



UNIVERSITY OF
TORONTO

Advanced Self-Care through Digital Therapeutics

—
Joseph Cafazzo PhD PEng

Executive Director, Biomedical Engineering, University Health Network
Wolfond Chair in Digital Health
Professor, University of Toronto

HEALTHcare
HumanFACTORS

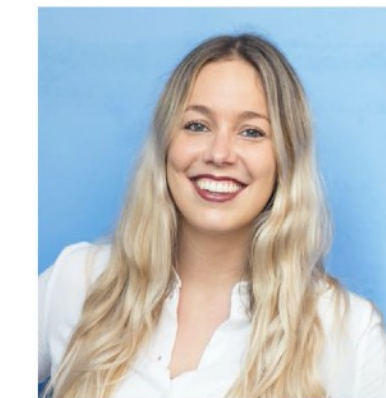
eHealth
INNOVATION

TECHiNA

 UHN

HEALTHcare HumanFACTORS

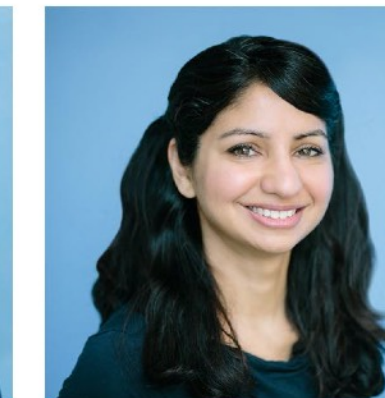
a proud partner of UHN



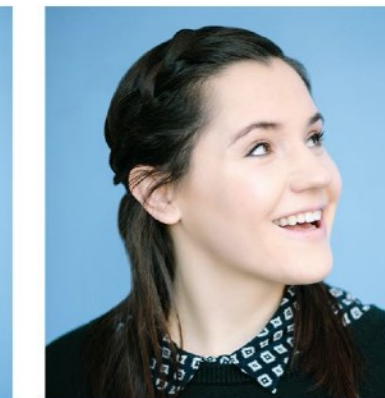
Alison Bisson
Research/Lab Coordinator



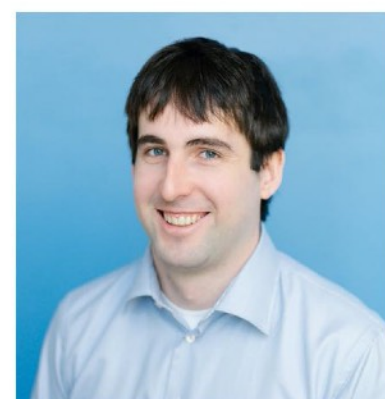
Joseph Cafazzo
Executive Director



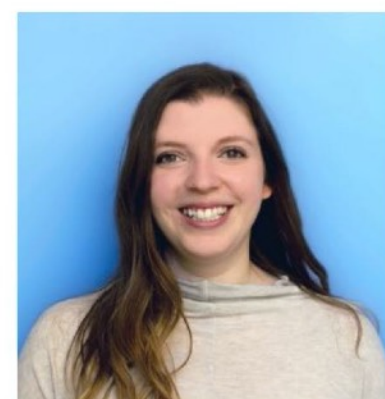
Anjum Chagpar
Managing Director



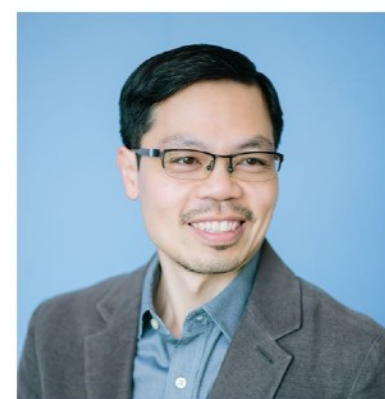
Jess Fifield
Marketing & Communications
Coordinator



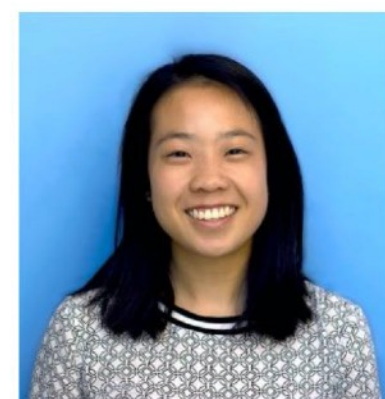
Chris Flewwelling
Associate Director, Medtech



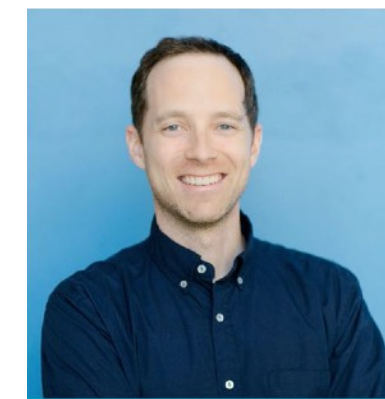
Kelsey Hannon
Human Factors Designer



Wayne Ho
Managing Director



Stephanie Hu
Human Factors Analyst



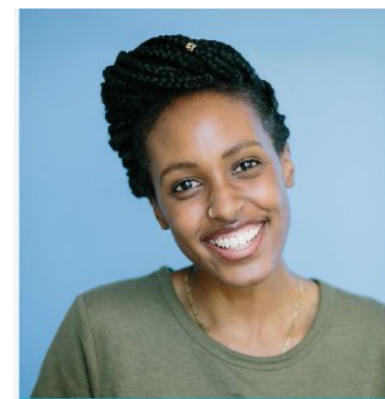
Mike Lovas
Design Director



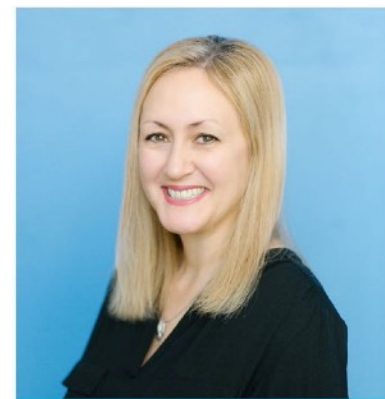
Aarti Mathur
Chief of Staff



Nathan Mills
Human Factors Designer



Pia Nyakairu
Human Factors Designer



Svetlana Taneva
Human Factors Specialist



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Lead, Global Ventures



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Laura Parente
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Human Factors Specialist



Damon Pfaff
Human Factors Specialist & Designer



Ilinca Popovici
Human Factors Specialist



Areeba Zakir
Human Factors Specialist



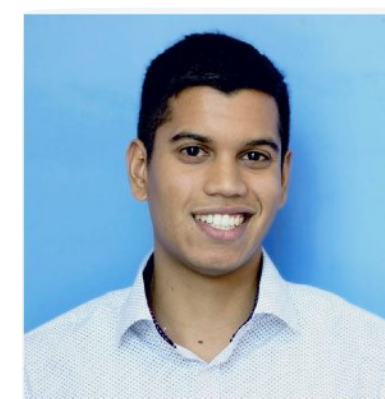
Adam Badzynski
Human Factors Design Intern



Ryan Cheng
Human Factors Student Intern



Lauren Ip
Human Factors Student Intern



Mikael Ragbar
Human Factors Specialist



Athina Santaguida
Human Factors Designer



Ashleigh Shier
Human Factors Specialist



Neil Sokol
Human Factors Specialist



Odelia Lee
Human Factors Design Intern

HEALTHcare HumanFACTORS

a proud partner of UHN

- 35 staff and graduate students dedicated to the design of safe and effective systems. Includes human factors engineers, cognitive psychologists, and designers
- Hospital safety initiatives on designing resilient solutions to cognitive, behavioural, and environmental challenges
- Work with private sector companies to design safer products

HEALTHcare HumanFACTORS

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CANNONDESIGN



HealthPRO[®]

Choice. Support. Results.



AMGEN

Dräger



smiths medical
bringing technology to life

EXACT⁺IMAGING

MAQUET
GETINGE GROUP

PROFOUND
MEDICAL

B|BRAUN

Elekta

eQOL

MýndTec



Value Life







Ethnography

Co-Design



Co-Design

ent
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ase

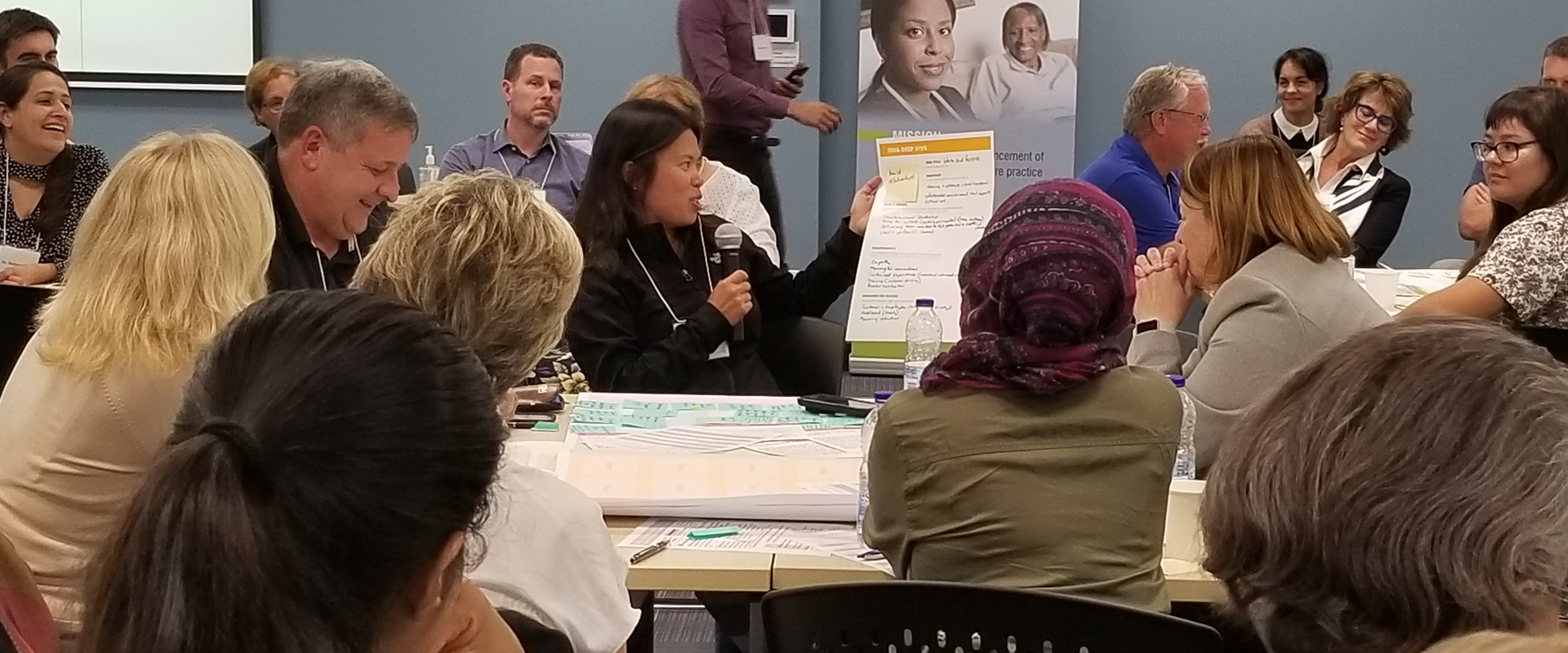


MISSISSAUGA HALTON LHIN
REGIONAL LEARNING CENTRE

MISSION

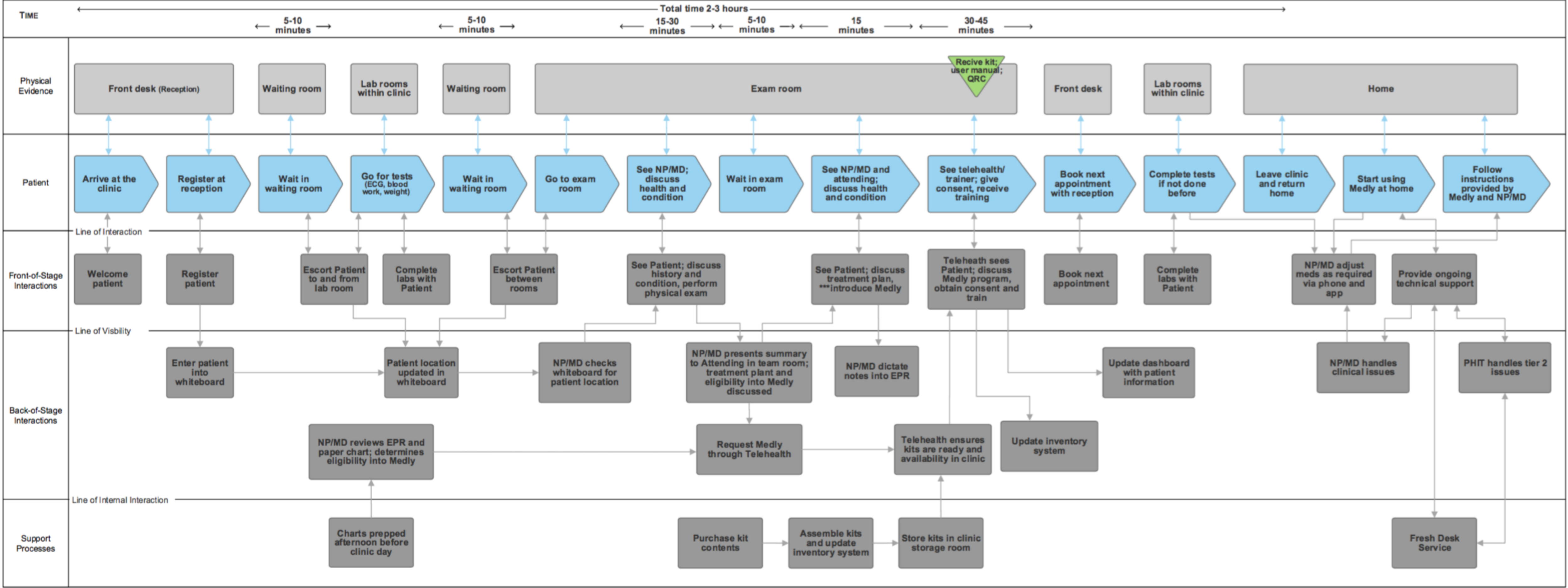
IDEA DEEP DIVE

Handwritten notes on a document held by a woman in the foreground.

