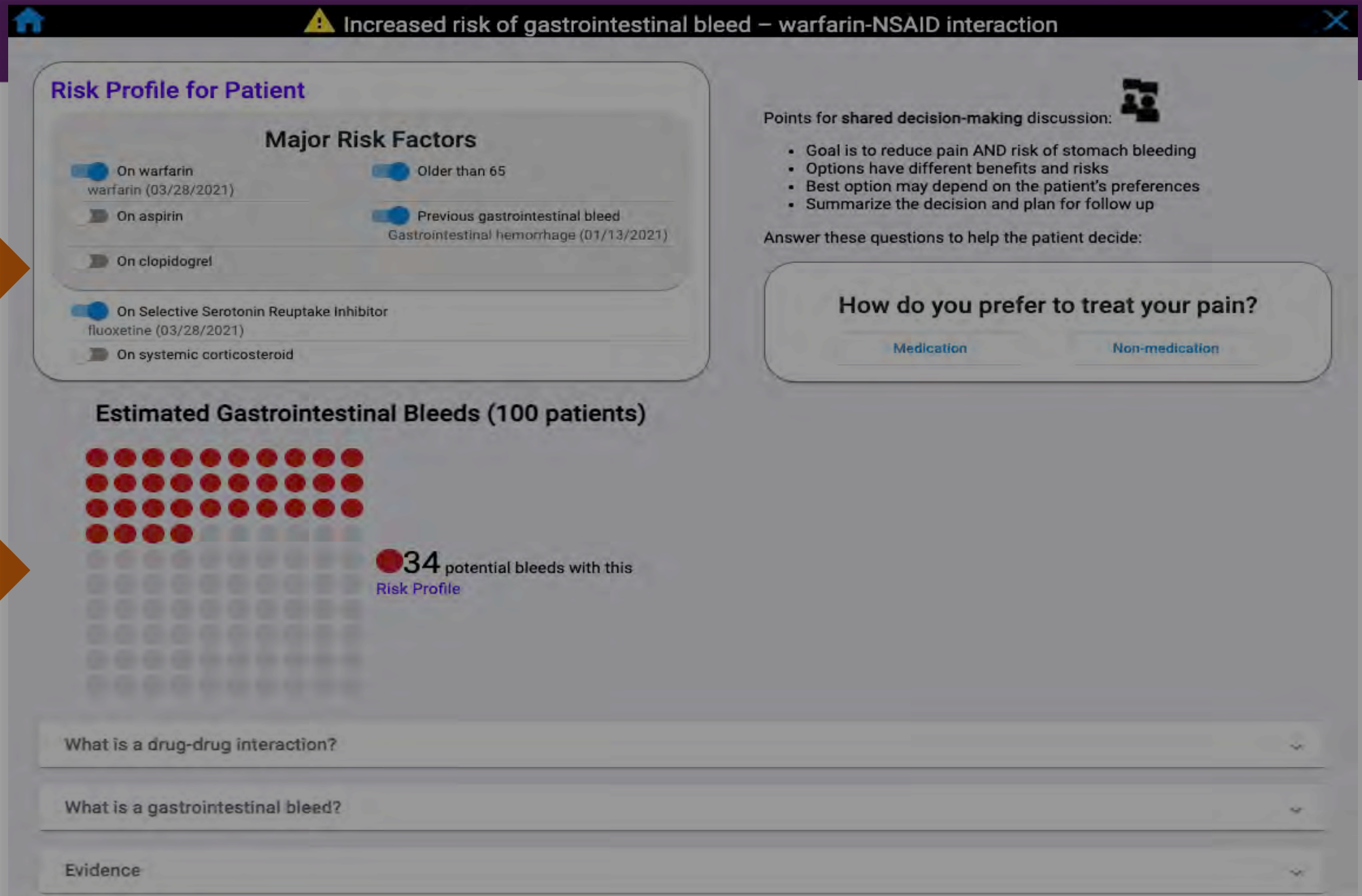
Clinical Documentation

Accept

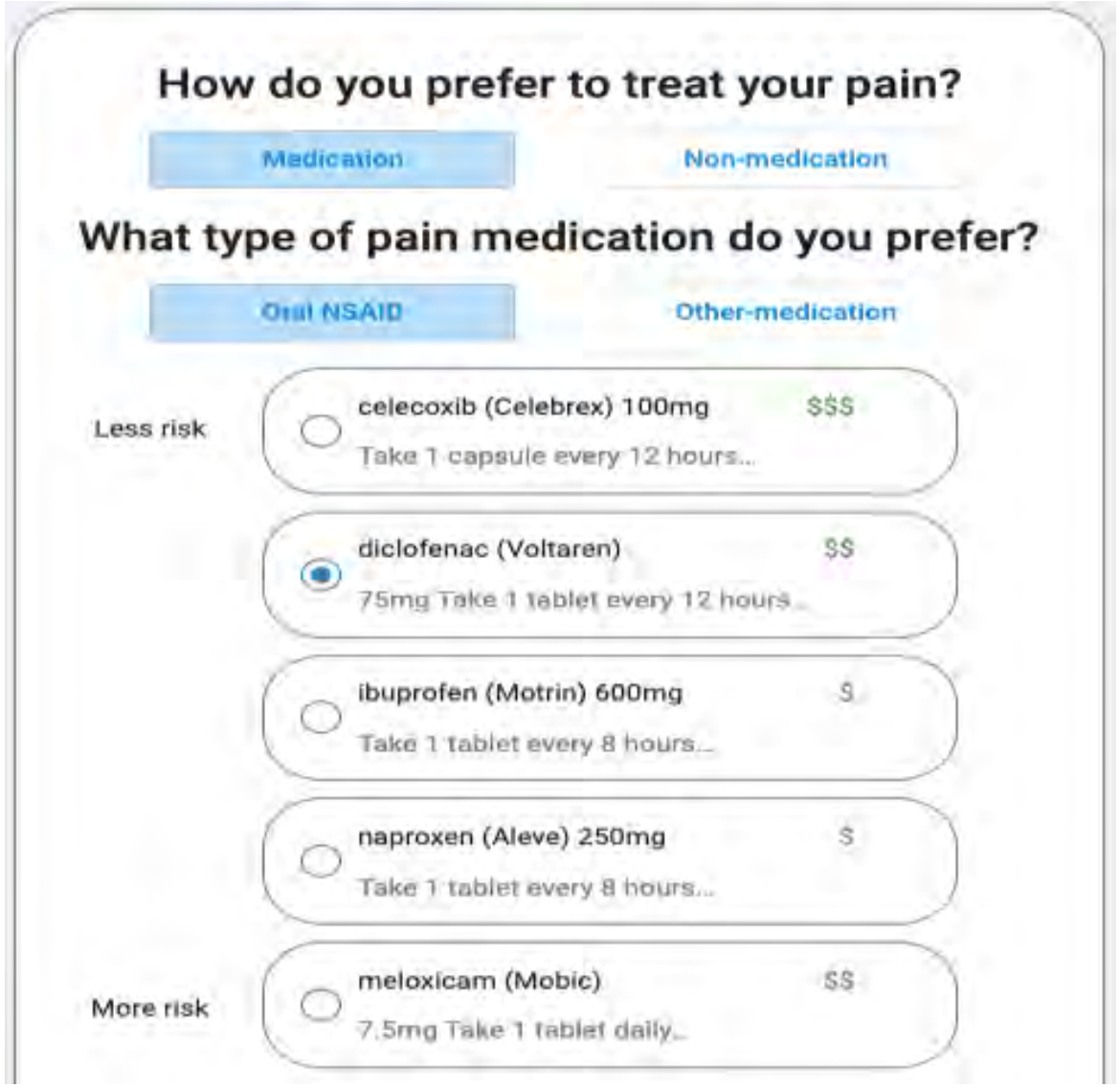
Primary Display

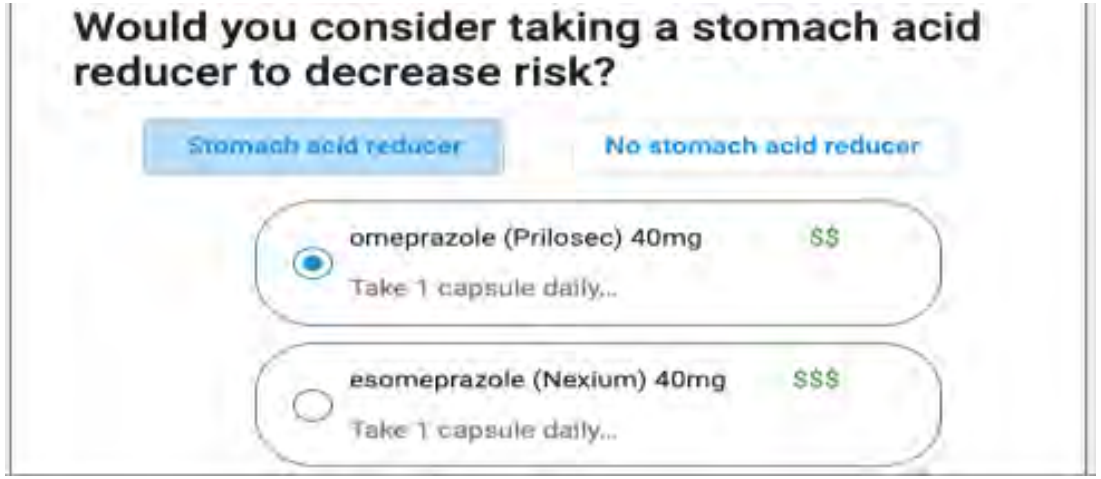
Risk Factors

Risk Array



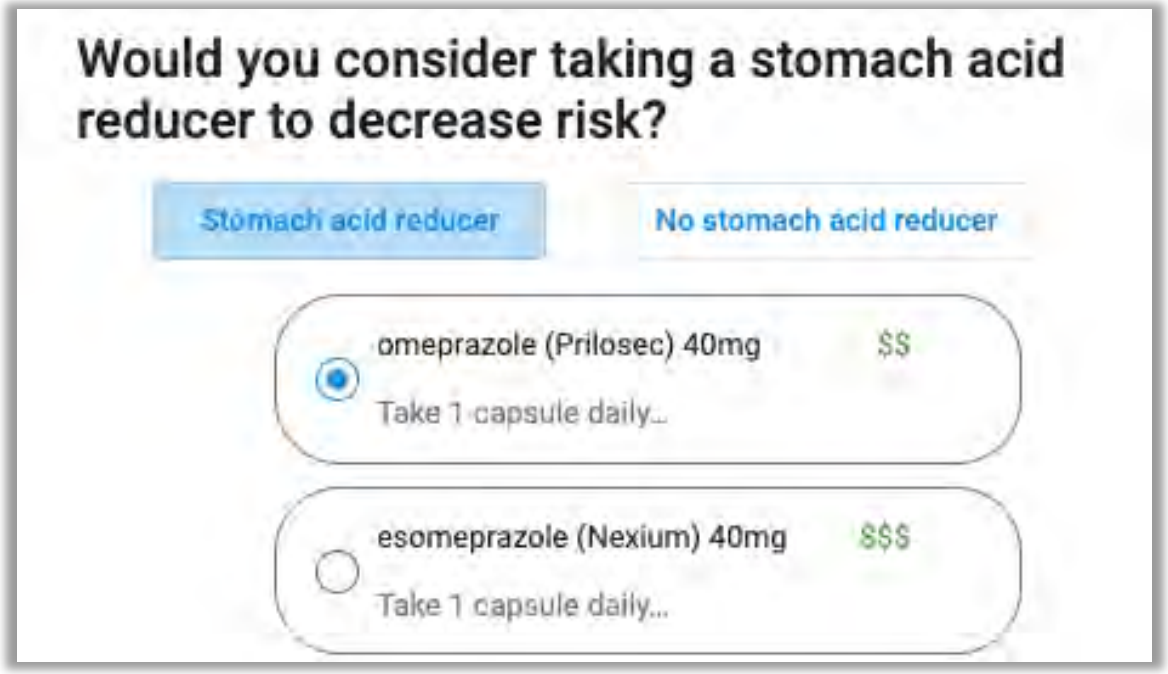
NSAID Selection



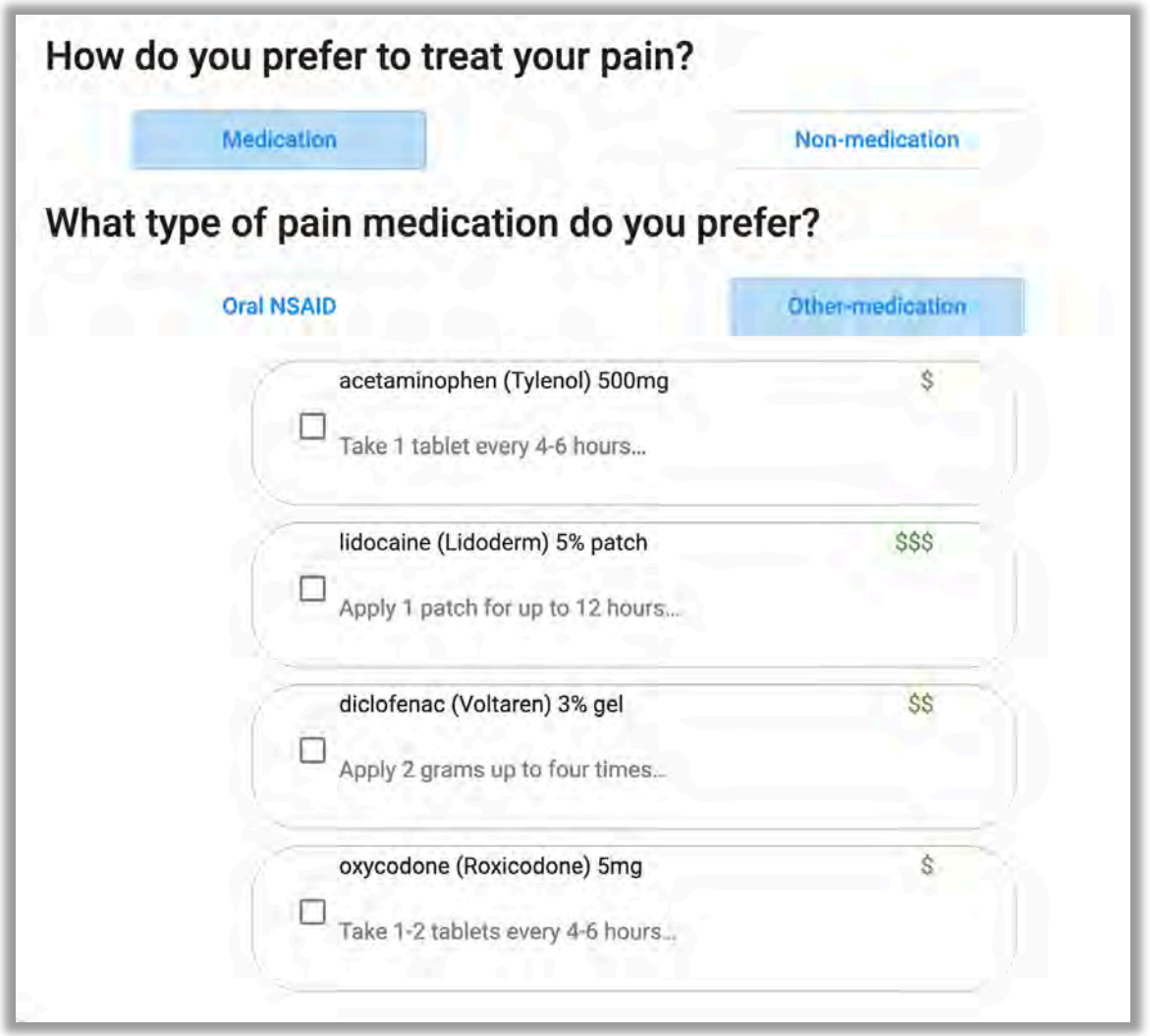


Approaches to Mitigate Risk

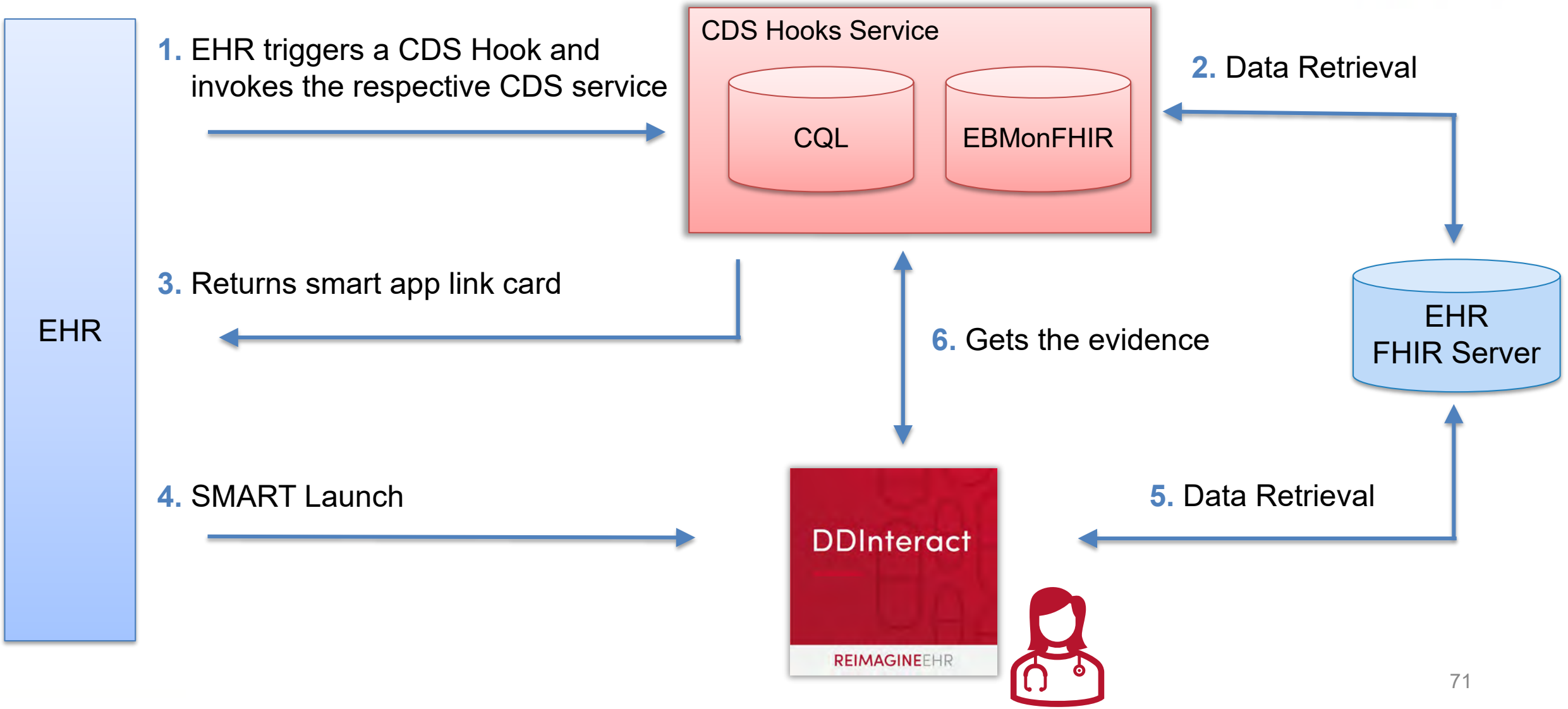
Medications Reducing Risk of Harm



Alternative Non-Interacting Medications



SMART on FHIR

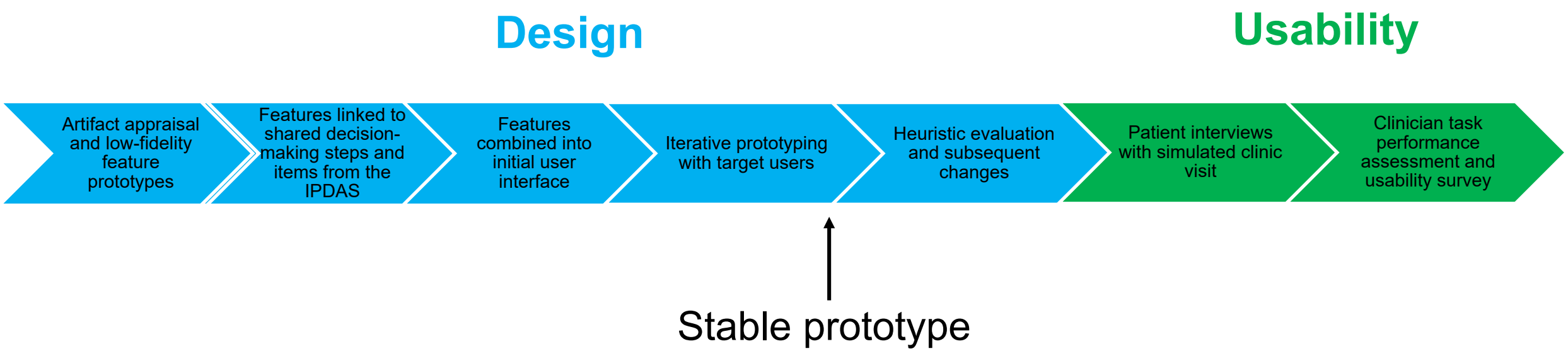


Phase I – Design and Usability Testing

Design & Usability

Objective:

To design and evaluate the usability of DDInteract, a shared decision-making tool for the warfarin and NSAID drug-drug interaction



