FallPredict

Real-time patient monitoring during independent movements in the Hospital.

KBC Rijeka is one of five clinical hospital centres in Croatia. It is a regional hospital centre covering three counties, providing medical care for approximately 600,000 inhabitants. Consists of 18 clinics, 6 clinical institutes, 6 independent institutes, 2 independent departments and the hospital pharmacy. KBC Rijeka employs more than 3.400 employees, 312 biomedical, and health researchers. The hospital performs activities of health care and diagnostic activities in the field of medicine with more than 3 mill. medical services. KBC Rijeka is a clinical partner for several higher education institutions (HEIs) such as The Faculty of Medicine Rijeka, The Faculty of Health Studies, and The Faculty of Dental Medicine.

Challenge description

Currently, prevention efforts rely heavily on manual supervision by healthcare staff. However, taking into account the number of medical staff (74 nurses working in shifts and 8 caregivers) in the Clinic for cardiovascular diseases and number of beds 53 and 8 special chairs for one day hospital stay (therapy and diagnostic procedures), it's not feasible that each patient is monitored all the time. Although tenders are announced and scholarships are approved, we are faced with an insufficient number of nurses.

To provide continuous and better supervision or assistance for patients who need to go for a walk, use the restroom, etc. implementing a solution that allows for remote monitoring of patients during unassisted movements during hospital stay can bring several significant benefits. It enhances patient safety, reduces the risk of falls and injuries, optimizes staff resources, and improves overall operational efficiency. The hospital benefits from increased patient satisfaction, reduced incidents of adverse events, and a more proactive approach to patient care.

Additionally, the solution contributes to a positive impact on key performance indicators, such as fall incidence rates, patient engagement in physical activities, and overall healthcare quality measures.

In the Clinic for Cardiovascular Diseases of KBCRI, around 20 falls of patients occur in a year. Of all these falls about 15% are serious one with severe injures like bone fractures. With this solution, this number can be reduced, but also if a fall happens nurses will be immediately alerted which can reduce the pain and suffering of the patients as the reaction of medical staff can be quick.

The solution would improve patient hospital experience as their mobility and independence within the hospital environment wouldn't be limited only to their room and bed. It should be noted that only patients who will give approval will wear wearable sensors for fall detection.

Furthermore, in recent years, fall risk assessment has gained prominence with the realization that falls require significant medical attention and can pose significant financial burdens.

Challenge main objectives

The main objective of the challenge is to enhance patient safety by providing a solution that can detect potential falls in real-time. The solution aims to minimize the risk of injuries

resulting from falls and improve the response time of healthcare providers, while at the same time, patients can preserve their mobility and independence within the hospital environment.

Solution functional requirements

Compulsory functional requirements

- The solution shall support and include patient held devices, for example, wearable sensors on the patient or their clothing (e.g. wrist, leg, slippers) to accurately detect changes in posture and movement.
- Wearable sensor for fall detection should be designed with careful consideration of various factors to ensure optimal usability, effectiveness, and user comfort. Following requirements must be achieved:
  - Compact design and lightweight - allowing patients to wear it comfortably without hindering their movements.
  - Comfort and Skin-Friendly Materials: Use soft and hypoallergenic materials to prevent irritation and ensure comfort during prolonged wear.
  - Water Resistance: Sensor should be water-resistant.
  - Battery Life: Sensor should be able to work normally without re-charging or changing batteries for 30 days.
  - Sensor should support wireless connectivity (e.g., Bluetooth) with monitoring system that will be placed in the room for nurses or smartphones of nurses.
  - Language mode: the software should have a possibility to choose the Croatian language.
- The system must have an immediate alerting mechanism that notifies healthcare providers when a potential fall is detected in real-time. Also, it must show the exact location of the patient at the time of alert.
- The system should provide a user-friendly interface for healthcare providers to view real-time data, alerts, and patient information related to fall detection.
- The system should be able to monitor several patients at the same time.

Desirable functional requirements

- It would be good if the sensor can also track number of the steps in certain time interval (6 minutes intervals) by the patients as this data can be used to determine if the patient is feeling healthier and can be discharged from the hospital ("6-minute walk test").

Pilot scope

End-user type	Role	Number
Medical staff (Cardiologists and nurses)	They have to provide requirements, recruit patients, use and validate the solution.	10
Patients	Participate in the pilot and validate the solution.	20

Table 1. Targeted users

Language

- Solution and the whole pilot, including the communication with the end-users will be conducted in Croatian language.

