Implementation of personalized care plans based on evidence-based guidelines on top of an HL7-FHIR based interoperability layer

Gökçe B. Laleci Ertürkmen, PhD.

Who am I?

Gökçe Banu Laleci Ertürkmen, PhD

Senior Researcher| R&D Director

SRDC Software Research & Development and Consultancy Corp.

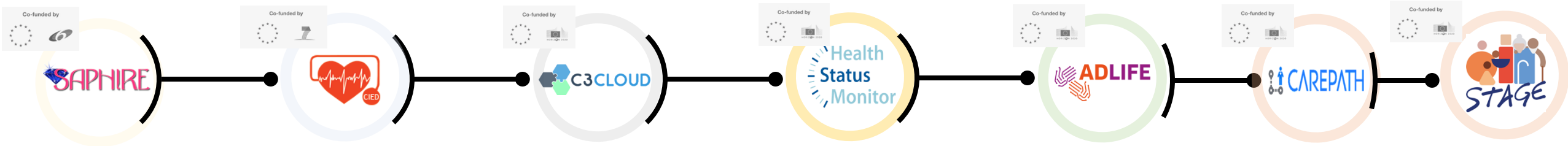
SRDC Corp. ODTU Teknokent Silikon Blok Kat:1 No:16 06800 Ankara, TURKEY

Overview

- Our previous work on automation of clinical guidelines for creating personalization of care plans
- Integrated care platform for chronic disease management based on evidence based guidelines: a national deployment in Türkiye
- Architecture: From clinical guidelines to Care Plans
- Sharing Care Plans with Patients

Our work on Care Plans and Clinical Guidelines

- Building clinical decision support solutions for increasing adherence to clinical guidelines to enable standardized care since 2006



2004-2006

SAPHIRE
Intelligent Healthcare Monitoring based on Semantic Interoperability Platform

Acute Coronary Syndrome
Ischemic heart disease followed by a revascularization therapy

ESC European Society of Cardiology

Guideline > Eur Heart J. 2003 Jan;24(1):28-66. doi: 10.1016/s0195-668x(02)00618-8.

Management of acute myocardial infarction in patients presenting with ST-segment elevation. The Task Force on the Management of Acute Myocardial Infarction of the European Society of Cardiology

2006-2008

iCARDEA
An Intelligent Platform for Personalized Remote Monitoring of the Cardiac Patients with Electronic Implant Devices

Atrial Fibrillation (AF) and Ventricular Arrhythmias (VT/VF)

ESC European Society of Cardiology

ACC/AHA/ESC 2006 Guidelines for the Management of Patients With Atrial Fibrillation: A Report of the American College of

2016-2020

C3-CLOUD
A Federated Collaborative Care & Cure Cloud Architecture for Addressing the Needs of Multi-morbidity and Managing Poly-pharmacy

Hypertension
CVD Risk
Diabetes
Heart Failure

NICE National Institute for Health and Care Excellence

FHIR CDS HOOKS™

2020-2021

SmartHT
Smart Hypertension Management through Integrated Care and Patient Empowerment

Hypertension

ESC European Society of Cardiology European Heart Journal (2018) **39**, 3021–3104 doi:10.1093/eurheartj/ehy339

FHIR CDS HOOKS™

2020-2025

ADLIFE
Integrated Personalized Care for Patients with Advanced Chronic Diseases to Improve Health and Quality of Life

COPD
Heart Failure
Hypertension
CVD Risk
Diabetes
CKD
Depression

NICE National Institute for Health and Care Excellence

Global Initiative for Chronic Obstructive Lung Disease

FHIR CDS HOOKS™

2021-2025

CAREPATH
An Integrated Solution for Sustainable Care for Multimorbid Elderly Patients with Dementia

MCI
Mild Dementia
Hypertension
Heart Failure
CVD Risk
Diabetes
CKD
Depression

2024-2030

STAGE
Stay Healthy Through Ageing

SMART® on FHIR

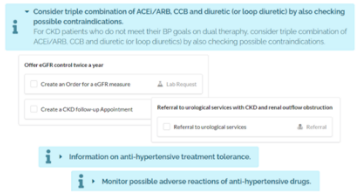
HL7/fhir-ips

EUROPEAN ELECTRONIC HEALTH RECORD EXCHANGE FORMAT

Integrated care platform for chronic disease management

Screening and Risk Assessment

Intelligent decision support services for personalized risk prediction, facilitating risk stratification and early diagnosis of diseases.



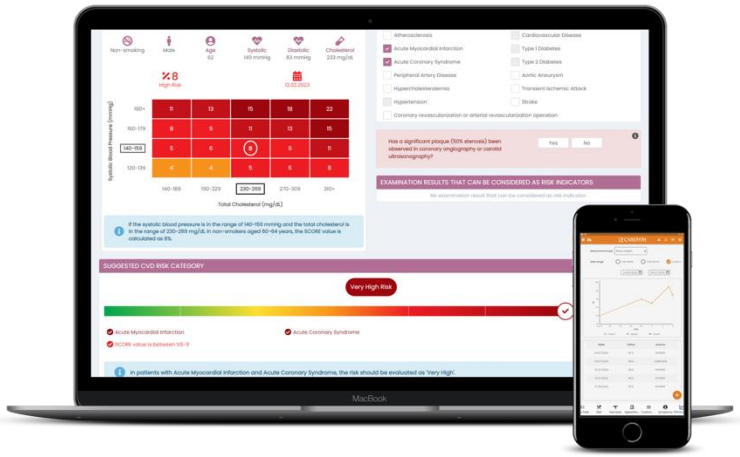
Automating Evidence-based Medical Guidelines

Routine monitoring of chronic disease patients using personalized recommendations aligned with evidence-based medical guidelines.