JMIR Human Factors 2021; 8(4):e28618. Doi: 10.2196/28618.

Usability Healthcare Providers

Participant Type	N	Specialty (N)	Participant years of experience				Participant clinical percent effort				Experience with warfarin from 0 to 100
			<5	6-10	11-15	>16	<21	21-40	61-80	>80	Mean (range)
Physicians	**7**	Family Medicine (4), Emergency / Critical care (2), Hematology (1)	2	2	2	1		2	3	2	67 (29-88)
Pharmacists	**4**	Anticoagulation / Ambulatory care (3), General (1)			2	2	1		1	2	93 (87-100)

Timed Task for Healthcare Providers

	Tasks	Mean time – seconds
1.	Navigate to patient education	39
2.	Find the picture of multiple NSAIDs	42
3.	Remove fluoxetine (Prozac) as a risk factor	2
4.	View medication options	3
5.	Select acetaminophen (Tylenol) and lidocaine (Lidoderm)	30
6.	Select that a stomach acid reducer is not needed	32
7.	Select the oral NSAID option with the most risk and add esomeprazole (Nexium)	13
8.	Place any order in the queue	15

Healthcare Provider Evaluation

- Logical
- Efficient
- Effective
- Easy to use
- Enjoyed using
- Learned something
- Value of shared decision making
- Value of tool

4.32 out of 5

Patient Statements (N=4)

"If I wasn't able to see the [treatment] options, I wouldn't know what to ask."

"I usually forget what we [patient and provider] talk about during the appointment, so I would go to my After Visit Summary to review what we talked about."

"I personally don't like taking medications and want to avoid taking more. It looks like I can try other ways to relieve my pain and I would prefer trying those."

"Doctors usually make decisions like these for me. I like to help [make decisions]."

Phase II – Formative Evaluation

Formative Evaluation

- Randomized formative evaluation of DDInteract compared to Usual Care
- Study period: March - August 2021
- 12 simulated clinical encounters using either DDInteract or usual care
- Virtual sessions with clinical vignettes
  - Physicians and patients instructed to behave similar to routine encounters
  - Patients receiving anticoagulation treatment (inclusion criteria)