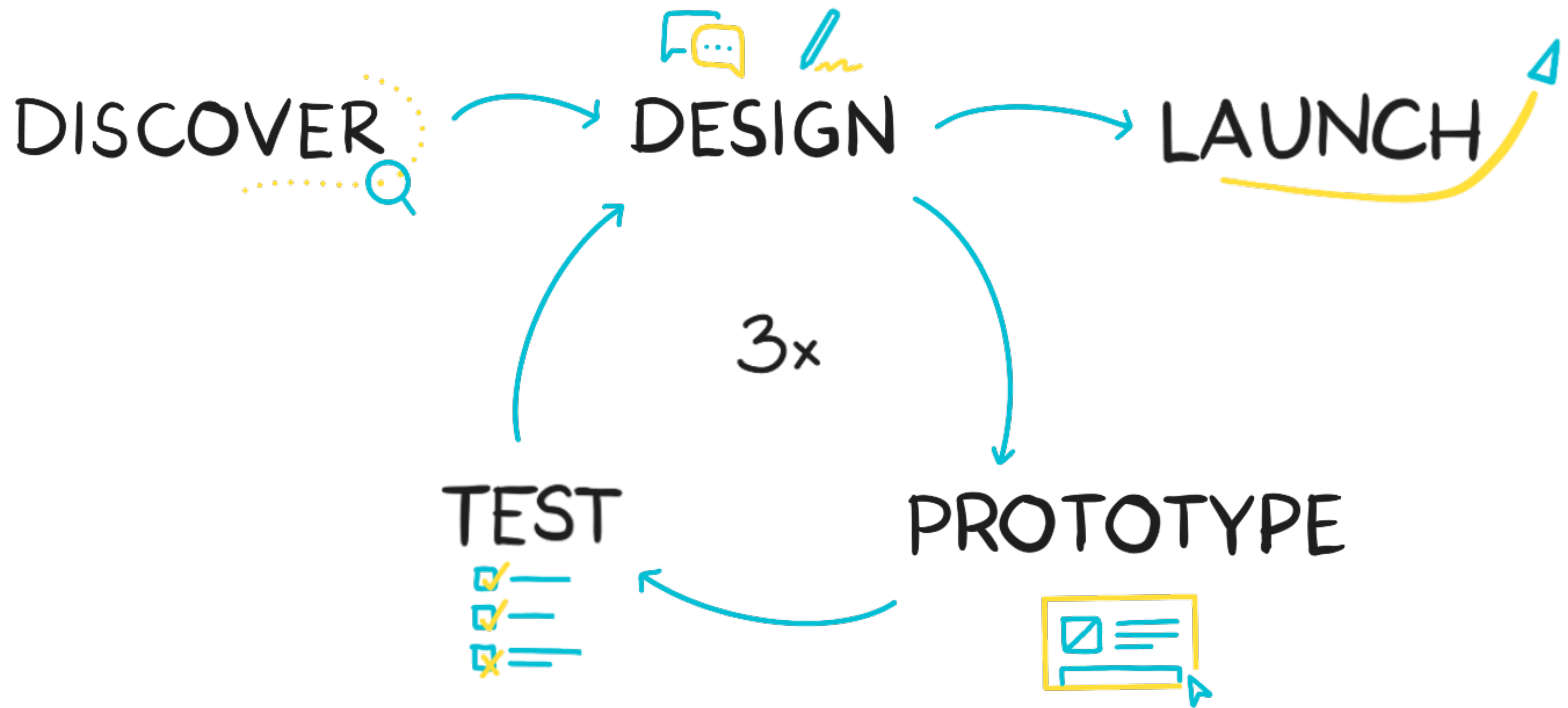




Workshop



Synthesizing



eHealth

INNOVATION

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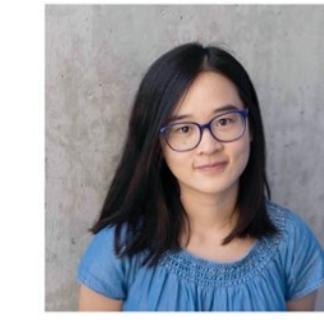
DR. JOSEPH CAFAZZO
Executive Director



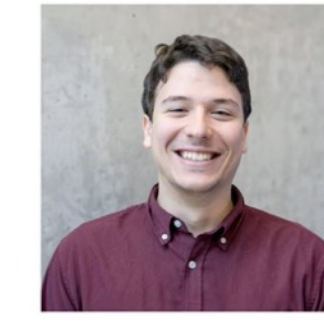
AKIB UDDIN
Manager



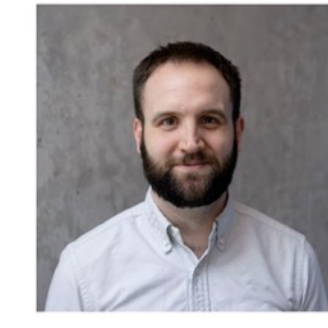
HARRY QIU
Hardware Developer



ANNA YUAN
Office Coordinator & Assistant to the Executive Director



MAX FRATTOLIN
Software Developer



SEAN WATSON
Software Developer



MELANIE YEUNG
Manager



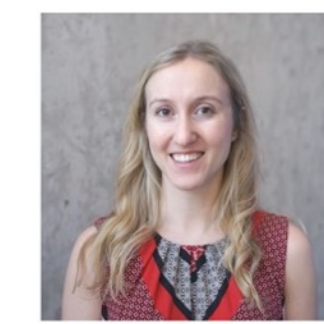
DR. SHIVANI GOYAL
Lead, Strategy & Research



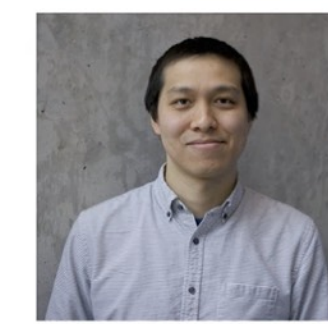
CAITLIN NUNN
Research Analyst



ANTHONY MEI
Software Developer



ALANA TIBBLES
Research Analyst



KUO-CHENG TONG
Software Developer



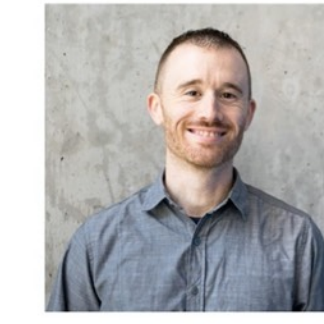
DAVID NGO
Quality Assurance Analyst



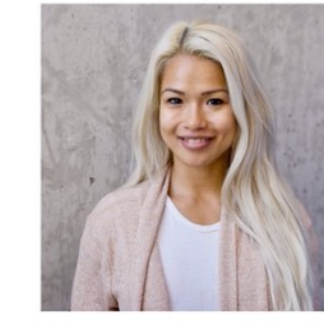
SHEENA MELWANI
Product Manager



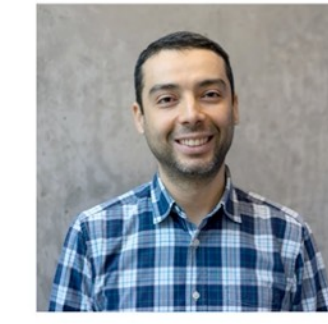
JAMES AGNEW
Technical Manager



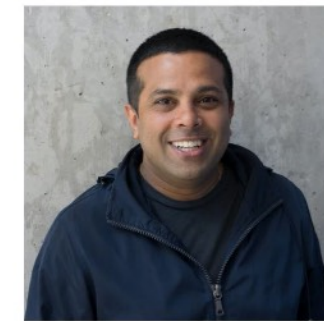
KEVIN TALLEVI
Hardware Developer



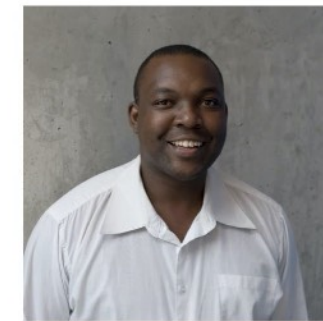
RACHEL WALTON
Project Manager



AMEEN DEMIDEM
Software Developer



ADRIAN DE ALMEIDA
Software Developer



RON MARANGWANDA
Quality Assurance Analyst



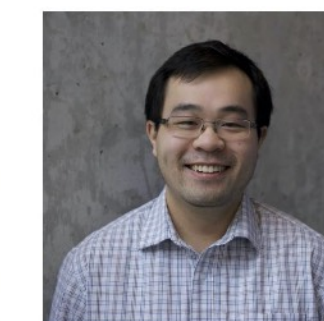
DR. PETER ROSSOS
Chief Medical Information Officer