Integration with External Systems

Seamless integration with Electronic Health Records (EHR) systems via HL7 FHIR-based interfaces.

kronIQ



https://kroniq.health/

Shared Care Plans & Transition of Care

Empowering healthcare professionals within multidisciplinary care teams to collaboratively create and update shared care plans.

Self-Management Support for Patients

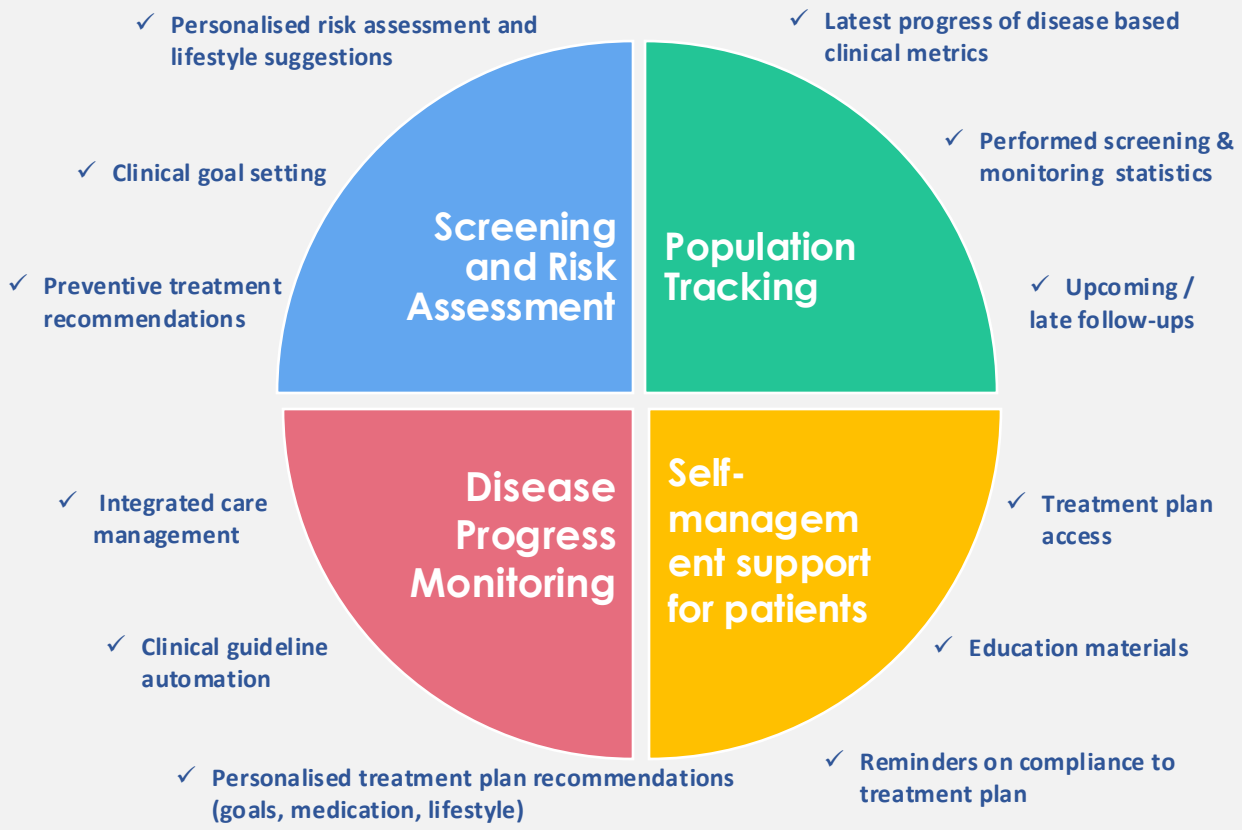
Access to personalized treatment plans, receiving motivational reminders, and support with educational materials.