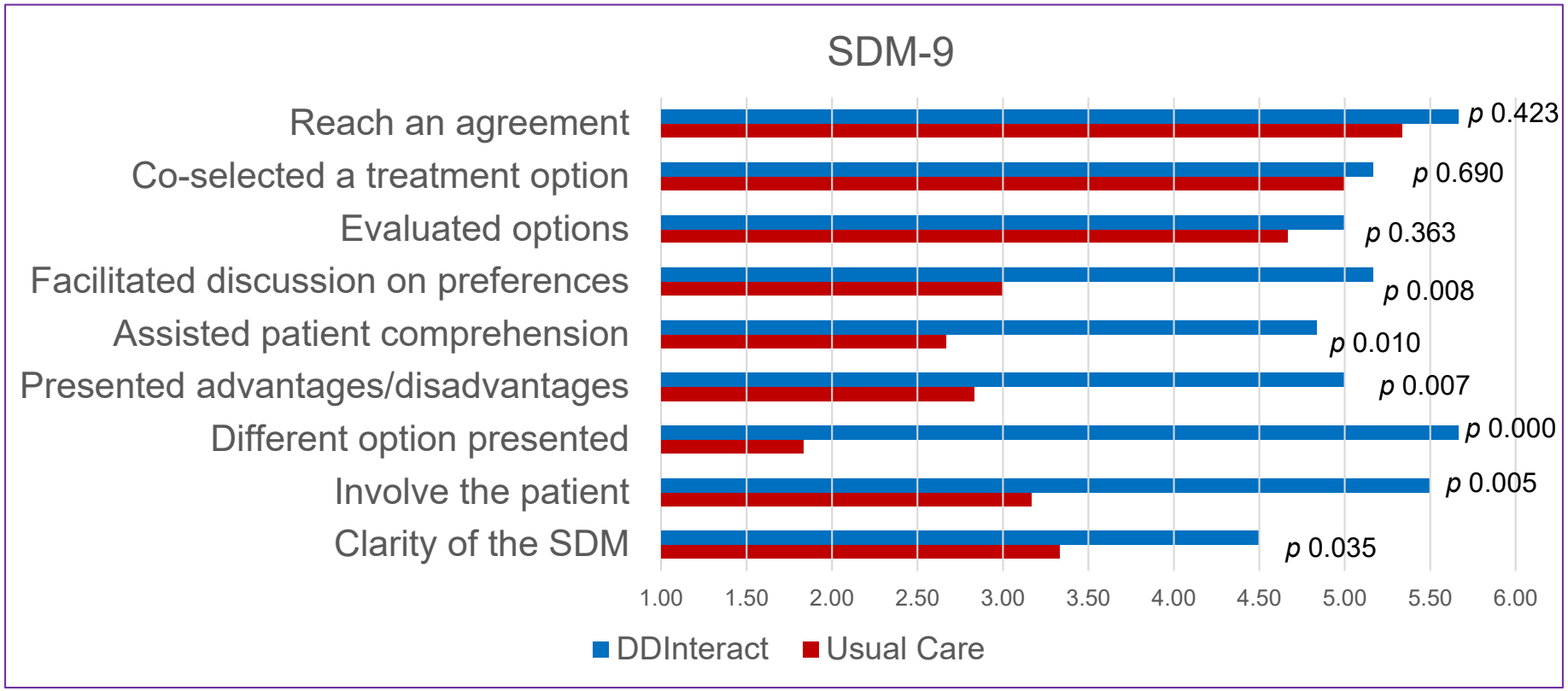
Methods

- **Primary outcome:** SDM-9 (physicians)
- **Secondary outcomes:**
  - System Usability Scale (SUS) (adapted)
  - NASA-task-Load Index (NASA - TLX) (physicians)
  - Unified Theory of Acceptance and Use of Technology (UTAUT) (physicians)
  - Perceived behavioral control (physicians)
  - Decisional Conflict Scale (DCS) (patients)

DDInteract Primary Outcome

Shared Decision Making-9

Physician Ratings
Likert scale from 1 (Completely Disagree) to 6 (Completely Agree)



Scholl I, et al. *Patient Educ Couns*. 2012;88(2):284-290. doi:10.1016/j.pec.2012.03.005

System Usability Scale

Likert scale from Strongly Agree (5) to Strongly disagree (1)