EMILY SETO
Assistant Professor



KEVIN LEUNG
Software Developer



DAVID THAI
Software Developer



QUYNH PHAM
PhD Candidate



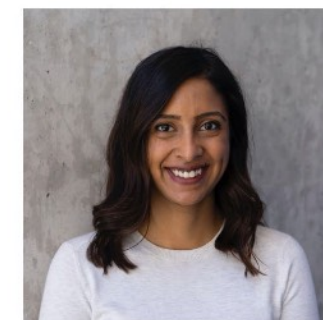
PATRICK WARE
PhD Candidate



MARIA AQUINO
Research Analyst Student



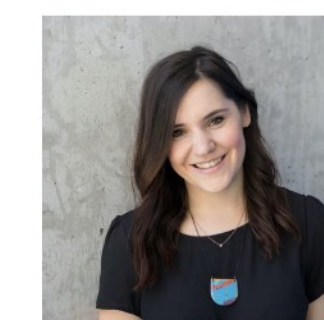
AARTI MATHUR
Chief of Staff



MALA DORAI
Product Manager



GARY GRAHAM
Software Developer



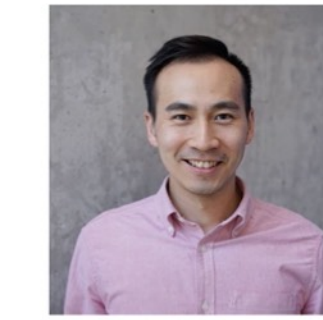
JESS FIFIELD
Communications Coordinator



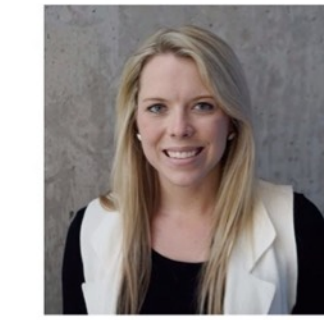
LILY ALEXANDER
Quality System Manager



VLAD VOLOSHYN
System Administrator



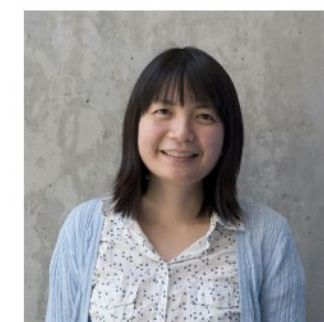
RYAN HO
Project Analyst Student



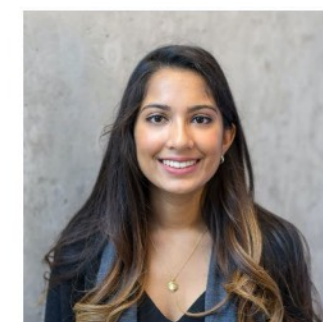
KAYLEIGH GORDON
PhD Candidate



SAHR WALI
PhD Student



DIANE DE SOUSA
Project Manager



LAUREN RIBEIRO
Project Analyst



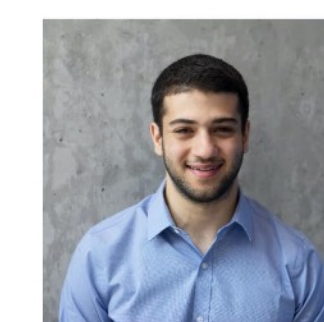
JASON MOORE
Software Developer



MYLES RESNICK
Tier 2 Site Coordinator



JEREMY JURKIEWICZ
Software Developer



ABOOD MUFTI
Software Developer



YOUR HOME



PHARMACIES

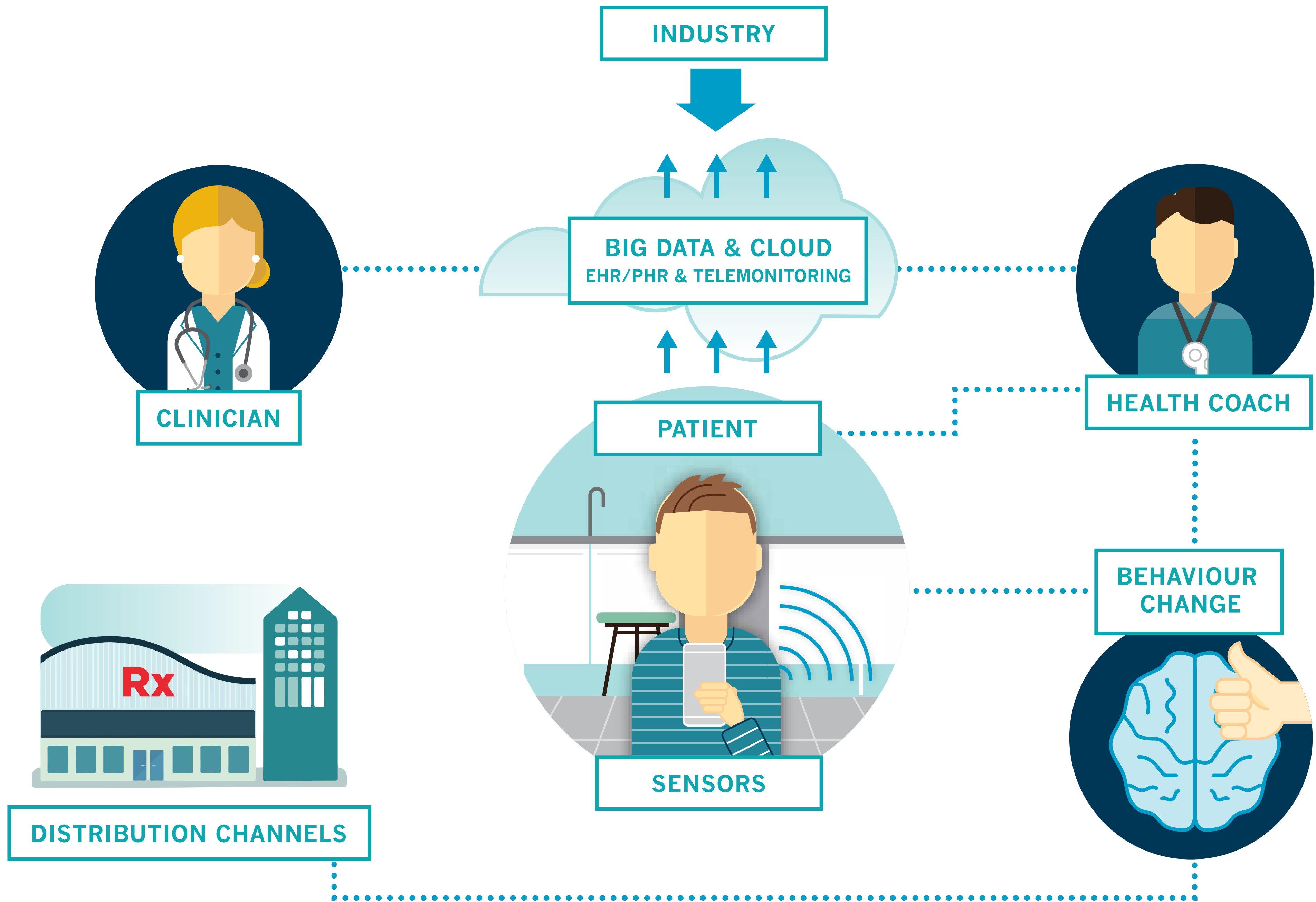
NEW SPACES



REMOTE COMMUNITIES



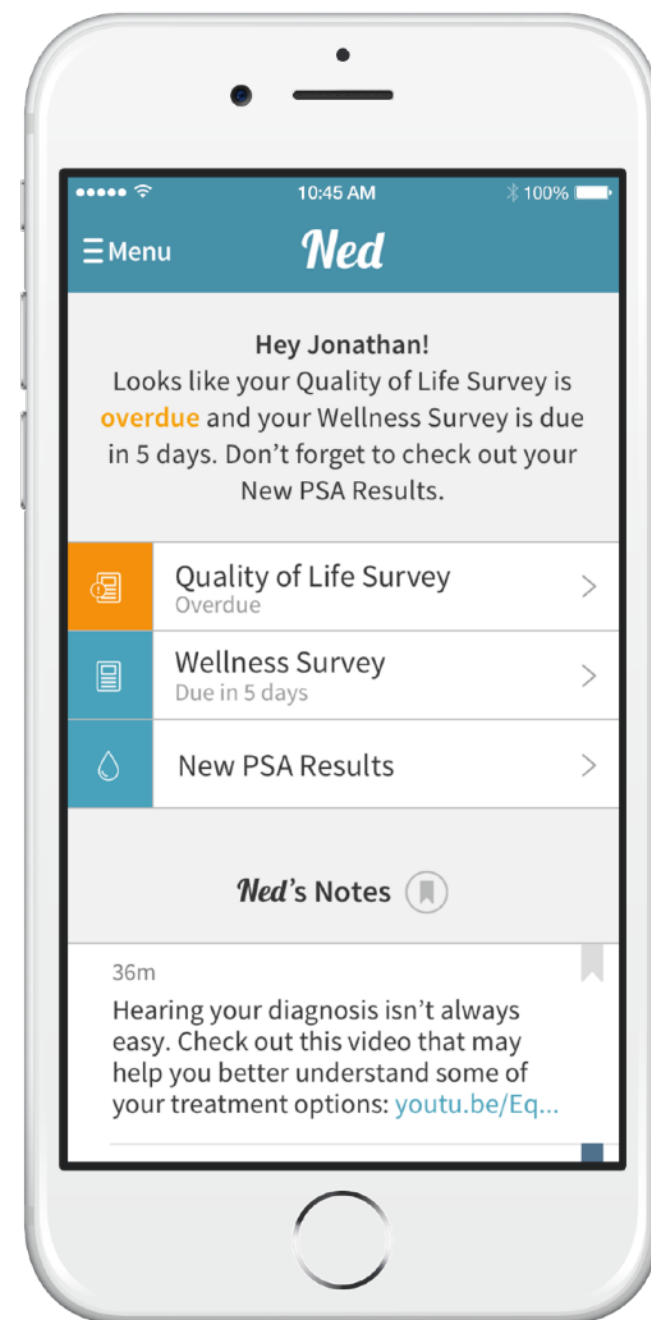
SCHOOL & WORK



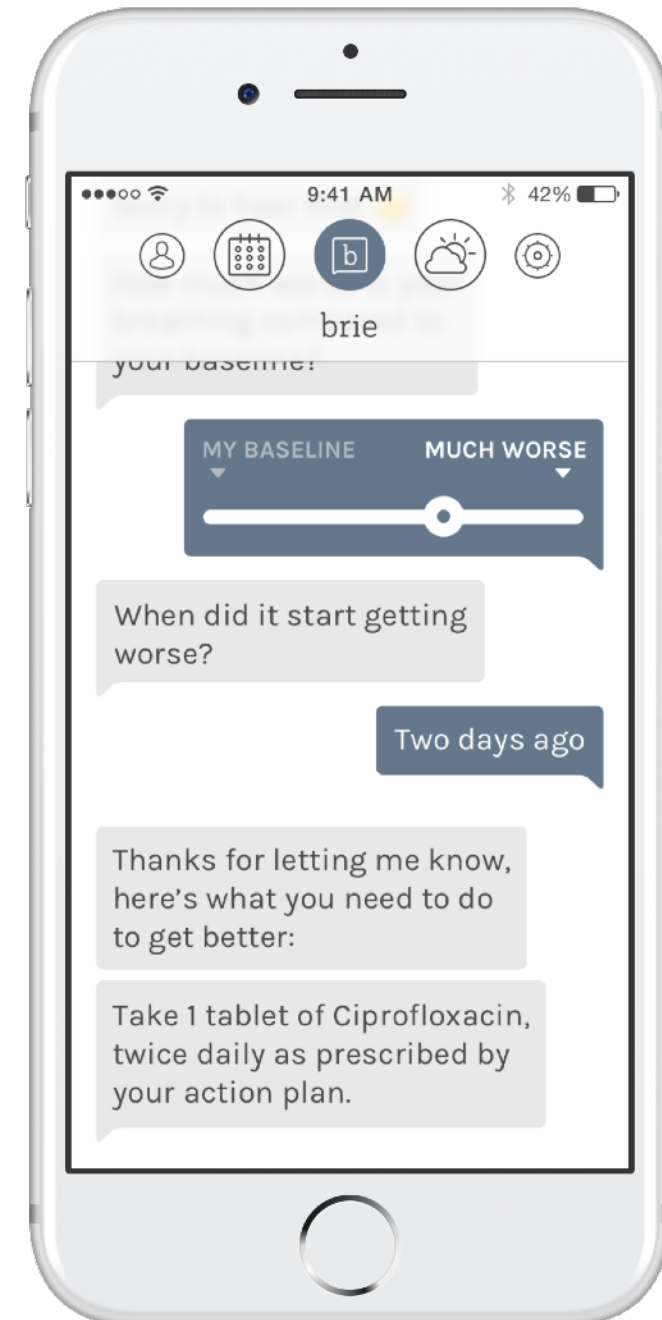
DIGITAL THERAPEUTICS

QMS : ISO 13485

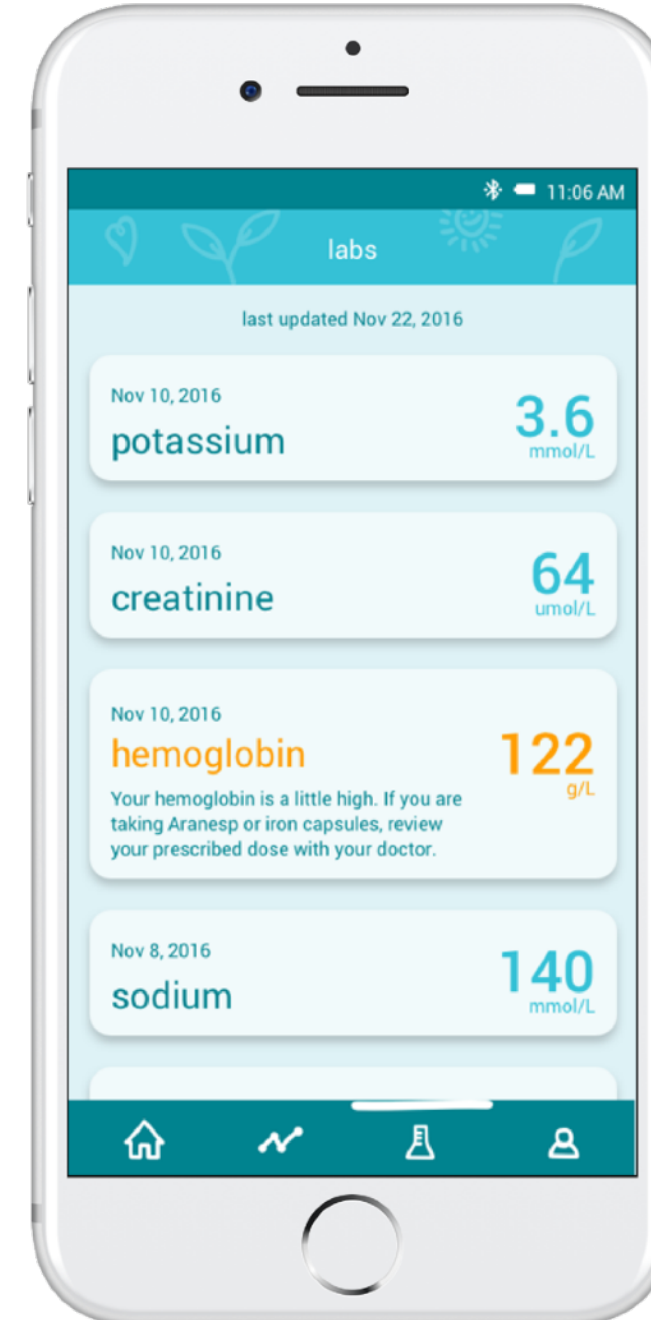
Ned



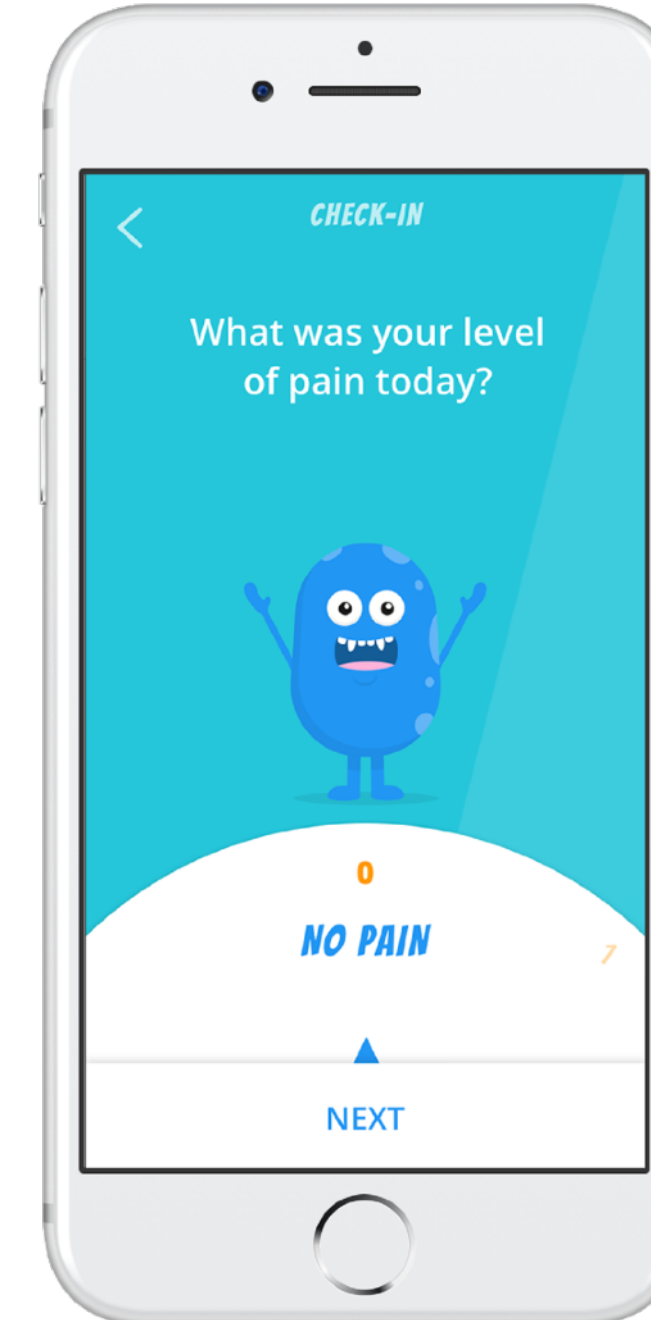

breathe
for asthma & COPD



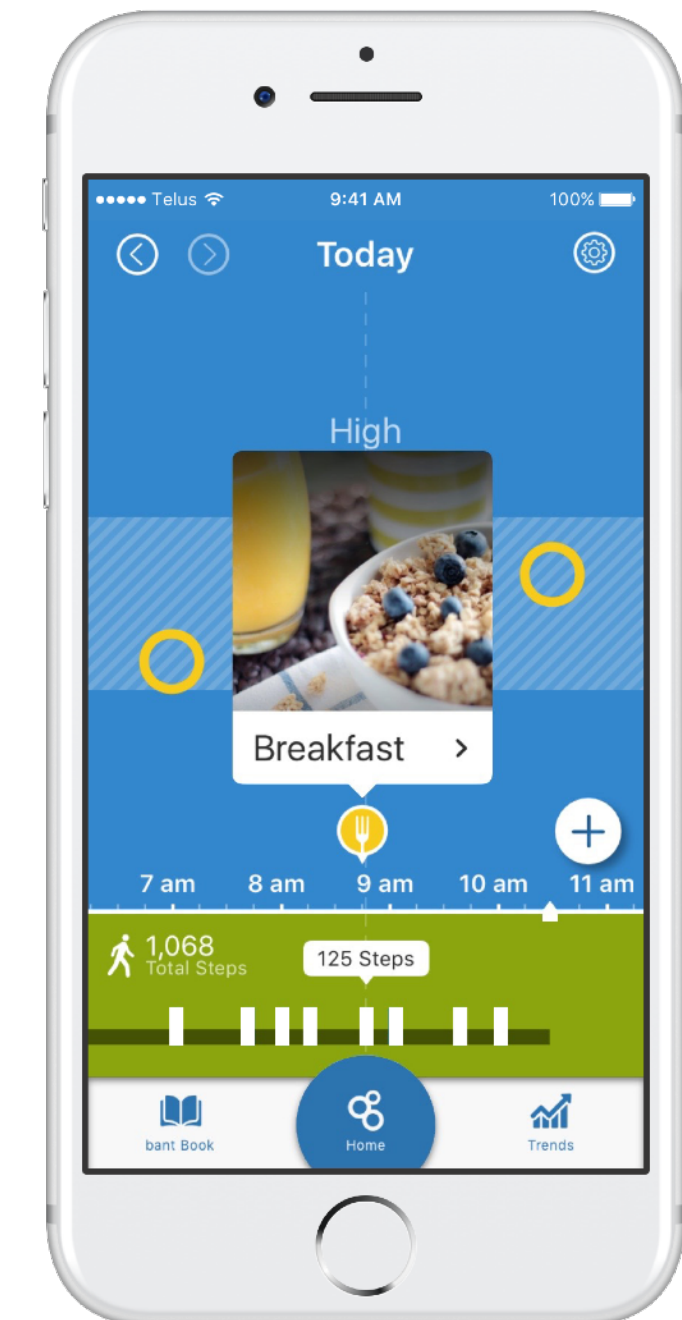
medly



ICANCOPE

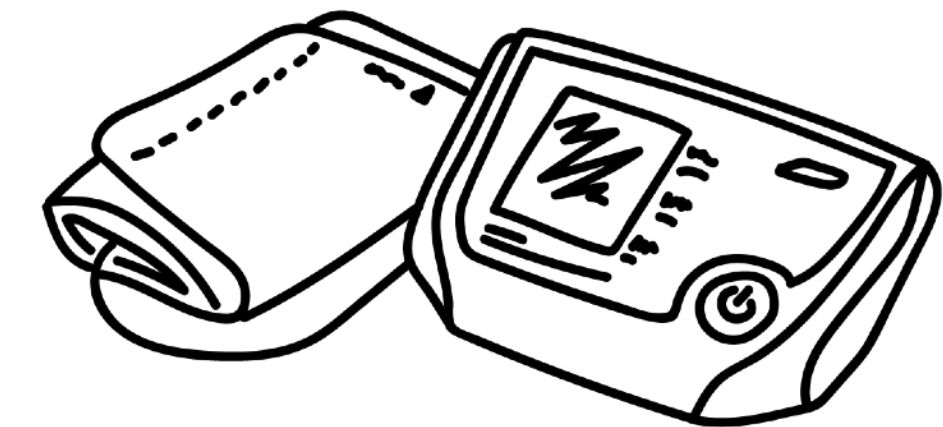
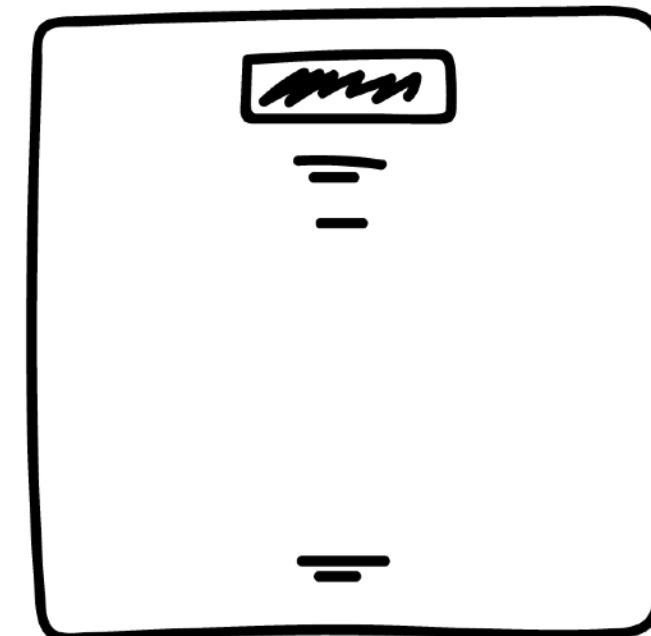
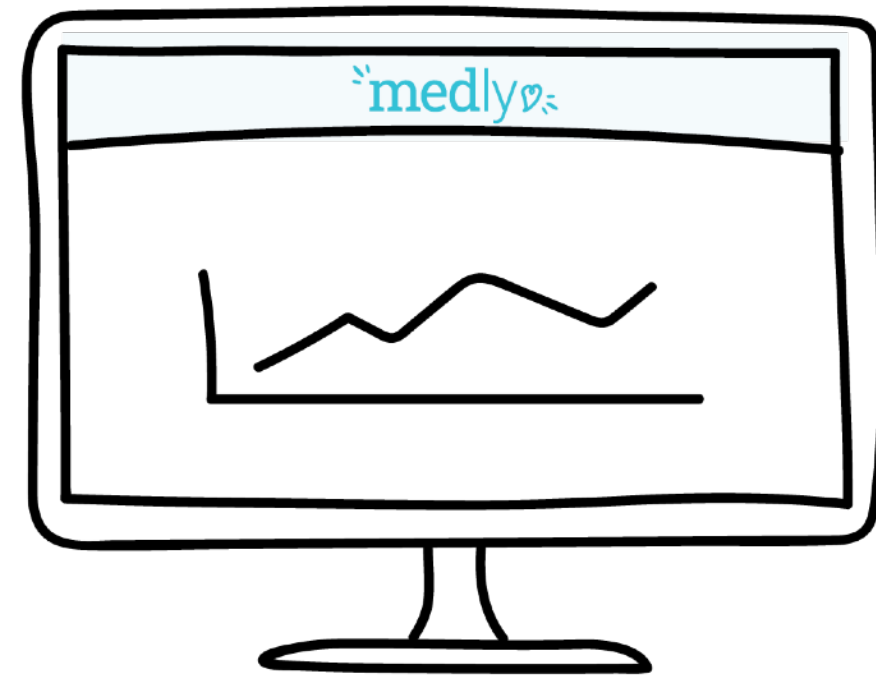


 bant





Remote Patient Monitoring for
Heart Failure





AND
A&O Medical

SYS.
mmHg

DIA.
mmHg

PUL.
/min.