Population Tracking

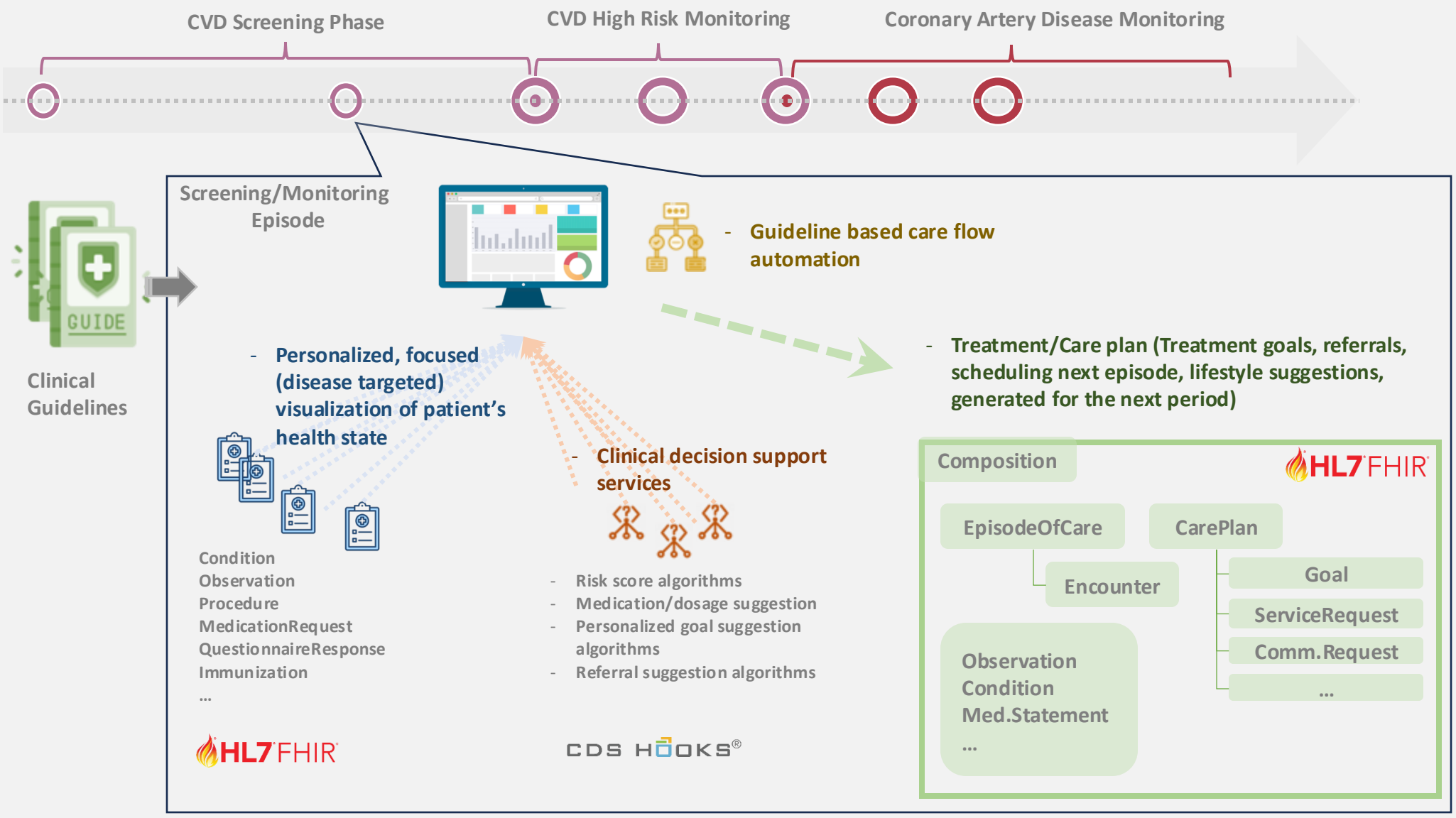
Value-based care through dashboards to monitor the latest status of disease-based clinical indicators for patients and populations.

National Chronic Disease Management Platform (HYP)

- Supports 35K GPs and 27K GP nurses
- 42M+ citizens in Turkey have at least one care plan
- Digitizes clinical guidelines for screening, monitoring and care planning
- Integrates tightly with eNabiz (national EHR/PHR system)



Chronic Disease Management in Primary Care



- Hypertension