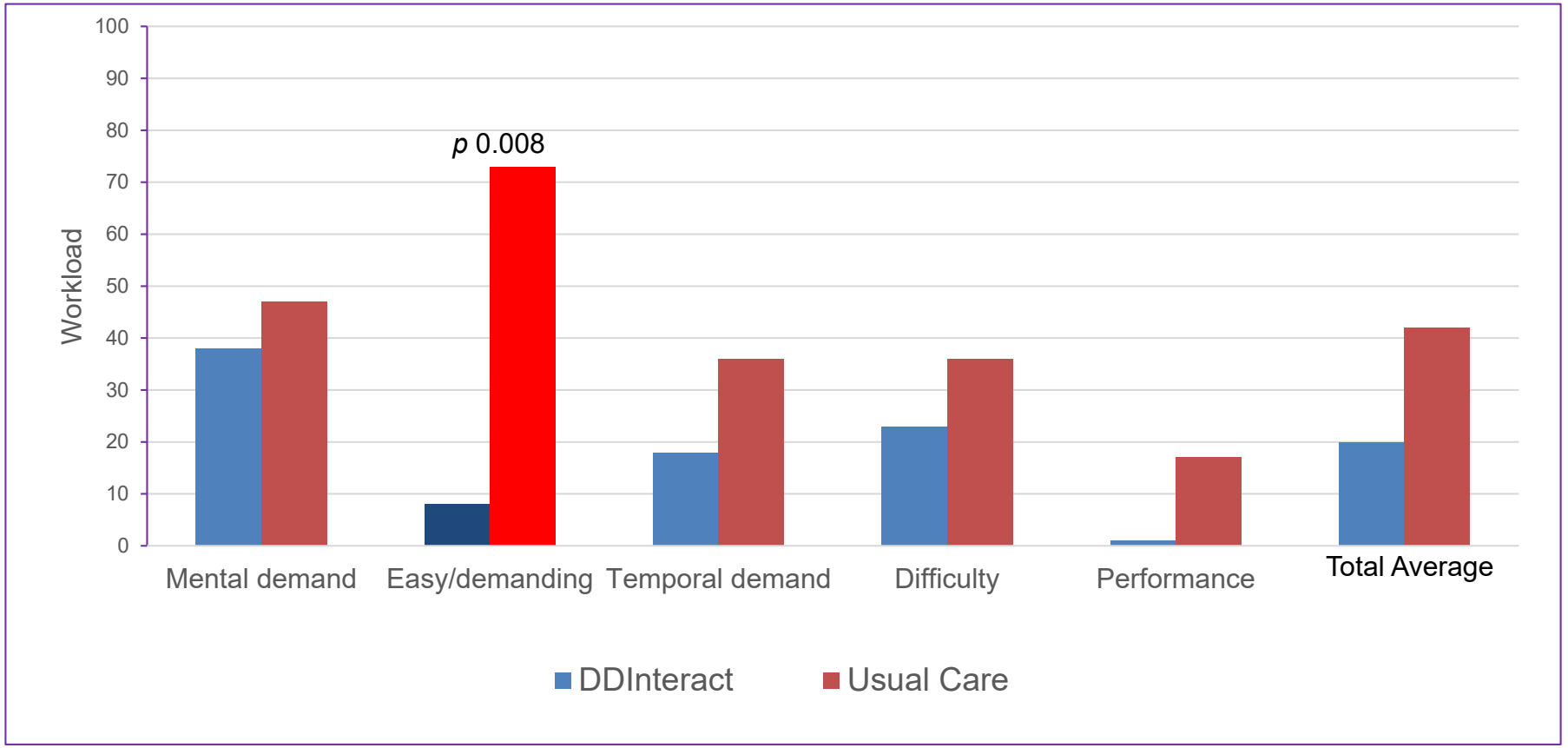
	Patients (mean, SD)			Physicians (mean, SD)		
	DDInteract	Usual Care	p	DDInteract	Usual Care	p
It was logical	4.7 (0.5)	4.8 (0.4)	.65	4.8 (0.4)	3.7 (1.0)	.03
It was efficient	4.5 (0.5)	4.4 (0.5)	.77	4.7 (0.5)	3.5(1.0)	.04
Helpful/effective in the decision-making process	4.7 (0.5)	4.4 (0.9)	.57	4.5 (0.5)	2.8 (1.2)	.02
The SDM using the tool was valuable	4.5 (0.5)	4.8 (0.4)	.26	4.7 (0.5)	2.8 (0.7)	<.001
The tool was valuable	NA			4.3 (0.5)	2.8 (1.2)	.02
Easy to use	4.5 (0.5)	4.4 (0.9)	.83	4.8 (0.4)	3.2 (1.5)	.04
Enjoyed the experience	4.7 (0.5)	4.8 (0.4)	.55	NA		
Learned something from this experience	4.8 (0.4)	4. 7 (0.8)	.67	4.5 (0.5)	2.8 (1.7)	.06