START

Bluetooth
SMART

medly

Bluetooth
SMART

Home

Alert - 5:00 AM

You have had a really big change in your weight, please contact the heart function clinic.

Connect me to the clinic

Ok, we talked

readings - before breakfast

heart rate
79
bpm

blood pressure
99
79
mmHg

symptoms
none

Daily Measurements

Take daily morning measurements

View instructions to take readings and health information at a glance.



Answer Symptom Tracking Questions

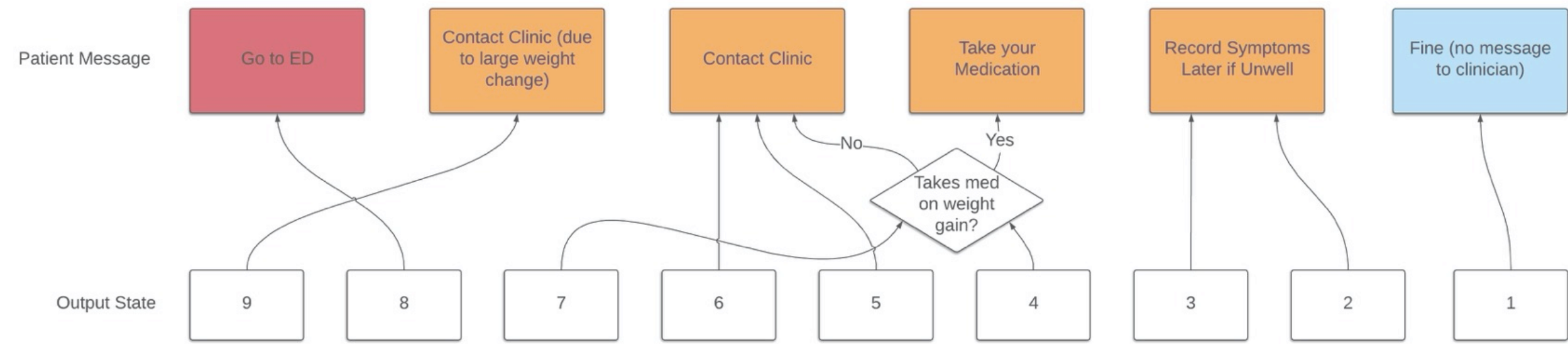
Questionnaires for self-monitoring.

The screenshot shows a questionnaire titled "how are you feeling?". It contains five questions, each with "y" (yes) and "n" (no) radio button options. The questions are: "Have you fainted?", "Has your ICD gone off?", "Has your breathing at night worsened?", "Do you have more chest pain than usual?", and "Are you more tired than usual?". The "y" option is selected for the third and fourth questions.

Review trends

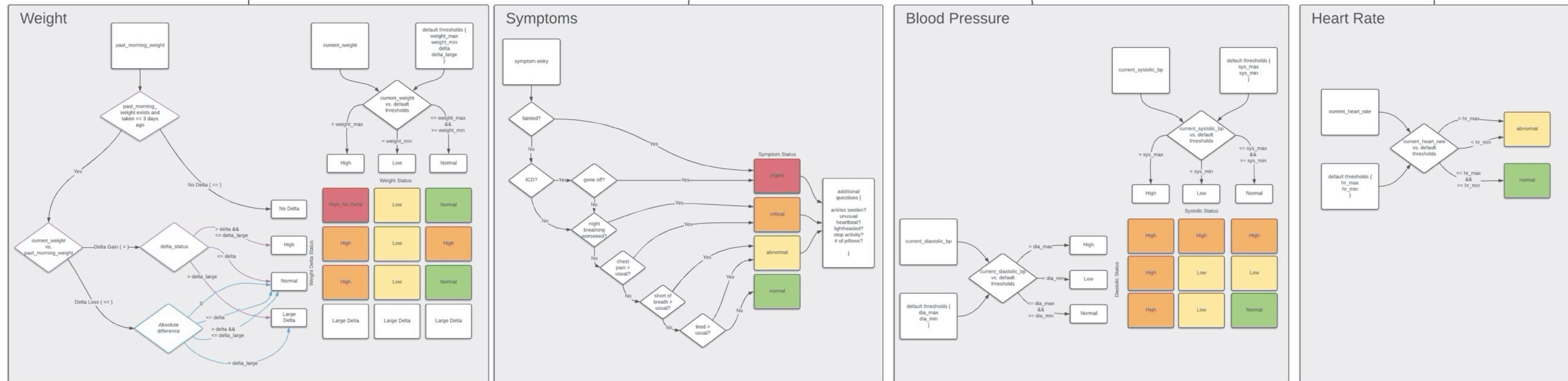
View trends and identify patterns.





SYMPTOMS

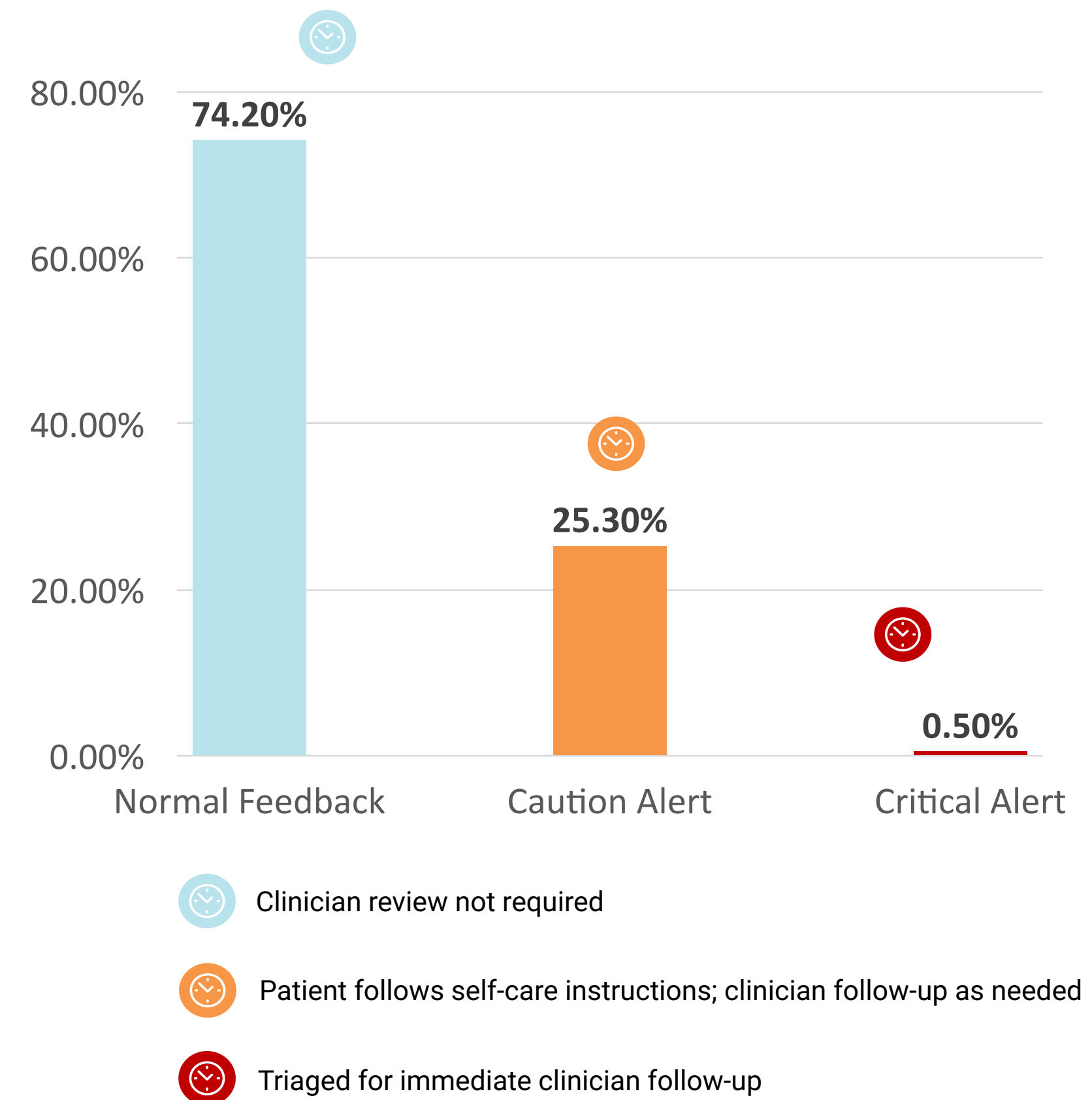
	Normal				Abnormal				Critical				Urgent			
	BP		HR		BP		HR		BP		HR		BP		HR	
N	1	2	2	2	2	6	1	6	6	6	1	6	8	8	8	8
High	4	4	8	8	7	7	8	8	7	7	8	8	8	8	8	8
High, No Delta	6	6	8	8	6	6	8	8	6	6	8	8	8	8	8	8
Low	5	5	5	5	6	6	6	6	6	6	6	6	8	8	8	8
Large Delta	9	9	9	8	9	9	9	8	9	9	9	8	8	8	8	8
N/A	1	3	3	3	2	6	6	6	6	6	6	6	8	8	8	8



Algorithm & Clinical Triage

The *Medly* algorithm is a rule-based expert system that was developed in an iterative fashion with input from PMCC heart failure experts.

- ✓ **Supports the rapid triaging of patients,** while keeping the clinicians updated on the patient's status
- ✓ The Medly software is licensed as **Health Canada Class II Medical Device**, due to its robust clinical evidence base and advanced clinical-decision support functionality.



Health
Canada

Santé
Canada

LN/NH: 104447

Scaling



PROVIDER



PATIENT

CONVENTIONAL

1

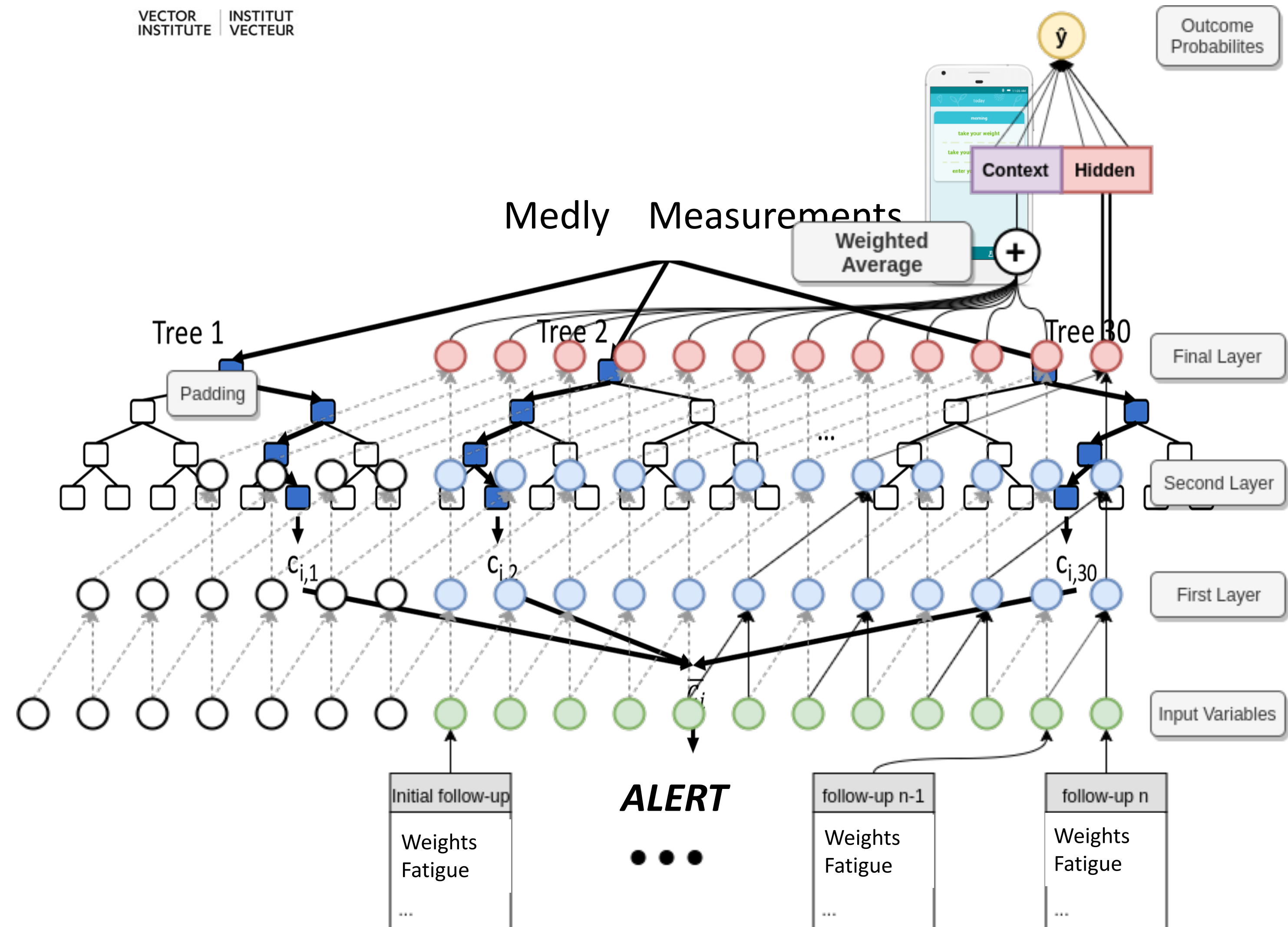
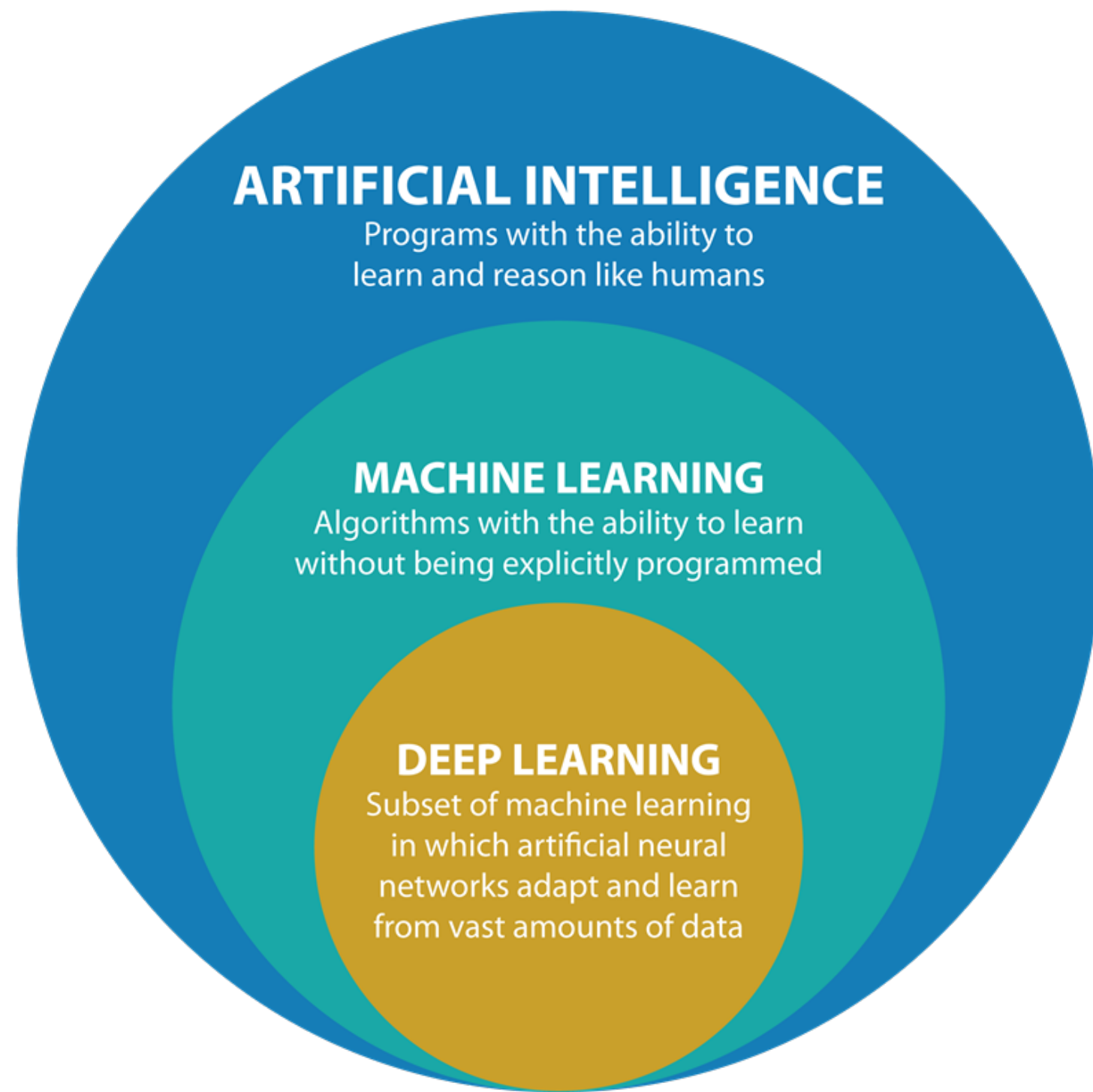
25 to 100