- Diabetes
- CVD Risk
- Obesity
- Coronary Artery Disease
- Stroke
- Chronic Kidney Disease
- Geriatric Monitoring
- COPD
- Asthma

KronIQ in action – scale of usage in Türkiye

35K Used daily by GPs since **July 2021**

220M Avg FHIR interactions per day

250M Total screening and monitoring episodes

42M Total citizens with at least one care plan

47B FHIR resources

2.6ms Avg. duration for FHIR Read

6.1ms Avg. duration for FHIR Search

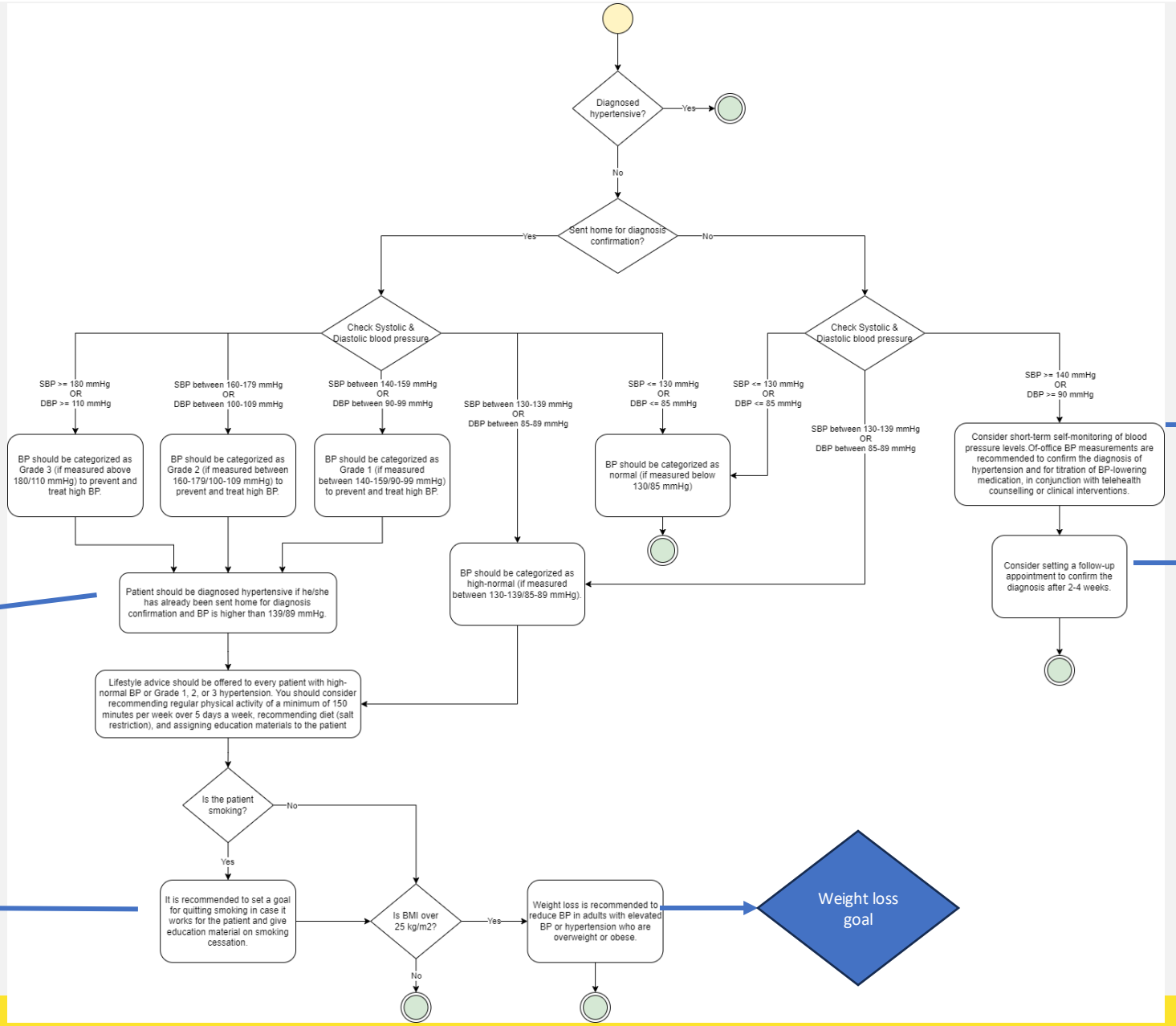
18ms Avg. duration for FHIR Create/Update