Brooke J. *SUS: A Quick and Dirty Usability Scale.* (Patrick W. Jordan and Bruce Thomas and Bernard A. Weerdmeester, ed.).; 1995.

DDInteract Secondary Outcomes (Physicians)

NASA-TLX Score

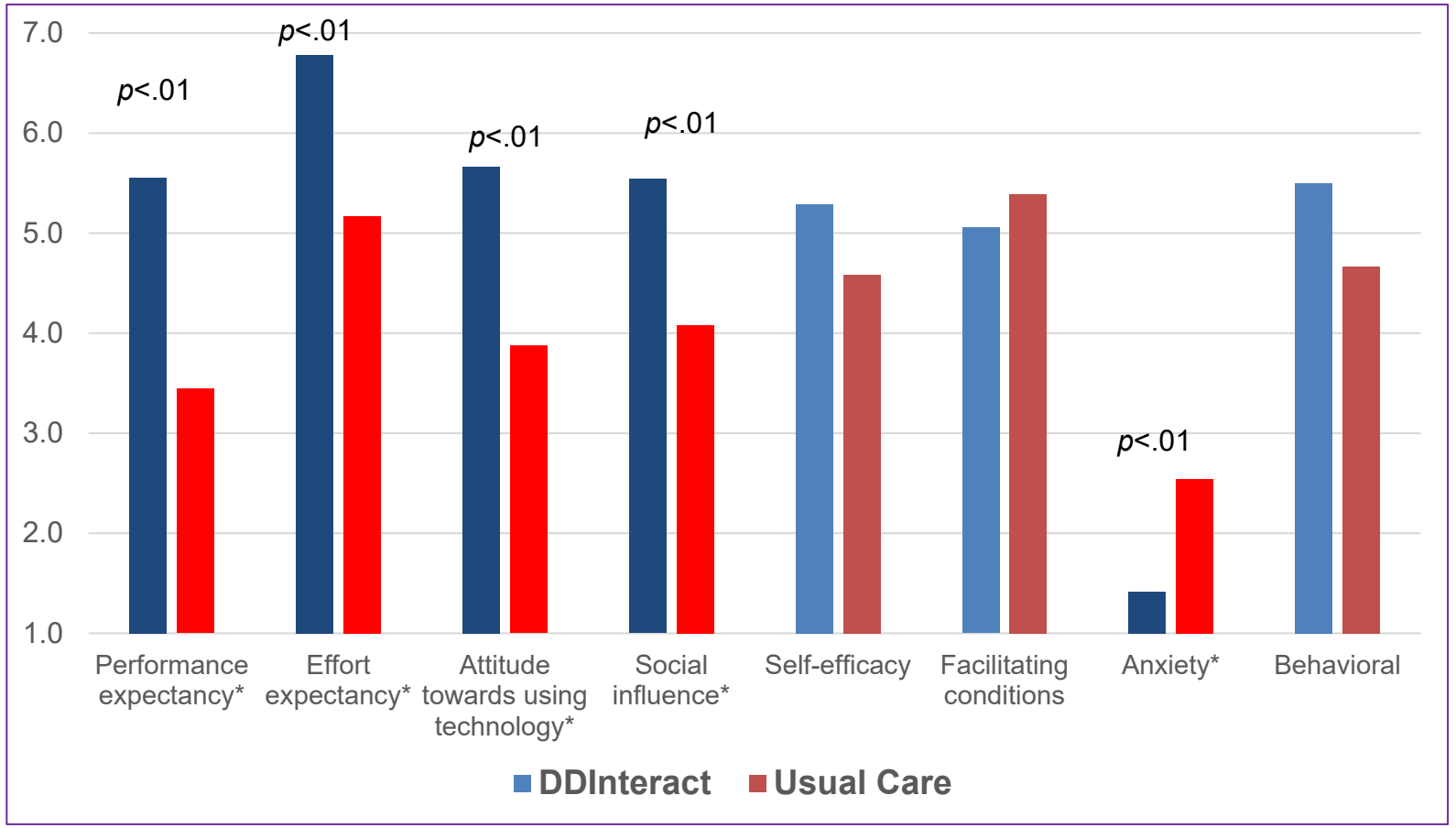
Method to assess workload on 5 (physical demand excluded) dimensions
(0: low/easy/successful to 100: high/demanding/unsuccessful)