medly

1

>350

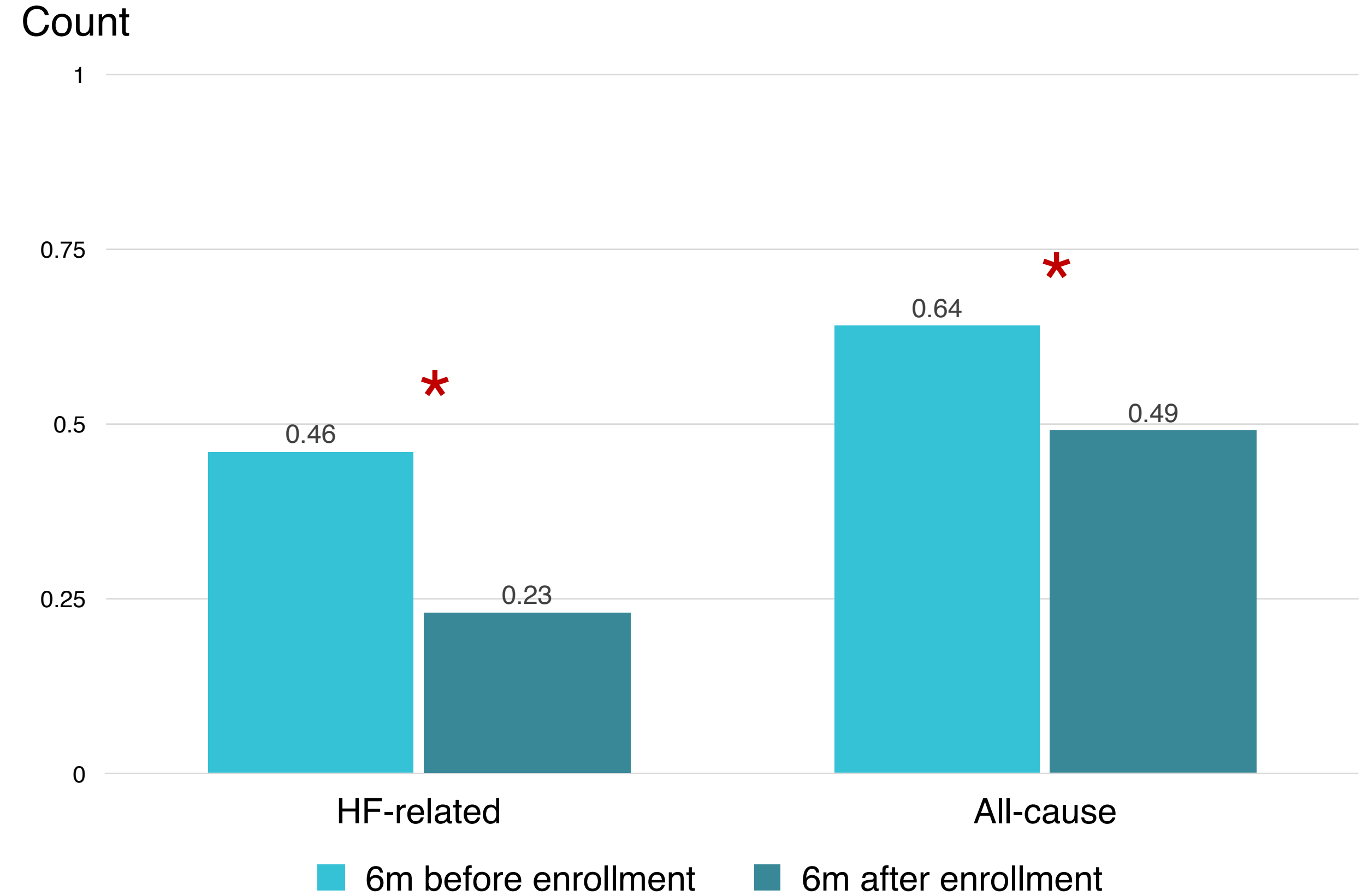
medly AI



Medly's Impact

HEALTH SERVICE UTILIZATION

Number of Hospitalizations



* Statistically significant change (P<.05)

INTERPRETATION

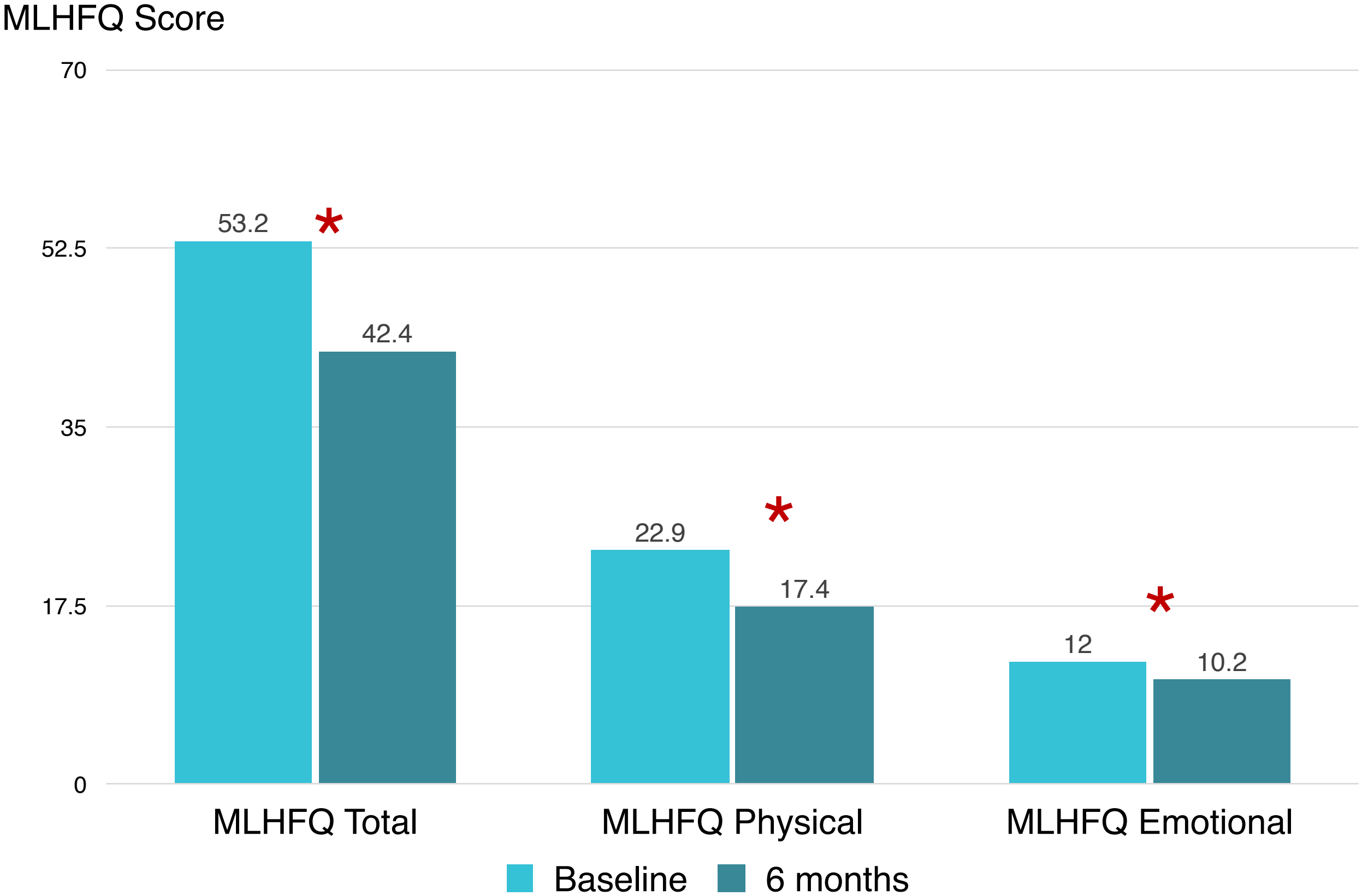
Enrollment in the Medly Program resulted in a:

- ✓ **50 % reduction** in heart failure-related hospitalizations
- ✓ **24% reduction** in all-cause hospitalizations

Ware P et al.. *Outcomes of a Heart Failure Telemonitoring Program Implemented as the Standard of Care in an Outpatient Heart Function Clinic: Pretest-Posttest Pragmatic Study.* J Med Internet Res 2020;22(2):e16538;

QUALITY OF LIFE

Minnesota Living with Heart Failure Questionnaire (MLHFQ)



* Statistically significant change (P<.05)

INTERPRETATION

Enrollment in the Medly Program resulted in an improvement in:

- ✓ **Overall** heart failure-related quality of life
- ✓ **Physical** heart failure-related quality of life
- ✓ **Emotional** heart failure-related quality of life

Ware P et al.. Outcomes of a Heart Failure Telemonitoring Program Implemented as the Standard of Care in an Outpatient Heart Function Clinic: Pretest-Posttest Pragmatic Study. J Med Internet Res 2020;22(2):e16538;

SELF-CARE

Self-Care of Heart Failure Index (SCHFI)



* Statistically significant change (P<.05)

INTERPRETATION

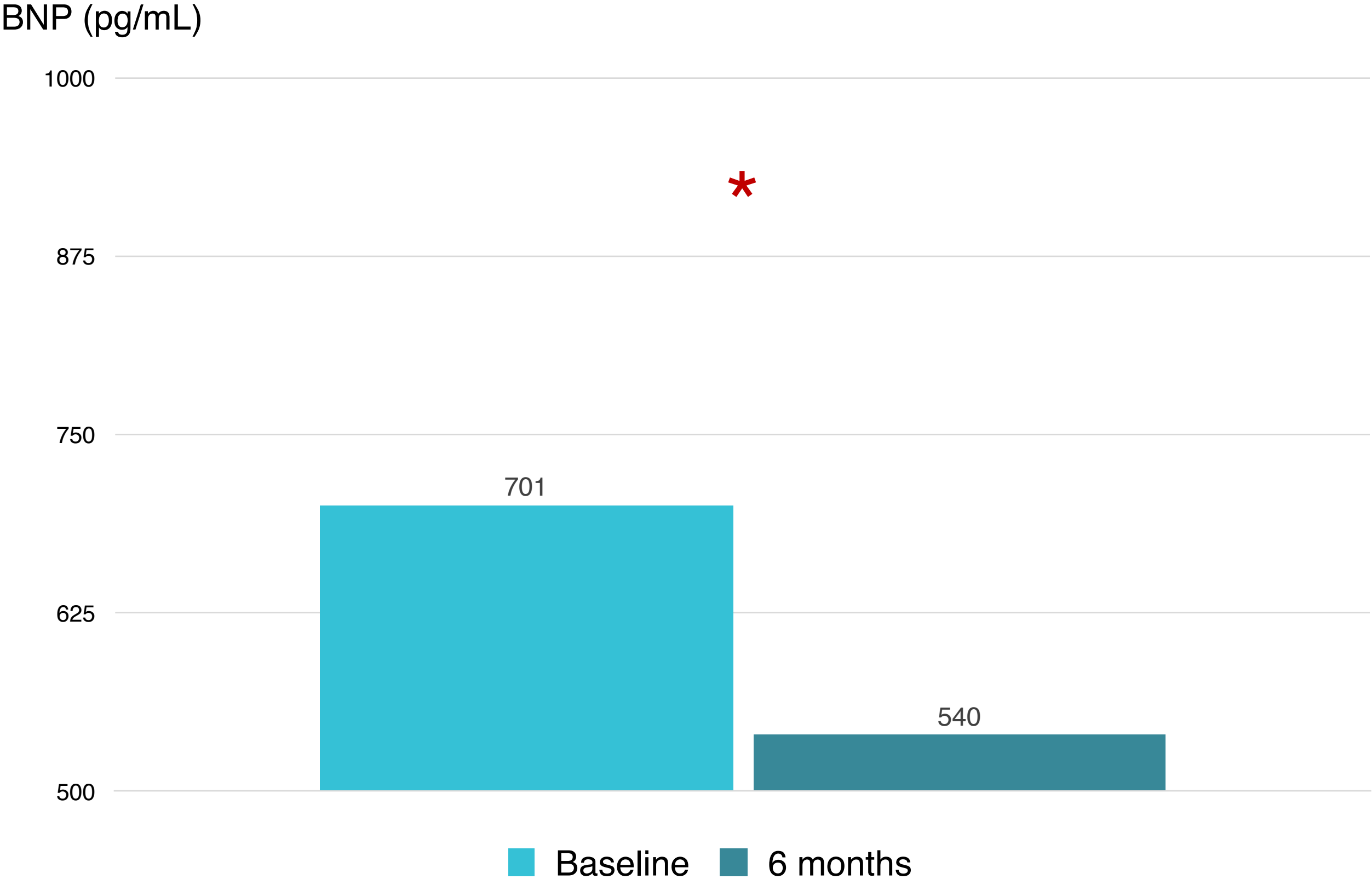
Enrollment in the Medly program resulted in an improvement in:

- ✓ **Self-care maintenance** (behaviours aimed at maintaining physiologic stability)
- ✓ **Self-care management** (behavioural response to symptoms when they occur)

Ware P et al.. *Outcomes of a Heart Failure Telemonitoring Program Implemented as the Standard of Care in an Outpatient Heart Function Clinic: Pretest-Posttest Pragmatic Study.* J Med Internet Res 2020;22(2):e16538;

PROGNOSTIC INDICATORS

B-Type Natriuretic Peptide (BNP)



* Statistically significant change (P<.05)

INTERPRETATION

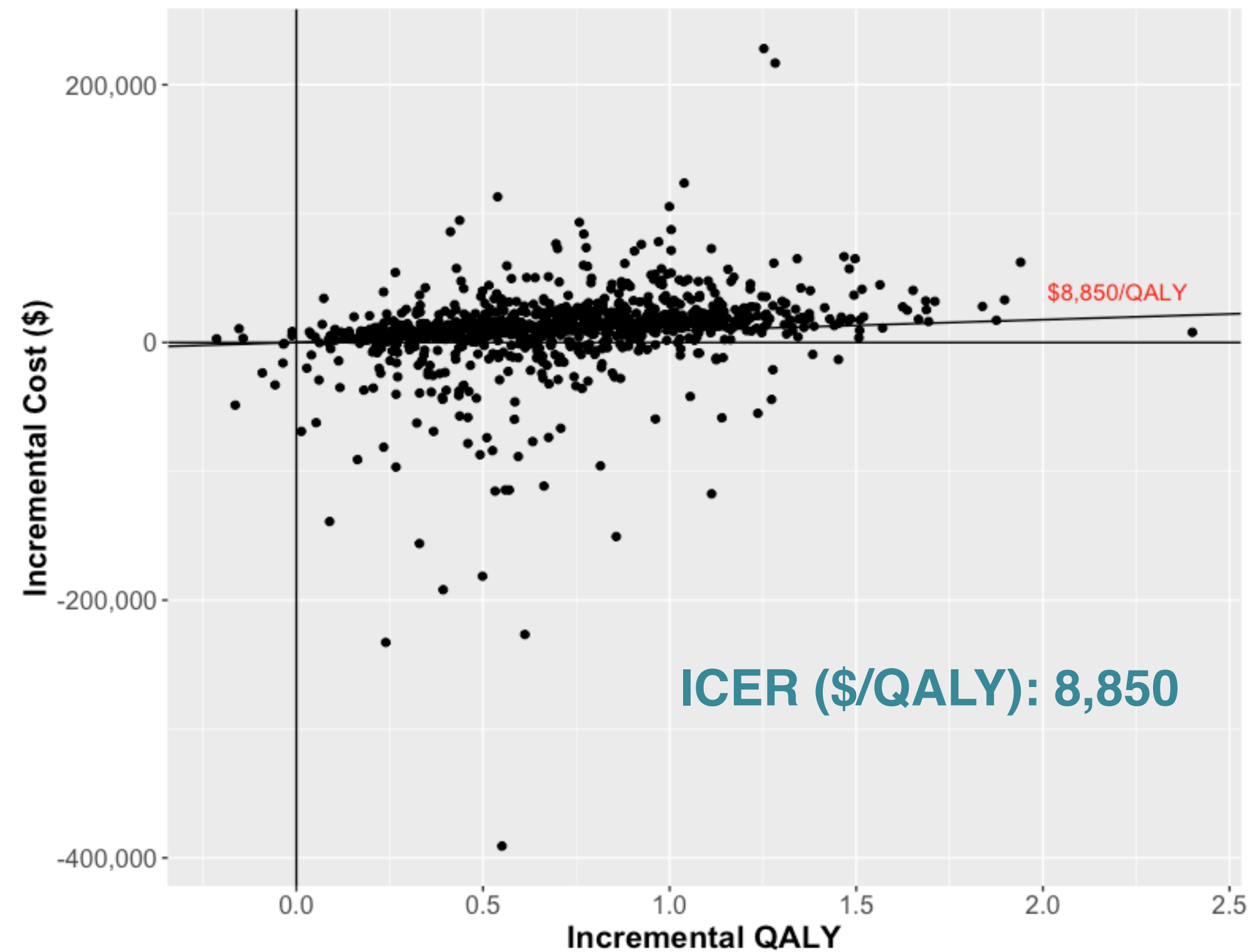
Enrollment in the Medly Program resulted in a:
✓ 59% decrease in BNP¹ values.

¹ BNP is secreted by the heart in response to stretch from pressure or volume overload. It is a key HF prognostic indicator, with higher levels being associated with an increased risk of mortality and hospitalization.

Ware P et al.. Outcomes of a Heart Failure Telemonitoring Program Implemented as the Standard of Care in an Outpatient Heart Function Clinic: Pretest-Posttest Pragmatic Study. J Med Internet Res 2020;22(2):e16538;

MEDLY'S IMPACT: COST-EFFECTIVENESS

Cost-utility plane



INTERPRETATION

The Medly program is cost-effective compared to standard care*

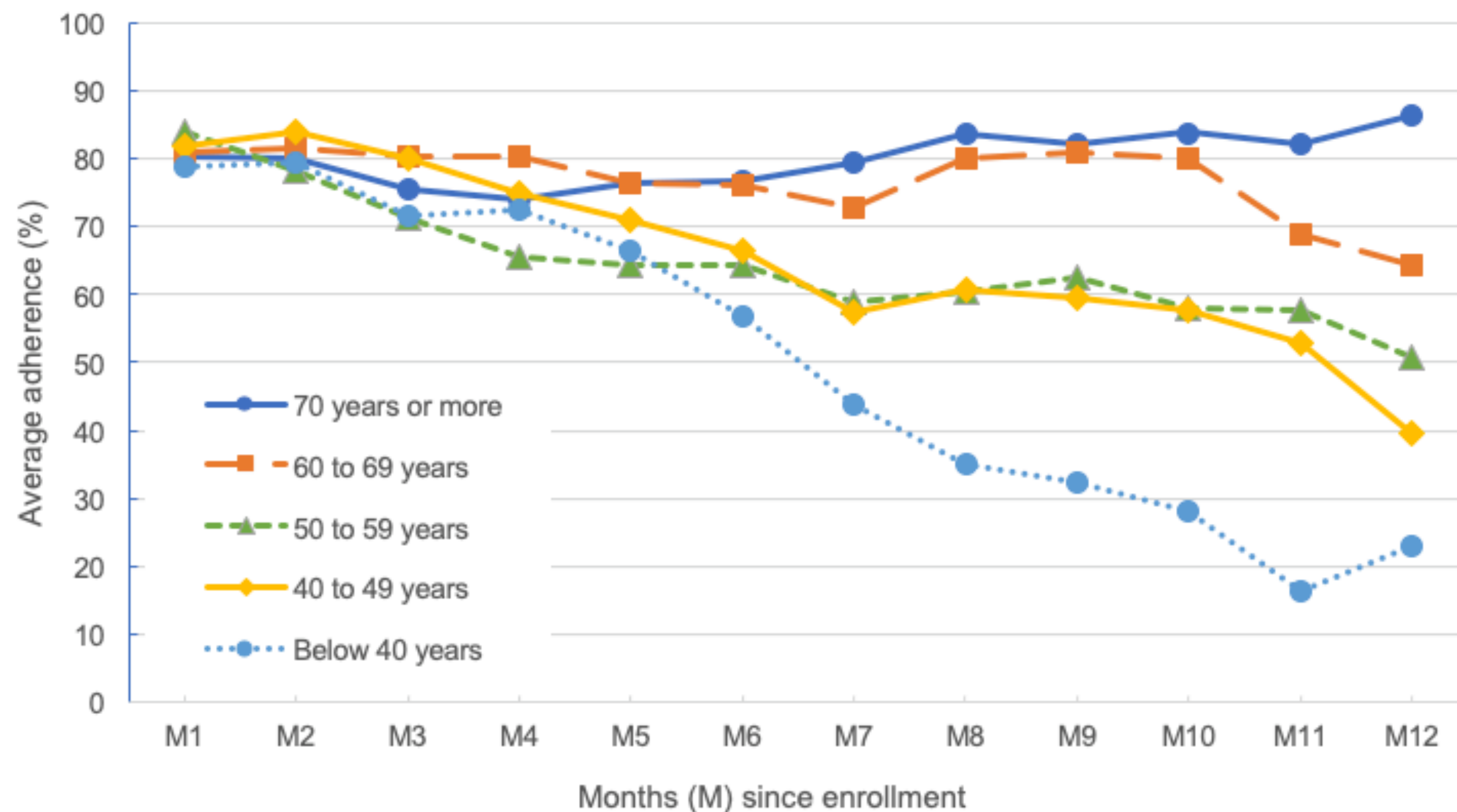
- ✓ High probability (90%) of being cost-effective
- ✓ Cost-effectiveness improves in cohorts with more advanced HF
- ✓ Cost-effectiveness improves as more patients use their own devices

Boodoo C , Qi Z, Ross HJ, Alba, AC,, Laporte A, Seto E, Evaluation of the cost-utility of a heart failure telemonitoring program through a microsimulation model. J Med Internet Res 2020 (In Press)

Functional Class	Prob. of cost-effectiveness	ICER (\$/QALY)	Deployment model	Prob. of cost-effectiveness	ICER (\$/QALY)
NYHA I	90.5%	10,567	BYOE	92.9%	3,349
NYHA II	90.6%	8,510	Mixed	91.7%	5,780
NYHA III	90.5%	5,931	Full Kit	85.4%	15,362

PATIENT EXPERIENCE

Adherence to daily readings



INTERPRETATION

- ✓ Patients took, on average, 74% of their expected morning readings throughout their enrollment in the program, up to 1 year
- ✓ Older patients maintained high adherence throughout enrollment with adherence levels dropping over time for younger age groups

Ware P, Dorai M, Ross HJ, Cafazzo JA, Laporte A, Boodoo C, Seto E. Patient Adherence to a Mobile Phone-Based Heart Failure Telemonitoring Program: A Longitudinal Mixed-Methods Study. *JMIR Mhealth Uhealth* 2019;7(2):e13259

Key Findings:

- **50% reduction** in HF-related hospitalizations
- **24% reduction** in the number of all-cause hospitalizations
- **59% reduction** in BNP values
- **Significant improvements** in patient-reported outcomes of their experiences living with HF, and their physical and emotional quality of life
- **Significant improvements** in patient-reported outcomes of their ability to maintain self-care and manage their HF
- **Significant improvements** in patient-reported outcomes of their ability to maintain self-care and manage their HF
- **74% average adherence** to taking symptoms on the Medly app for over 6 months