9.6ms Avg. duration for FHIR Transaction

1.1s Avg. online data transformation & synchronization time

From Clinical Guidelines to Care Plans

Clinical Guidelines



From Clinical Guidelines to Care Plans

Rule ID	Context	Purpose	Trigger	Rule description	Input as Prefetch	Output as Cards
Hypertension 9	Patient is high-normal, or Hypertension Grade 1, 2, or 3	Lifestyle advice	This CDS will be triggered by AICP during Care Plan is being created or updated	IF the patient is categorized as [high-normal] OR [Grade 1 hypertension] OR [Grade 2 hypertension] OR [Grade 3 hypertension]	Observations: *Hypertension Grade	**Lifestyle advice for hypertensive patients (Card 7)** -Recommend Regular physical activity of a minimum of 150 minutes per week over 5 days a week -Recommend Diet (Salt Restriction) -Recommend assigning Education Material (Hypertension Education Material) to the patient
Hypertension 11	Patient is high-normal, or Hypertension Grade 1, 2, or 3	Goal Setting	This CDS will be triggered by AICP during Care Plan is being created or updated	IF the patient's (([SBP] is ≥160 mmHg AND [Age] >65 year) OR ([SBP] is between 140–159 mmHg AND ([Age]not >80 years)) AND does not have [Antihypertensive drugs]	Observations: *Hypertension Grade *BP measurement *Systolic Blood Pressure *Diastolic Blood Pressure Demographics *Age Medication *Antihypertensive drugs	**Start hypertension treatment to achieve blood pressure goals (Card 11)** -Recommend BP Goal BP GOAL should be set as between 130 and 140 mmHg, and diastolic BP (DPB) to <80 mmHg

From Clinical Guidelines to Care Plans

Rule ID	Context	Purpose	Trigger	Rule description	Input as Prefetch	Output as Cards
Hypertension 9	Patient is high-normal, or Hypertension Grade 1, 2, or 3	Lifestyle advice	This CDS will be triggered by AICP during Care Plan is being created or updated	IF the patient is categorized as [high-normal] OR [Grade 1 hypertension] OR [Grade 2 hypertension] OR [Grade 3 hypertension]	Observations: *Hypertension Grade	**Lifestyle advice for hypertensive patients (Card 7)** -Recommend Regular physical activity of a minimum of 150 minutes per week over 5 days a week -Recommend Diet (Salt Restriction) -Recommend assigning Education Material (Hypertension Education Material) to the patient
Hypertension 11	Patient is high-normal, or Hypertension Grade 1, 2, or 3	Goal Setting	This CDS will be triggered by AICP during Care Plan is being created or updated	IF the patient's ([SBP] is ≥160 mmHg AND [Age] >65 year) OR ([SBP] is between 140–159 mmHg AND ([Age]not >80 years)) AND does not have [Antihypertensive drugs]	Observations: *Hypertension Grade *BP measurement *Systolic Blood Pressure *Diastolic Blood Pressure Demographics *Age Medication *Antihypertensive drugs	**Start hypertension treatment to achieve blood pressure goals (Card 11)** -Recommend BP Goal BP GOAL should be set as between 130 and 140 mmHg, and diastolic BP (DPB) to <80 mmHg

FHIR Repository

Fetches CDS card input

Adaptive Integrated Care Platform

Triggers a CDS Hook and invokes a remote service

Clinical Decision

Returns CDS cards

- Symptom Reporting
- Dietary Regiments
- Exercises
- Patient Reported Outcome Measure Questionnaires
- Self Measurements

Measure stand seated bloo

Goal: Keep blo under control (below 140/90 mm/Hg)

suggestion card

Medication Request: Offer a antihypertensive treatment with calcium-channel blocker (CCB)