Other aspects

- Solver needs to provide KBCRI with the wearable sensors for fall detection of patients. KBCRI estimates that 5 wearable sensors would be sufficient to conduct the pilots, but other agreements could be reached.

Pilot set-up conditions

Ethical, legal, or regulatory

An Ethics Committee of the KBCRI must previously validate the approach of the pilot. The solution shall be fully GDPR compliant. Solver should familiarize with the Croatian national law and all relevant legal or other documents that regulate healthcare system and IT sector in Croatia as well as European union. The hospital will not take the responsibility or obligation to perform legal/administrative/technical corrections or advises to selected Solvers or options. Solver will be responsible for the innovative solution/product that is not in line with all legal conditions that arrange the healthcare system in EU and/or Croatia.

Technological

The technical solutions are focused on the use of wearables like sensors in smart watch or bracelet devices, to help determine if fall has occurred, and if that statement is true, alert medical personnel about the incident, location of the fall and identification of the patient. Every patient wears a device identified to his/her name, the device is via WIFI connected to the hospital network and registered in the database. On the central console computer, hospital personnel watch the status of every patient in real time. If the fall occurs the smart watch registers the changes in values in its gyroscope and acceleration sensors and sends the alert of possible incident and location of the fall to the central console computer, as well as to the mobile version of the monitoring application on the phone of selected personnel. As the device is registered to the exact patient, in monitoring application we also know the identification of the patient that is subjected to the possible fall incident. Every device is in local hospital network (central console monitoring stations, smart watches, mobile phones, central database server) so the communication between the devices is ensured. As for requirements for this project there are hardware and software parts of the development. As for hardware, central computer monitoring station, mobile phones, smart watches, wireless access points and server is required. For software part, the development of monitoring applications, API (application programming interface) for communication with smart watch sensors, and database management system is needed. Manny commercial smart watches (Samsung, Huawei, Apple watch, etc.) already have fall detection functionality built in as feature, as well as functionality of sending fall detection alarm to predefined locations, so there is no need for developing complex algorithm for measuring data from the sensors, but it is needed to develop monitoring applications that can receive data from communication protocols used by smart watches.

The system doesn't need to be interoperable with our current IS, but if applicable than it should have the possibility to communicate to our HIS over HL7 (Health layer 7) protocol. As for technical solution, we need device on patient that monitors the possible fall in real time, and if fall occurs alarms the personnel of the possible fall. Specified system should be standalone application on local network, but with built in mechanism for communication with other systems in the future over HL7 protocol (sending and receiving HL7 messages).

Data access

Solution will work as a separate system and no data will be extracted from organisational systems, or any other for this solution. The Confidentiality Agreement will be signed between KBCRI and the chosen supplier/solver (SME) of the innovative solution.

Expected impact and KPIs.

To provide continuous and better supervision or assistance for patients who needs to go for a walk, use the restroom, etc. implementing a solution that allows for remote monitoring of patients during unassisted movements during hospital stay at Clinic for cardiovascular diseases can bring several significant benefits. It enhances patient safety, reduces the risk of falls and injuries, optimizes staff resources, and improves overall operational efficiency. The hospital benefits from increased patient satisfaction, reduced incidents of adverse events, and a more proactive approach to patient care.

Additionally, the solution contributes to a positive impact on key performance indicators, such as fall incidence rates, patient engagement in physical activities, and overall healthcare quality measures.

- **Reduce number of fall incidence rate by 10%.** In the Clinic for Cardiovascular Diseases of KBCRI, around 20 falls of patients occur in a year. The goal is to compare patients who will have wearable sensor with group of patients who won't (both groups will be of similar age/health condition) in certain period of time.
- **Reduction in Fall-Related Injuries**: Compare the severity and types of injuries in falls of the patients who have wearable sensor and patients who don't. Goal is to compare if the quick reaction of the medical staff (they receive alert by the solution) can reduce severity of injuries.
- **Patient Satisfaction**: Administer patient satisfaction surveys on the patients who participated in testing (e.g. if they feel better and safer wearing it, does it impact their comfort during the stay, did they feel that the system respected their privacy, did the fall monitoring system impact their ability to engage in daily activities, etc.). Goal is to analyse scores and feedback to assess satisfaction levels. The aim is to have at least 20 patient surveys received and have 60% of positive answers. Likert scale will be used for rating.[1] The satisfaction of the medical staff who will participate in the pilot will be also measured by the survey. The aim is to have 60% of positive answers (Likert scale will be used for rating).