breathe

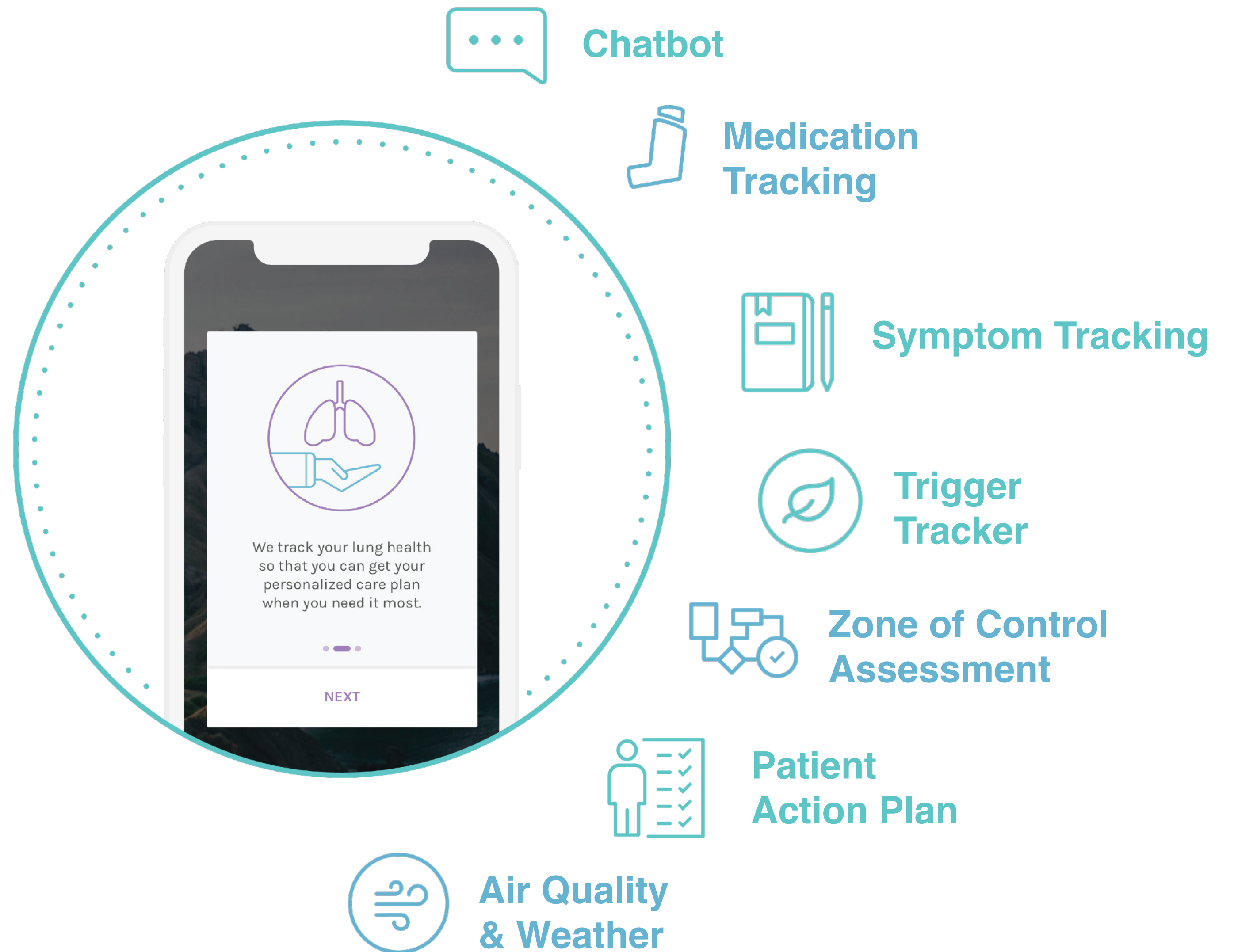
for COPD



Respiratory Self-Management Spectrum



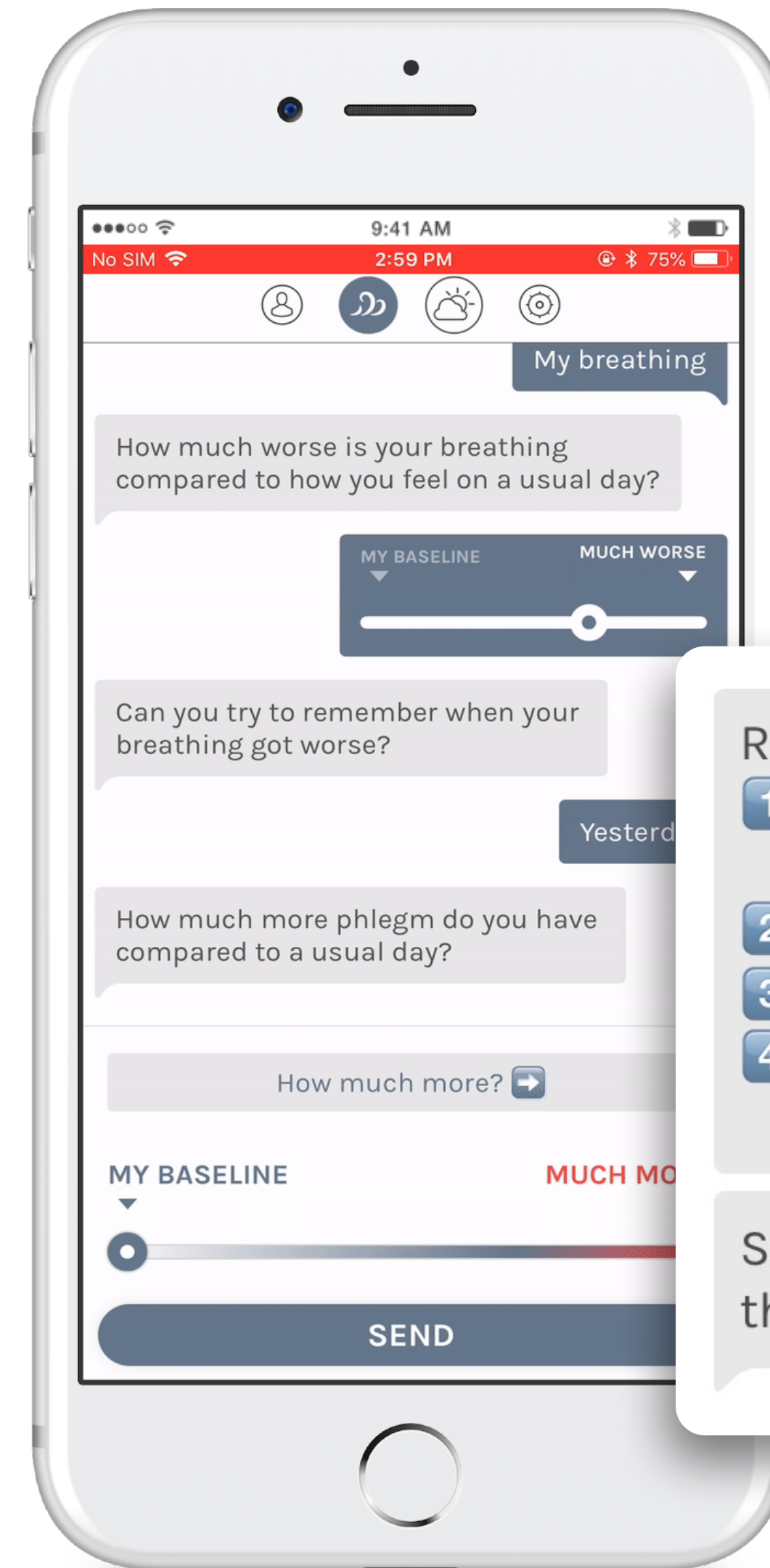
Build capacity for patients to take appropriate action when they feel unwell.



② Exacerbation Detection

Features:

- Symptom Questionnaire
 - Patients have difficulty in recognizing when there is a clinically important change from their baseline
- Chatbot
 - Asks symptom questions to understand type and amount of change from baseline
 - Interface governed by a decision tree in the background
 - Guides user through the entire experience

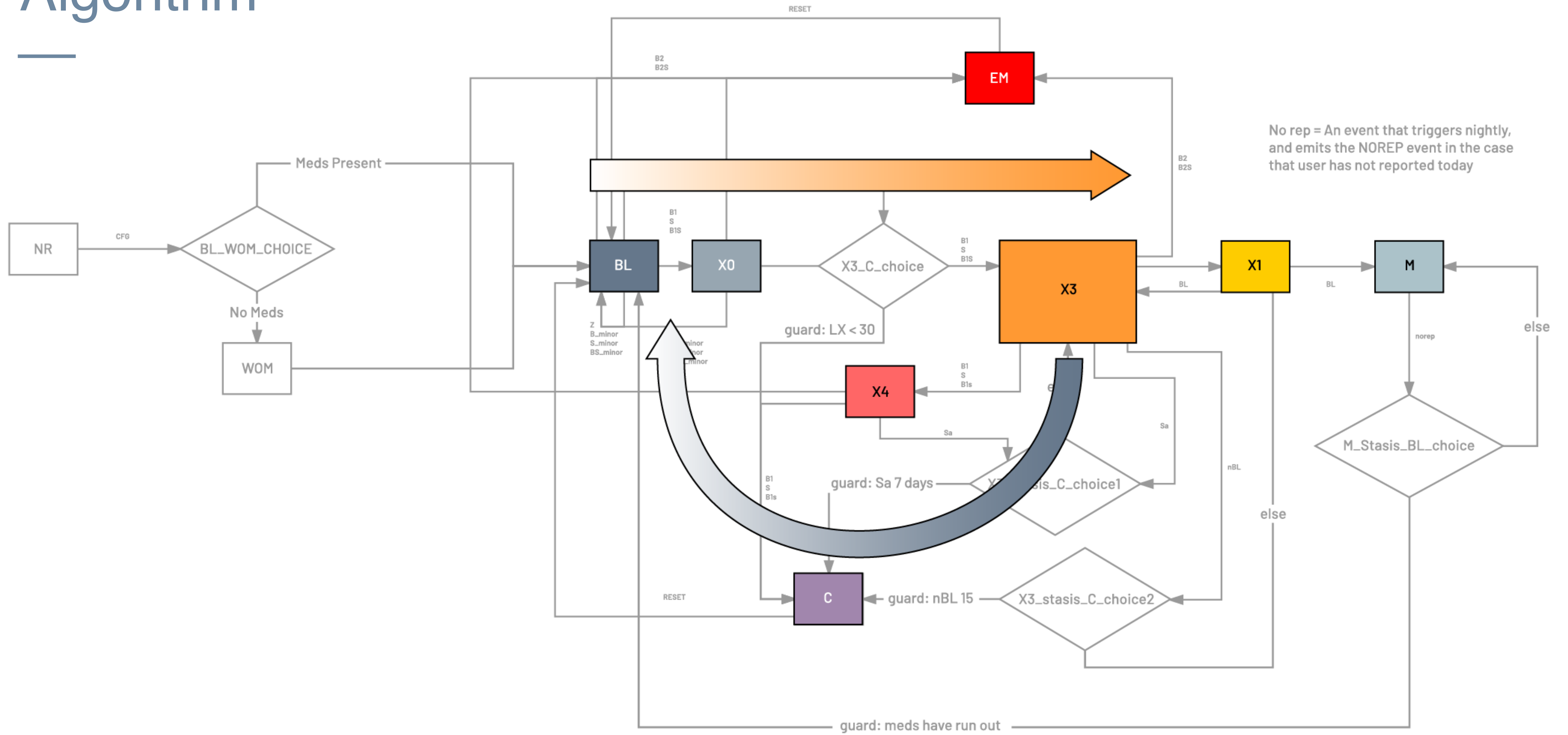


Remember, your baseline is:

- 1 You have trouble breathing with some activity
- 2 Your phlegm colour is
- 3 Your phlegm is thick
- 4 You have less than a teaspoon of phlegm

Select all that apply, then hit send.

Algorithm



 @nedapp

 getned.com



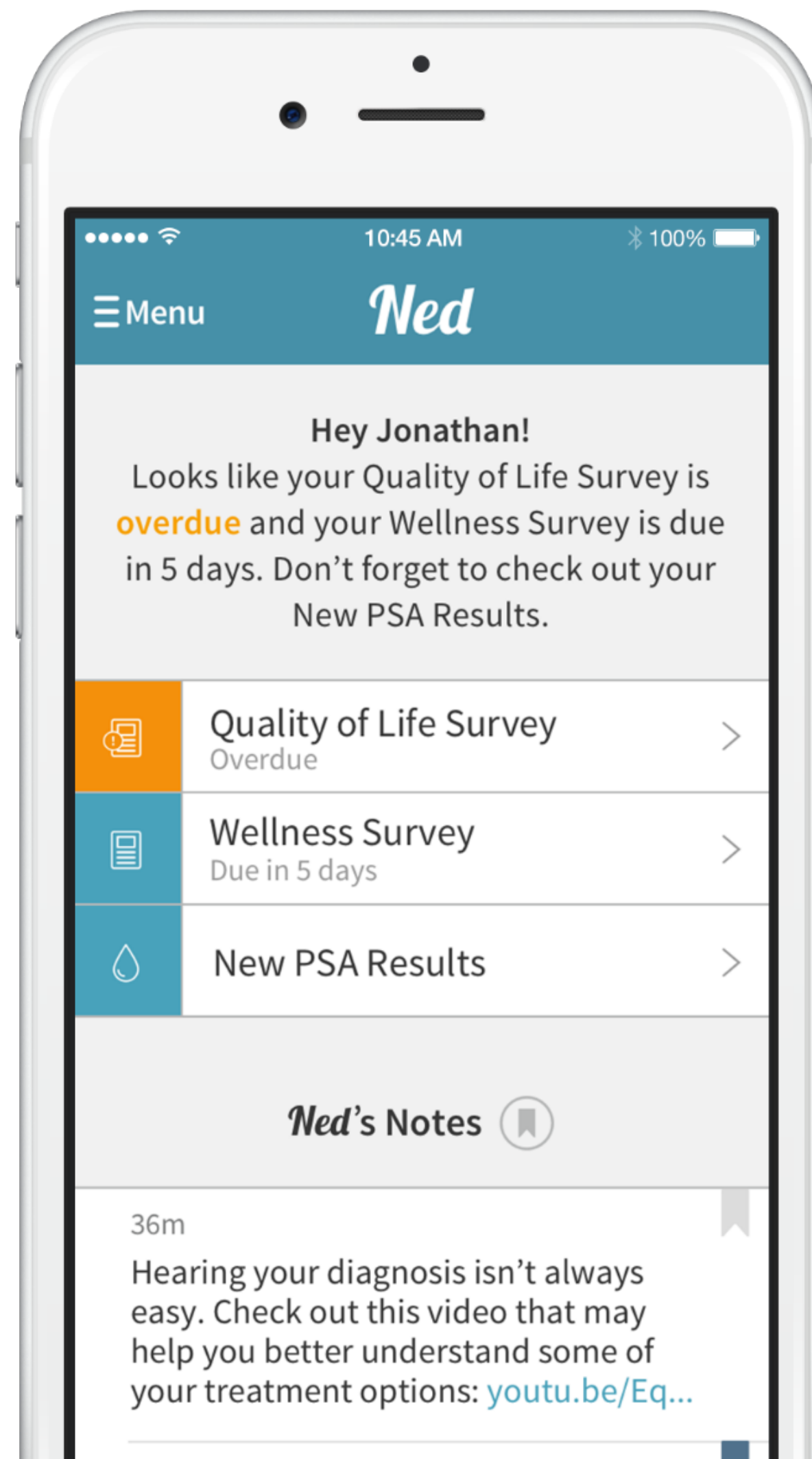
Elevating the Cancer Survivorship Experience





Ned

A companion app for men with prostate cancer



Ned brings together:

- Patient Reported Outcomes (reported through Ned on a monthly bases)
- Lab results (directly from OLIS)

Ned shares this information with both patients and their clinicians.

Giving patients and clinicians access to the same information in one location provides a cohesive picture of the patient's well-being and enables shared strategies for improved quality of life.

ABOUT *NED*

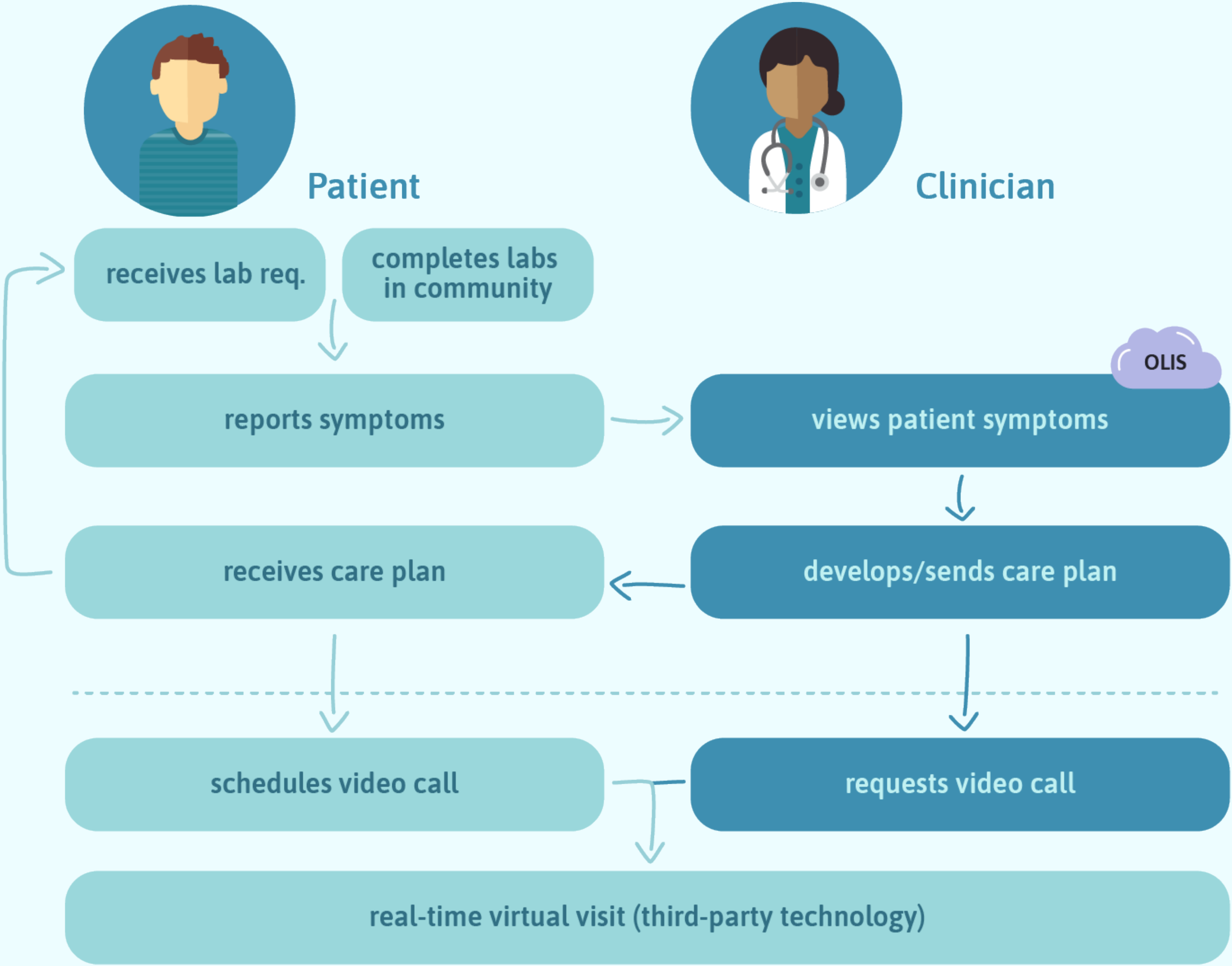
Ned Virtual Clinic

Ned (“No Evidence of Disease”) is a PCa survivorship platform conceived by Dr. Andrew Feifer at Trillium Health Partners and developed at University Health Network.

The *Ned* Virtual Clinic is built upon the *Ned* platform, which aims to transform the traditional model of survivorship care through virtualizing services.