CDS HOOKS®

Suggestion Cards

Care Plan Bundle

Treatment/ Lifestyle Goals → Goal

Lab Order → Service Request

Referrals → Service Request

Patient Activity → Service Request

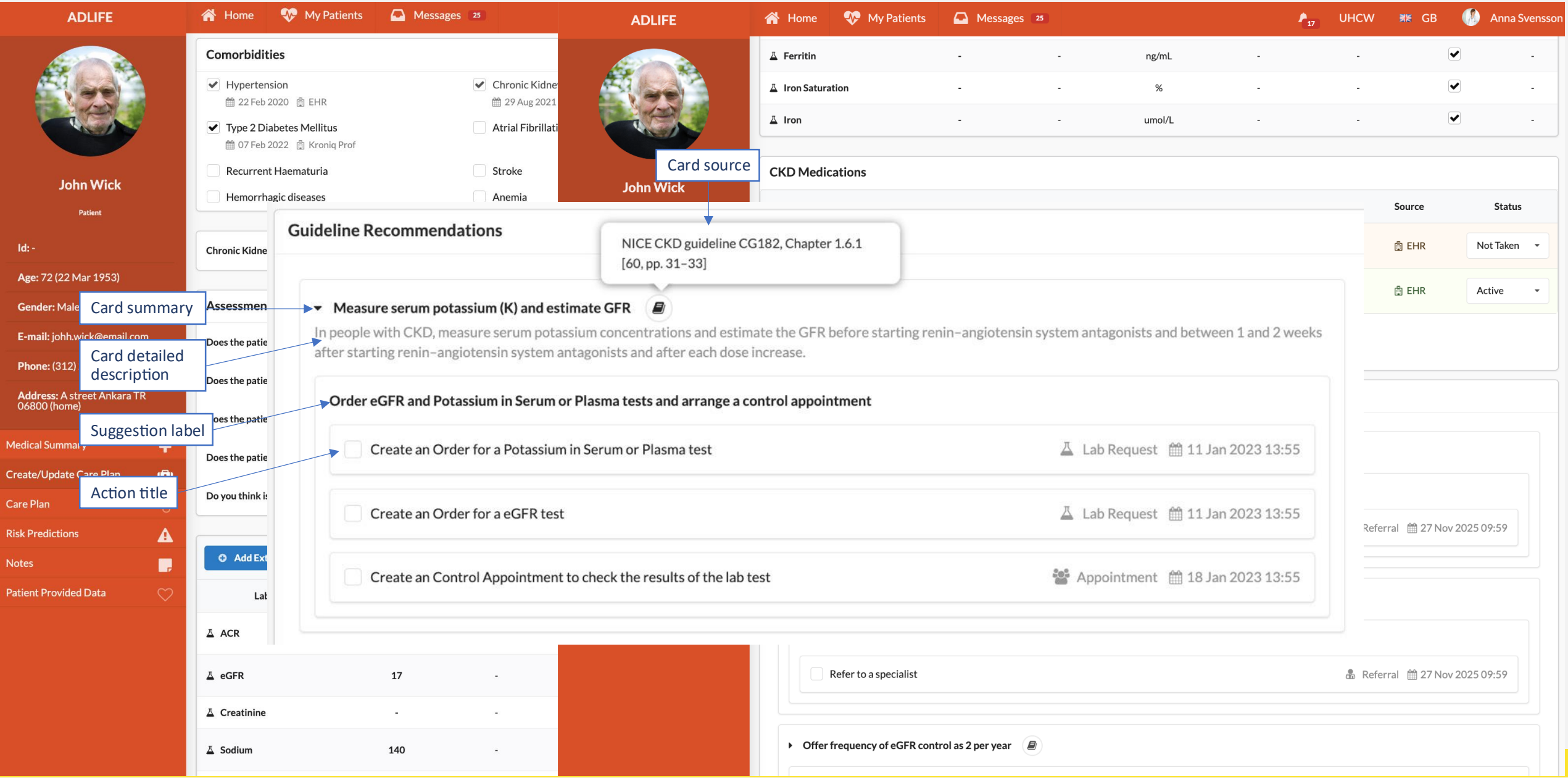
Follow-up Appoint. → Appointment

Education Materials → Communication Request

Medication Suggestions → Medication Request

CareTeam

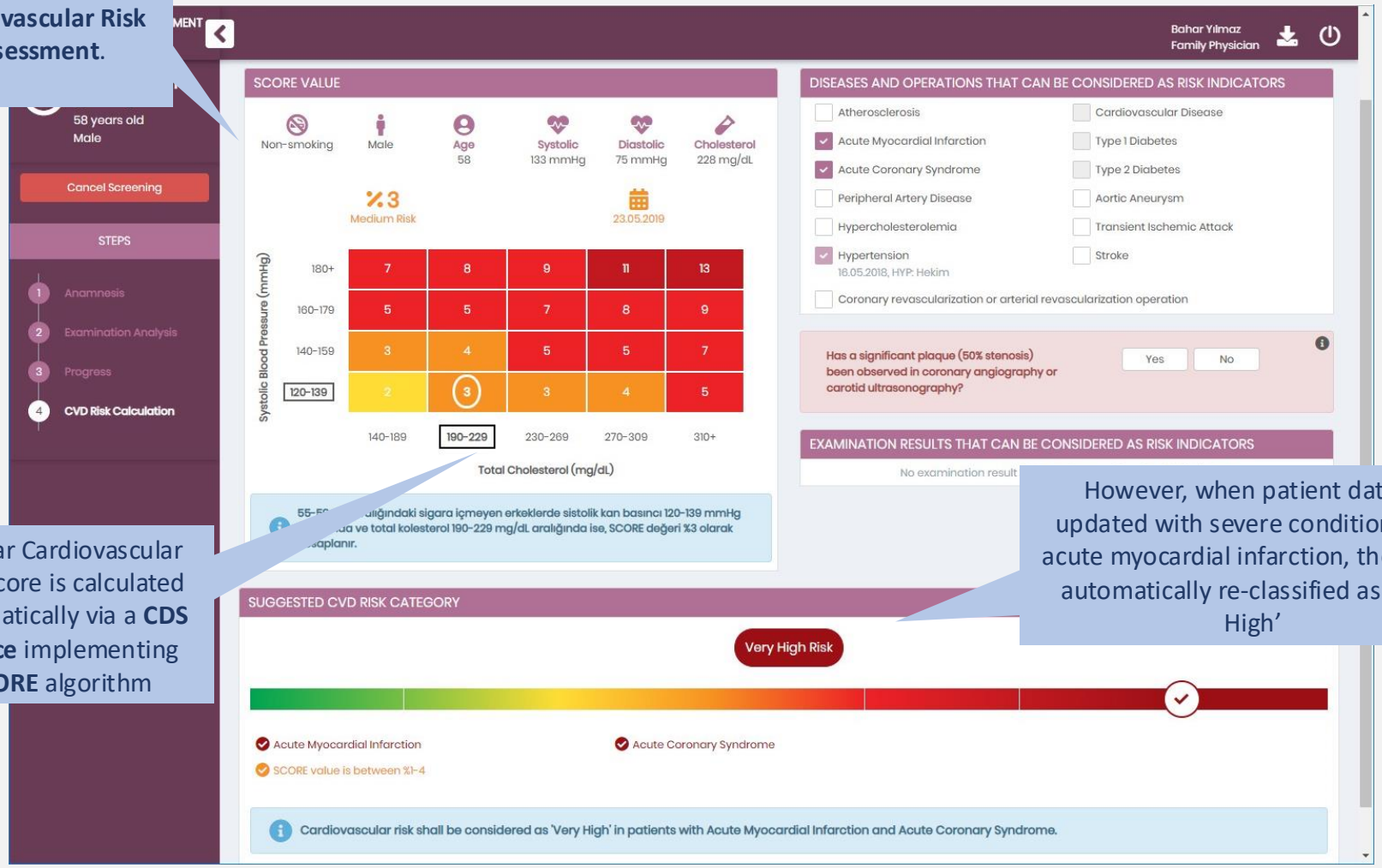
From Clinical Guidelines to Care Plans



Risk Stratification through Clinical Decision Support Services

- Personalized Risk assessment via Scored Algorithms (e.g. SCORE)

Cardiovascular Risk assessment.