Business opportunity

Market size

- *Internally, the KBCRI is* a regional hospital centre covering three counties, providing medical care for approximately 600,000 inhabitants. Consists of 18 clinics, 6 clinical institutes, 6 independent institutes, 2 independent departments and has the total capacity is 1069 patient beds. More than 45,000 patients are hospitalized annually at the Rijeka Clinical Hospital Center and about 300,000 patient days are realized. This solution can be replicated in other clinics in the KBCRI who have hospitalized patients that are the target group (elderly or frail patients).
- At the national level in Croatia there are thirteen (13) Clinical institutions which include five (5) main Clinical Hospital Centres, there are twenty-two (22) General Hospitals and twenty-eight (28) Special hospitals. There are also a number of private hospitals which are not included in this calculation. According to the last available data (2022.), there were 22.717 beds in Croatian hospitals and 658.189 patients were treated. The market size estimates indicate the potential for substantial revenue and positive impact on

[1] https://www.questionpro.com/blog/what-is-likert-scale/#:~:text=Definition%3A%20A%20Likert%20scale%20is,%2C%20product%2C%20or%20target%20market

patient safety across the Croatian healthcare landscape if the solution proves to be efficient and effective.

Adoption plans

If the pilot project will be successful, our internal decision-making body will decide about the acquisition of the innovative solutions. There is no commitment for KBCRI to adopt or purchase the innovation if successful.

Leading SME

GENERAL INFORMATION	
NAME OF THE SME	Full name: Sparky solution d.o.o. Short name: Sparky
DESCRIPTION OF THE SME	Sparky is a data science company based in Croatia, focused on helping organisations leverage the power of their data to gain insights and create value. They are specialized in building custom data solutions, including end-to-end data science services. Sparky's offerings encompass data ingestion, preparation, big data technologies, machine learning, data visualization, and the creation of custom data products. They cater to various industries, including health, finance, telecommunications, media, and sports, providing solutions that enhance customer experience, predictive maintenance, and overall service quality using IoT, big data technologies, and advanced data science techniques. Sparky also offers consulting services and custom data science training for their clients, emphasizing their goal to make data science workflows more accessible to end users and clients. They already have several PoC project in EU market for health industry (development of data science application based on AI and advance analytics).
WEBSITE URL	https://sparky.science

Table 2. Leading SME general information

Solution proposed:

StabilityGuard: Advanced fall prevention system

Our proposal is to jointly co-develop "StabilityGuard", a sophisticated system designed to prevent and detect falls, in conjunction with the KBC Rijeka and the Follower SME which will be awarded through the HealthChain Call for SMEs. By employing state-of-the-art technology to monitor, forecast, and promptly address fall incidents, this system aims to paradigm shift patient safety in healthcare settings. The innovation of StabilityGuard resides in its ability to incorporate novel insights from the domains of healthcare, machine learning, and wearable technology. Through the utilization of real-time data analysis and predictive algorithms, StabilityGuard empowers healthcare providers to proactively avert mishaps, thereby signifying a substantial advancement in the provision of patient care and safety.

Key elements

- **Wearable sensors:** which are discreetly integrated into wristbands (or other bands approved by co-creation organisations), are utilized to continuously monitor the movements and vital signs of patients. In the prototype phase, preliminary accuracy and comfort tests are being conducted.

- **Monitoring dashboard:** Healthcare providers are able to monitor real-time data from all patients using a centralized dashboard. This dashboard employs intuitive visuals to emphasize any anomalous patterns or potential fall risks. Upon completion of the design phase and UI mock-ups, development is prepared to commence.
- **AI model:** Advance AI model built on sample dataset used for prediction of fall incidents based on provided data. This will add additional insights that will help professionals improve their monitoring process. Upon completion, Ai model is integrated into Monitoring dashboard.
- **Alert system:** Staff are promptly notified by the system in the event of a detected fall or high-risk circumstance, facilitating an expeditious response. It contains provisions for escalation and, if required, communication with emergency services. Upon completion of the phase, integration with the interface and wearable sensors is being done.

In order to implement the analytics component, specifically the algorithm for fall prediction, our configuration entails assembling a heterogeneous dataset from the ubiquitous sensors across a range of conditions.