Hart SG, Staveland LE. Results of Empirical and Theoretical Research. In; 1988:139-183. doi:10.1016/S0166-4115(08)62386-9

Unified Theory of Acceptance and Use of Technology (Physicians)

Likert scale from Strongly Disagree (1) to Strongly Agree (7)



Viswanath Venkatesh et al. User Acceptance of Information Technology: Toward a Unified View. *MIS Q.* 2003;27(3):425-478

Perceived Behavioral Control (Physicians)

Likert scale Strongly Disagree (1) to Strongly Agree (7)

	Mean (SD)		
	DDInteract	Usual Care	p-value
I am convinced that I can share decision-making in the clinic	6.8 (0.4)	6.0 (0.6)	.02
I have control over the level of SDM that is accomplished in the clinic	6.2 (0.8)	5.7 (0.5)	.21
I can perform SDM without extending the duration of the consultation	5.5 (0.5)	3.7 (1.5)	.03
Knowledge about SDM is important in order to apply SDM	6.5 (0.5)	5.7 (1.4)	.20
Communication skills are important for SDM	7.0 (0.0)	6.7 (0.5)	.17
Patients are motivated to participate in SDM	6.0 (0.9)	5.5 (1.2)	.44
In general patients have enough knowledge, intelligence and understanding needed for SDM	6.0 (0.9)	5.0 (1.7)	.23

Ajzen I. The theory of planned behavior. Organ Behav Hum Decis Process 1991;50(2):179–211

Decisional Conflict Scale (Patients)

Decisional conflict scale Strongly Disagree (1) to Strongly Agree (7)

	Patients (mean, SD)		
	DDInteract (N=6)	UC (N=6)	p
Decision is hard for me to make	3.3 (1.2)	3.5 (1.4)	0.83
Unsure what to do in this decision	3.7 (1.0)	3. 7 (0.8)	1.00
Clear what choice is best for me	1.8 (0.75)	2.2 (1.2)	0.57
I am aware of the choices I have to protect myself from drug interactions	1.8 (1.7)	1. 7 (0.5)	0.76
I know the benefits of avoiding drug interactions	1. 7 (1.2)	1. 7 (0.8)	1
I know the potential for harm for drug interactions	1. 7 (0.8)	1.5 (0.5)	0.69
I need more advice and information about my choices	3 (1.3)	2. 7 (1.2)	0.65
It's hard for me to decide if the benefits are more important to me than the risks, or opposite	3 (1.3)	3 (1.1)	1
I feel I have made an informed choice	1.7 (0.8)	1.8 (0.7)	0.72
My decisions show what is most important for me	1.8 (0.9)	1.7 (0.5)	0.72
I expect to stick with my decision	1.8 (0.9)	2.2 (0.7)	0.53

Conclusions

- DDInteract is a novel tool designed to facilitate SDM during encounters concerning potentially harmful DDIs
- The tool improved SDM
- Further research is needed to evaluate the impact of DDInteract on exposure to harmful DDIs and other important health outcomes

Collaborators

- Thomas Reese, Pharm.D., Ph.D., Vanderbilt University
- Guilherme Del Fiol, M.D., Ph.D., University of Utah
- Ainhoa Gómez-Lumbreras, M.D., Ph.D., University of Utah
- Jason Hurwitz, Ph.D., University of Arizona
- Richard Boyce, Ph.D., University of Pittsburgh
- Mary Brown, Ph.D., University of Arizona (retired)
- Malinda Tan, Pharm.D., University of Utah (former)

Contact Information

Daniel C. Malone, B.S. Pharm, Ph.D.

dan.malone@utah.edu