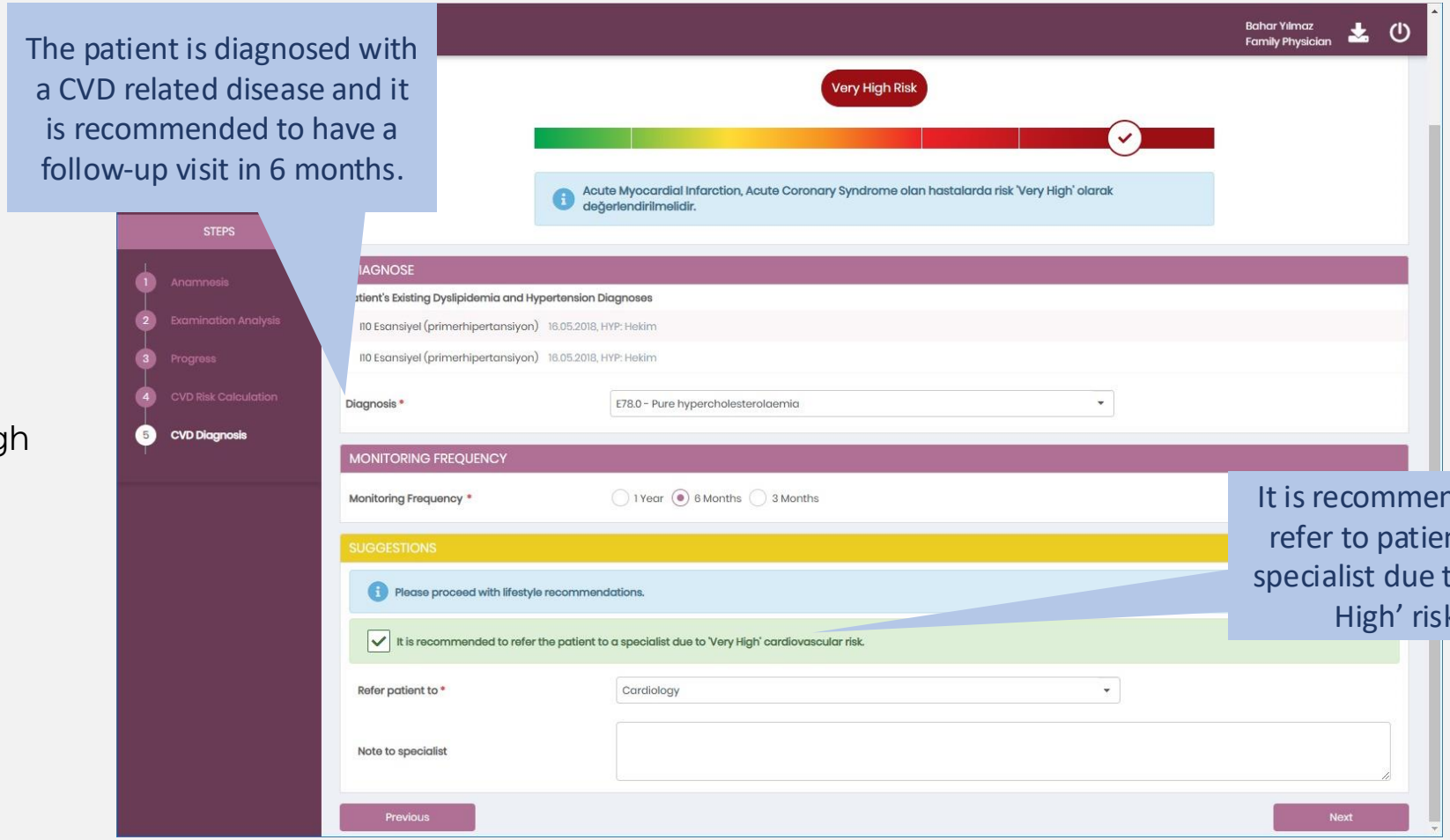


10 year Cardiovascular Risk Score is calculated automatically via a **CDS service** implementing **SCORE** algorithm

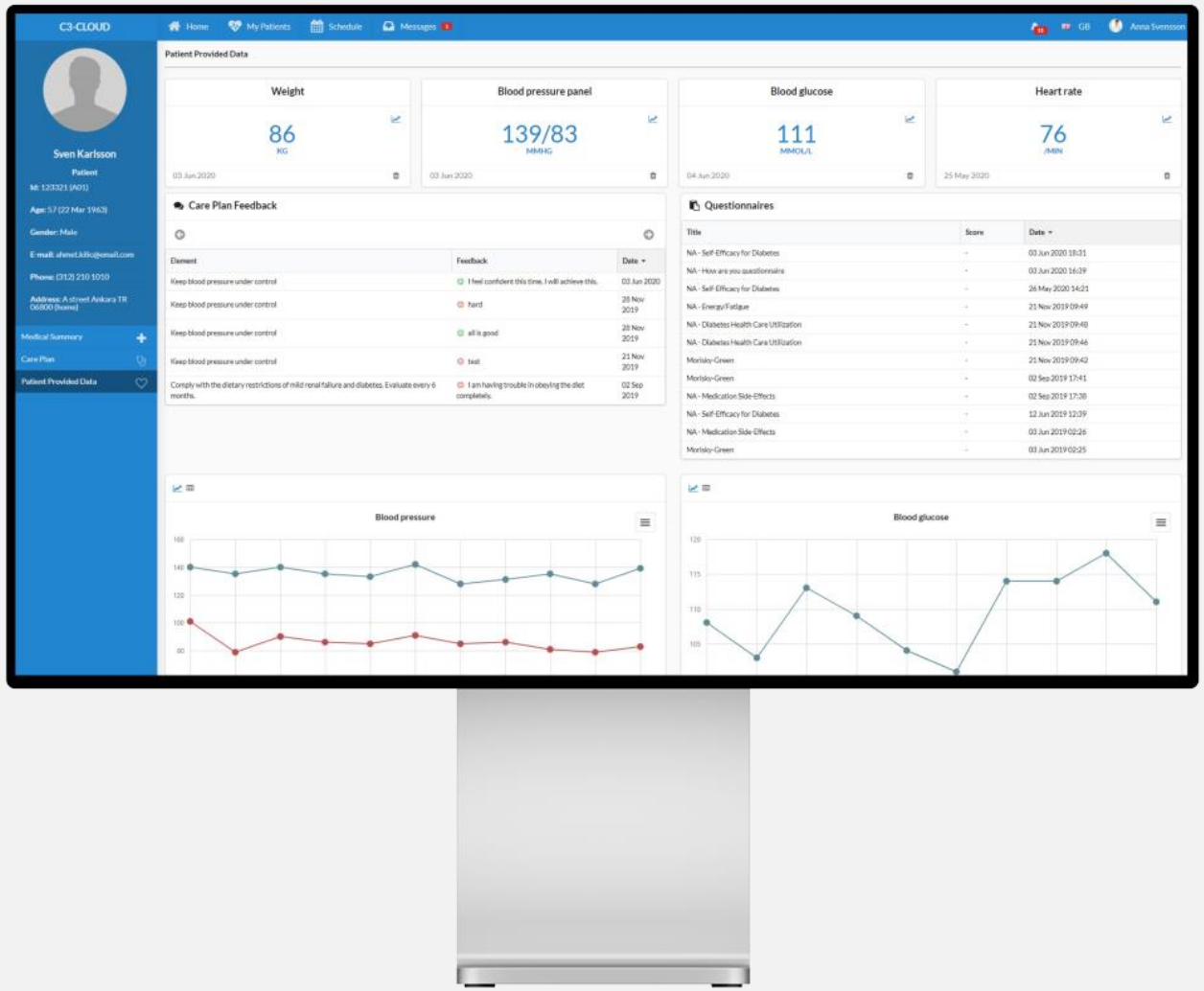
However, when patient data is updated with severe conditions like acute myocardial infarction, the risk is automatically re-classified as 'Very High'