Included in the validation strategy are:

- Cross-validation is a machine learning approach that verifies the algorithm's performance across various subsets of data.
- Real-world pilot testing involves the implementation of the system among a controlled cohort of patients in order to collect feedback and make algorithmic refinements.
- Performance metrics involve the assessment of the algorithm's specificity, sensitivity, and accuracy in the detection and prediction of falls.

By implementing this all-encompassing strategy, StabilityGuard surpasses the benchmarks set for effectiveness and innovation in healthcare fall detection and prevention.

Work to be done by the leading SME

1. Project coordination and risk management: Sparky will arrange and oversee the kick-off meeting to establish the project's scope and objectives, as well as plan frequent progress meetings to support decision-making and monitor project advancement. Sparky will detect potential dangers at an early stage of the project's lifespan and create strong measures to counteract these risks. This will encompass both technical and operational hazards, guaranteeing thorough coverage.

2. Technological development: Sparky will take charge of creating and enhancing interfaces that are easy to use and meet the requirements of different users, including healthcare professionals and patients. Also, the goal is to create the fundamental StabilityGuard system, integrating an efficient alarm mechanism to promptly inform personnel of potential fall hazards in real-time. Sparky will construct and enhance a sophisticated AI model that utilizes the given data to precisely forecast occurrences of falls. This process entails the careful selection of appropriate algorithms, training the model using a wide range of data sets, and seamlessly integrating it into the StabilityGuard system.

3. Testing and evaluation: Sparky will deploy the StabilityGuard system in a controlled setting to assess its functioning and ease of use. Also, it will guarantee the efficient functioning of the system in various healthcare environments. Evaluation of the performance data will be done, in relation to predetermined KPIs to determine the efficiency and dependability of the system. This analysis will provide guidance for additional optimizations and changes.

4. Stakeholder engagement and feedback: Sparky will organize extensive workshops including crucial stakeholders, to collect vital requirements and design suggestions. It will also collect and incorporate feedback from participants in a systematic manner during the pilot period to improve the system, with a specific focus on boosting user satisfaction and system performance.

5. Compliance and regulatory adherence: Sparky will oversee and guarantee adherence to all pertinent health data protection requirements, such as GDPR. Also, it will facilitate the preparation steps for the acquisition of essential regulatory approvals and certifications that are vital for implementing medical technologies in healthcare environments.

6. Maintenance and ongoing support: Sparky will create a strategy for continuous maintenance and updates of the StabilityGuard system to guarantee its efficiency and security against new threats. It will deliver extensive training and assistance to end-users, guaranteeing that healthcare providers possess the necessary skills to utilize the system proficiently.

Follower SME

Scope of work performed by the follower SME

1. Project management and compliance: Follower SME will provide assistance in project management by actively engaging in meetings and contributing to decision-making processes. This entails collaborating with Sparky and other partners to guarantee the timely achievement of all project milestones. It will offer specialized knowledge and guidance regarding adherence to healthcare regulations and standards. The follower SME will guarantee that the StabilityGuard system complies with all pertinent local and international regulatory prerequisites, such as GDPR, hence enhancing the project's credibility and feasibility.

2. Technological support and system enhancement: Follower SME will enforce efficient data management policies to guarantee that the data gathered by StabilityGuard is handled, kept, and utilized in accordance with the most stringent data protection and privacy regulations. It will strengthen the security framework of the StabilityGuard system to protect sensitive patient data from unauthorized access and potential cyber threats. It will also. aid in the seamless integration of the StabilityGuard and its components into pre-existing healthcare IT ecosystems. This involves assuring interoperability with EHR systems and other platforms for managing healthcare.

3. Solution validation: Follower SME will perform thorough testing of the StabilityGuard system, with a specific emphasis on usability, security, and performance, to verify that the system fulfills all given requirements. It will conduct periodic quality assurance audits to protect the system's integrity. Revise the risk management plan as required, taking into account the results of these evaluations and any additional hazards discovered during the testing stage.

4. Engagement and training: Follower SME will organize supplementary stakeholder engagement activities to obtain wider input and feedback on system development. This entails coordinating workshops and meetings in addition to those led by Sparky in order to guarantee thorough engagement of all stakeholders. It will also create customized training resources based on feedback to address the individual requirements of users. Assist in conducting training sessions to ensure that healthcare personnel and patients acquire the necessary skills to effectively utilize the StabilityGuard system.