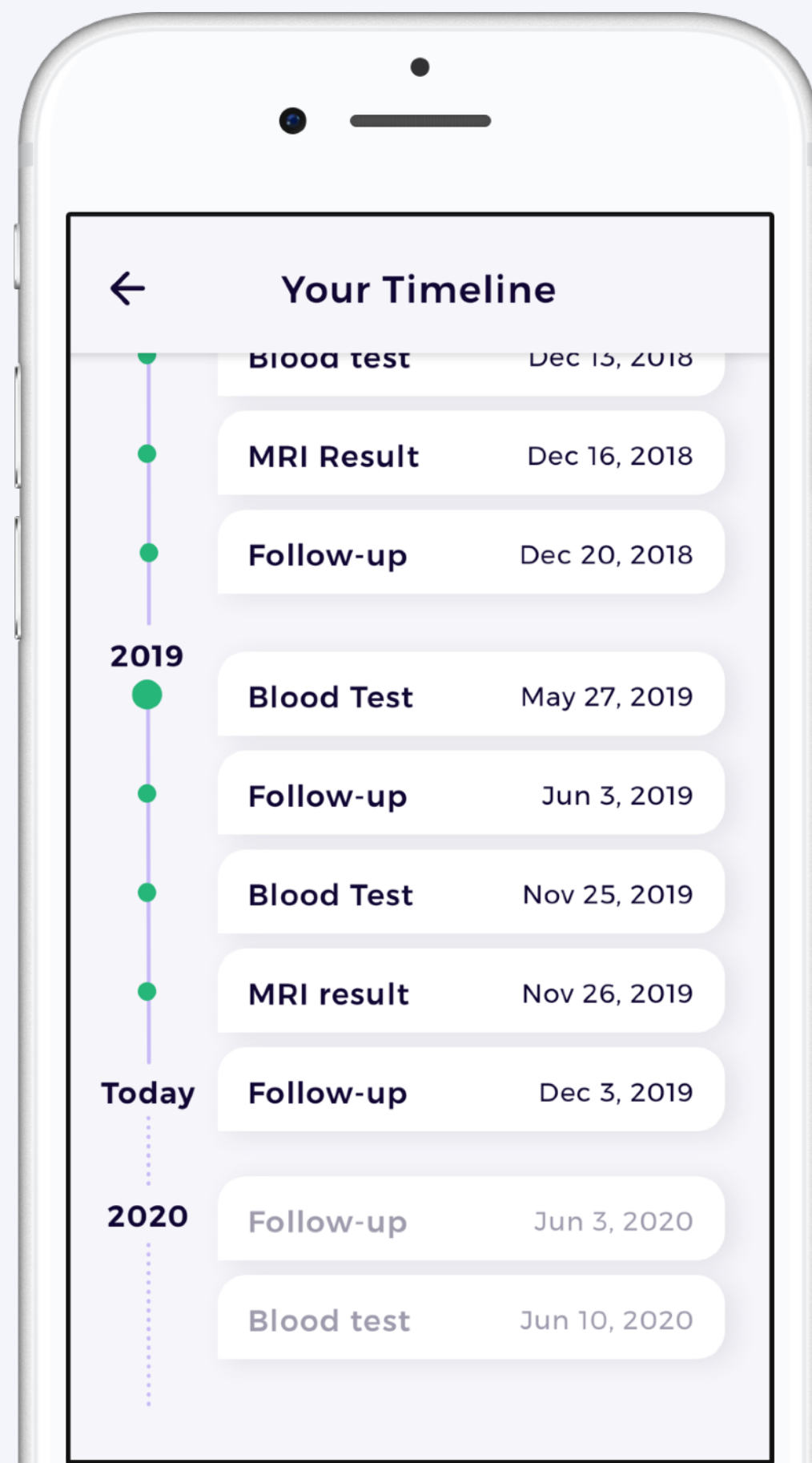
ABOUT NED



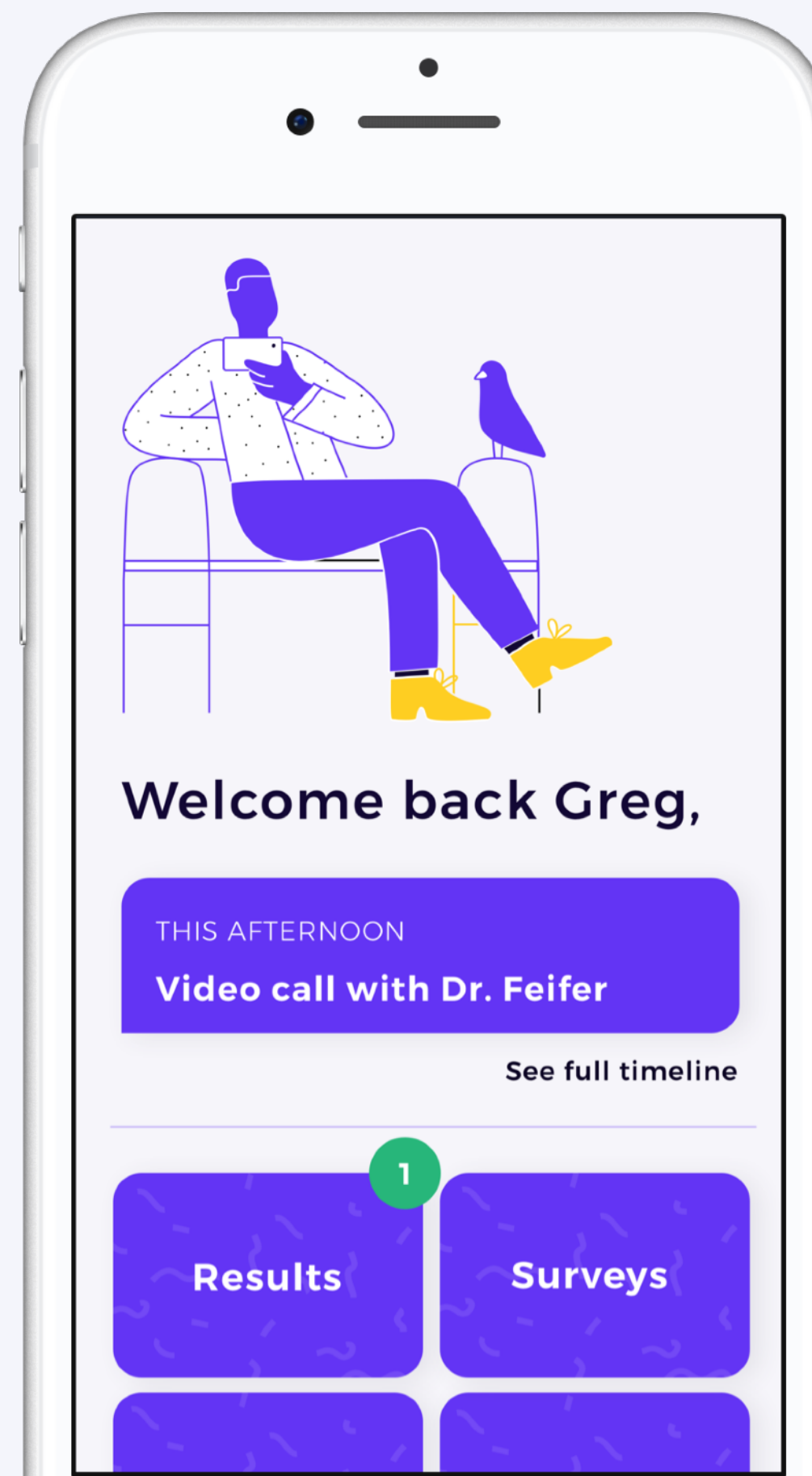
ABOUT NED

Patient Application

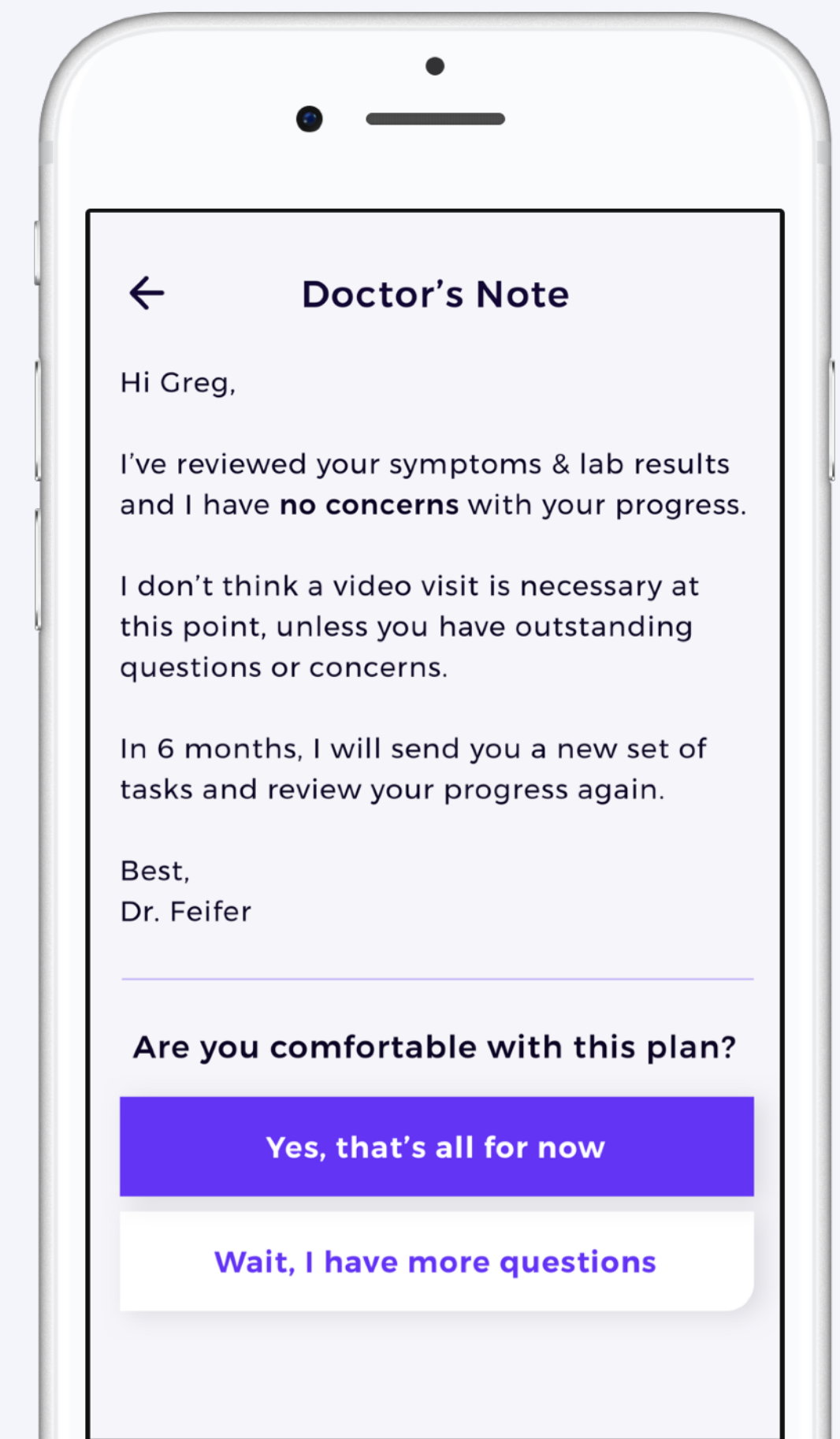
Reports symptoms and gets blood test at community lab



Schedules a video call appointment with specialist



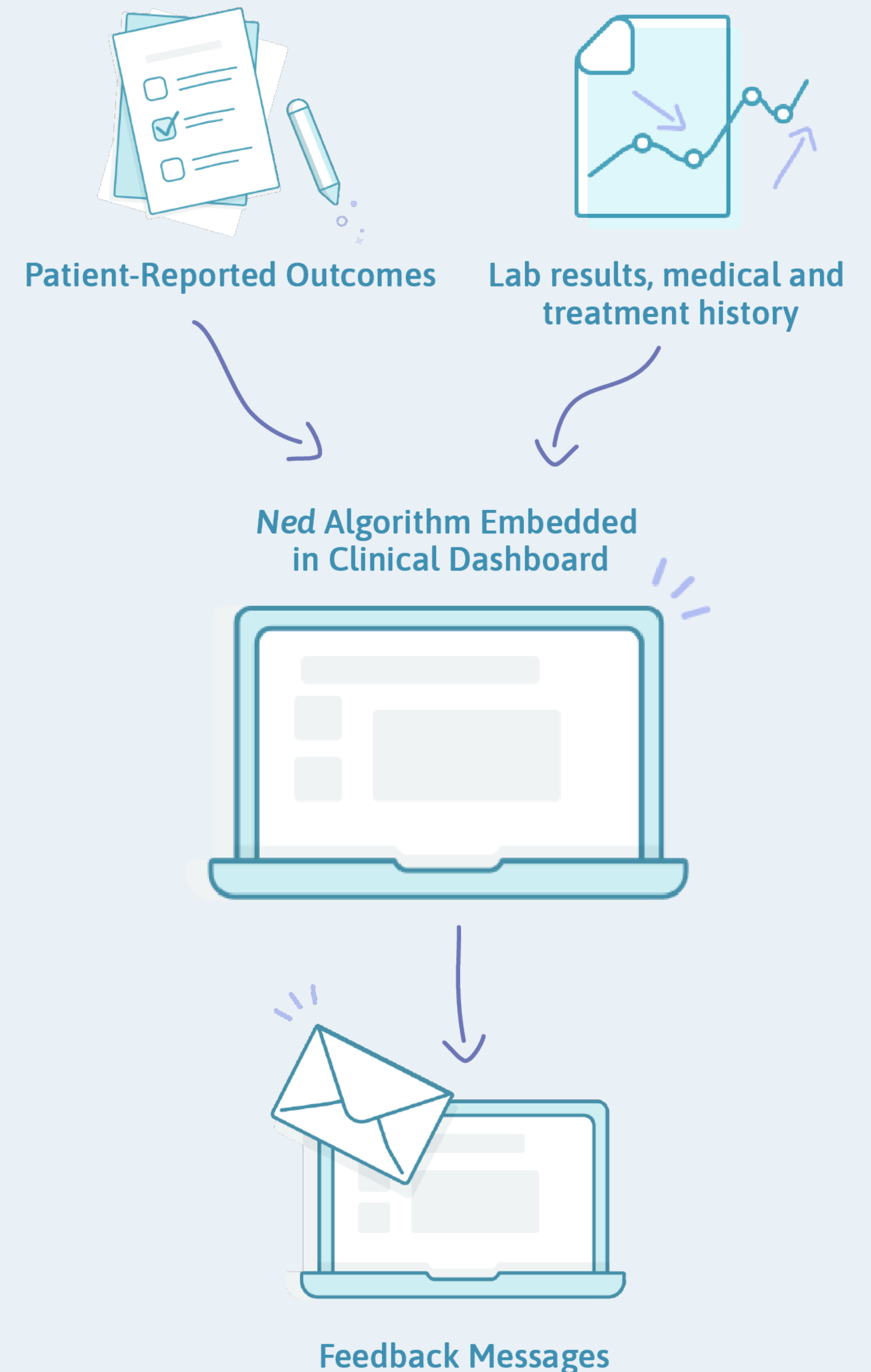
Receives a patient report with a care plan from specialist



Ned Algorithm

Assists *Ned* nurse with the capacity to remotely manage and care for survivors.

- Processes relevant survivorship indicators taken by the patient
- Aggregates a learning dataset for predictive purposes
- Generates feedback messages to direct *Ned* nurse to care for patients most in need





UNIVERSITY OF
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Advanced Self-Care through Digital Therapeutics

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