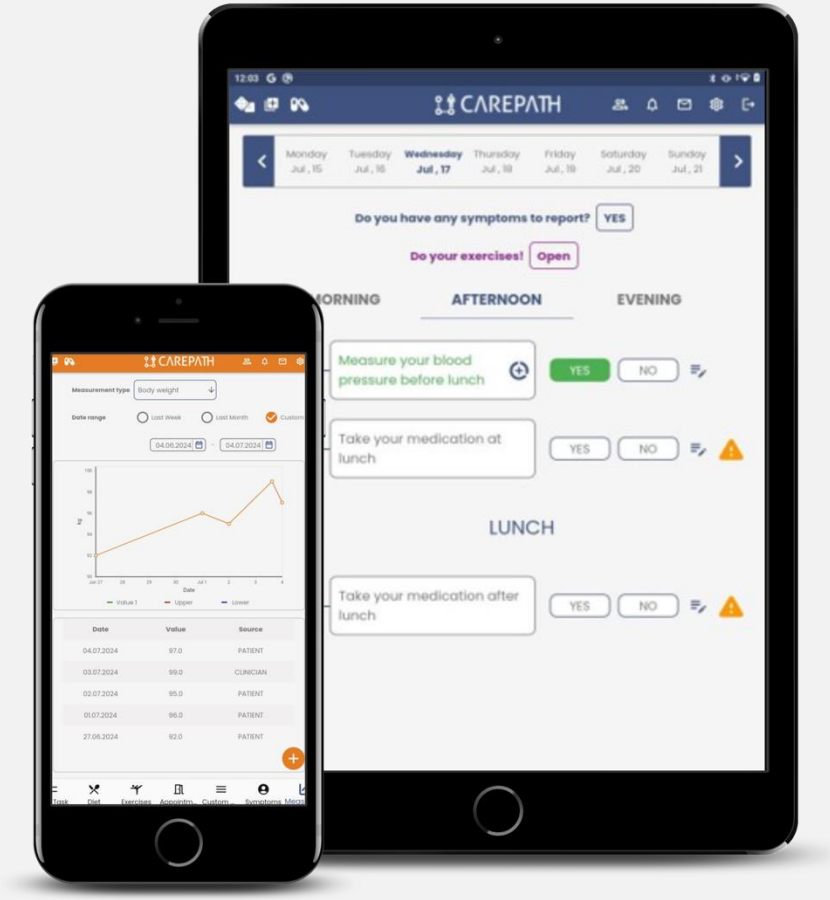
Recommendations for Diagnosis, Referrals and Control Visits

- Personalized diagnosis and Referral recommendations based on patient's current condition
- Personalized control visit recommendations (e.g. Screening after 2 years for low CVD risk patients, 1 year for high risk patients)



Sharing Care Plans with Patients





Progressive layers across SMART Guideline components

Paper systems

Smart digital systems

L1 Narrative		**Narrative guidelines**	Evidence-based guideline recommendations and accompanying implementation and data guidance
L2 Operational		**Digital adaptation kits**	"Human readable" software-neutral documentation of operational and functional requirements (e.g. personas, workflows, relevant metadata, transparently documented algorithms, minimum data sets, priority metrics, listing of relevant health interventions, functional requirements)
L3 Machine readable		**Machine readable recommendations**	Structured software-neutral specifications, code, terminology and interoperability standards
L4 Executable		**Reference software**	Software that are able to execute executable static algorithms and interoperable digital components to deliver the operational and functional requirements
L5 Dynamic		**Precision health model**	Executable dynamic algorithms that are trained and optimized with advanced analytics to achieve prioritized outcomes

Q&A

- More Information:
  - https://kroniq.health/
- Publications:
  - Igor Larrañaga, Javier Mar, Ania Gorostiza, et.al, Evaluation of the epidemiological and economic impact of the ADLIFE intervention on medium- to long-term in patients with advanced chronic disease, In Frontiers in Public Health, https://www.frontiersin.org/journals/public-health/articles/10.3389/fpubh.2025.1682492/full, November, 2025
  - A Nationwide Chronic Disease Management Solution via Clinical Decision Support Services: Software Development and Real-Life Implementation Report, JMIR Med Inform 2024;12:e49986, https://medinform.jmir.org/2024/1/e49986 DOI: 10.2196/49986
  - Transforming evidence-based clinical guidelines into implementable clinical decision support services: the CAREPATH study for multimorbidity management, Front. Med., 27 May 2024 Sec. Regulatory Science, Volume 11 – 2024, https://www.frontiersin.org/journals/medicine/articles/10.3389/fmed.2024.1386689/full ,DOI: 10.3389/1386689
  - A Collaborative Platform for Management of Chronic Diseases via Guideline-Driven Individualized Care Plans, Computational and Structural Biotechnology Journal, Volume 17, 2019, Pages 869-885, https://www.sciencedirect.com/science/article/pii/S2001037018303507
  - Implementation of HL7 FHIR-Based Interoperability Profiles to Manage Care Plans for Multimorbid Patients with Mild Dementia, In Medical Informatics Europe (MIE 2023), May, 2023, https://ebooks.iospress.nl/doi/10.3233/SHTI230075
  - Interoperability Architecture of the ADLIFE Patient Empowerment Platform, In Medical Informatics Europe (MIE 2021), May, 2021., https://ebooks.iospress.nl/doi/10.3233/SHTI210316

Contact

- You can reach me here:
  - Email: gokce@srdc.com.tr
  - Web site: www.srdc.com.tr

Gokce Banu Laleci Erturkmen
Director Of R&D at SRDC Software Research & Development and Consultancy Corp.