Introduction

ODIN will focus on hospitals, because they are crucial and expensive nodes of European National Health Systems. Within the hospital, ODIN will introduce novel technologies in 3 priority areas of interventions that will have a beneficial influence on hospital procedures, for both managerial and clinical areas. ODIN areas of intervention are:

- **Enhanced Hospital Workers (eWorkers):** the aim is to explore how to empower hospital workers (e.g., nurses, porters, technicians, doctors, etc.) with appropriate technologies in order to enhance their skills and support their daily work. Technology will be used to relieve workers from the overwhelming burden of their routinely activities, so that they can focus on those critical tasks which demand all their human capabilities.
- **Enhanced Robots (eRobots):** the aim is to automatize those hospital processes, which are no more in need of humans or can benefit from automations. These robots will not necessarily be anthropomorphic and will be employed as centrally synchronized swarms with a certain degree of independency. ODIN robots will have advanced perception functions (smell, vision, tact, taste, and hearing), extreme connectivity features (with other robots, hospital assets, humans, medical locations), advanced AI reasoning capability (both locally and remotely) and capability to perform tasks (wheels, arms, hands, etc.).
- **Enhanced Locations (eLocations):** the aim is to instrument medical locations for enabling them to proactively support hospital processes. Medical locations will be enhanced with sensors (smell, vision, tact, taste, and hearing), technologies for interacting with humans (screens, lights, speakers) and high connectivity in order to safely and effectively interact with workers, robots, devices and other relevant hospital

assets. Moreover, eLocations will have the capability to give in real-time information on their underlying technological infrastructures (e.g., electric plants, water pipes, air conditioning, medical gasses) which are critical for human safety (patients, visitors and staff), robots, medical devices and equipment.

These areas of intervention will be addressed in a wide variety of Hospital Use Cases, spanning from clinical, to logistic and covering clinical engineering, AI supported diagnosis, clinical experience, nursing or home tele-rehabilitation. ODIN Hospital Use Cases are:

1. **Aided logistic support:** ODIN will deploy technologies for contributing to improve the design, scheduling and execution of activities such as procurement, storage, and distribution of the different materials (medicines, medical and hotel supplies, meals, linens, waste). Currently, logistic management requires redundant activities (e.g., ordering consumables after using them, transport of objects, refill of ward magazines etc.). This use case will leverage on different combinations of eRobots, eWorkers and eLocations for optimizing procedures, improve working conditions of the healthcare operators, increase hospital efficiency and workflow.
2. **Clinical engineering, medical device locations real-time management and disaster preparedness:** The main enablers of modern medicine are medical devices. However, only their manufacturing, market and now post-market surveillance are currently regulated at central level. EU Member States are still responsible for all the other aspects, including medical devices management. Consequently, Health Technology Management (HTM) is poorly harmonised and standardised. The ODIN technology will allow real-time management of medical devices and medical locations by combining IoT, robots, ambient sensors, wearable devices for workers and the WASP platform, a semantic solution for web architectures. The lack of real-time exchange of information among staff, medical devices and medical locations has been one of the main causes for adverse events in hospitals in the past years. ODIN will overcome this challenge by supporting the optimization of hospital processing, combining real-time staff info, with medical devices and medical locations. This will be paramount in routinely times and also in terms of disaster preparedness, for possible future pandemic events or adverse events causing high influx of patients. As the recent COVID-19 outbreak has demonstrated, hospitals can be suddenly called to speedily adapt their asset and layouts.
3. **AI based support system for Diagnosis:** Optimal medical therapy relies on establishing a firm and correct diagnosis. Hence, diagnosis forms a significant part in medical education and daily care. The number of available measurements and their interpretation can be overwhelming even for experienced clinicians. The aim of this Use Case is to facilitate a high efficiency in diagnostics trajectory by:
    - personalizing the diagnostic trajectory of patients based on probabilities.
    - providing integrated capacity management of the full diagnostic supply chain.

4. **Clinical Tasks and patient experience:** Some patients require potential guidance and physical support during motion (walking, sitting/standing), complementary assistance during physically demanding tasks (recovering from a fall, moving while in bed) and substitution in simple daily life activities (reaching and manipulating objects). Motion guidance and physical support in performing motor tasks are currently provided only by nurses or relatives. ODIN technology is expected to reduce the effort of the clinical staff, by overcoming practical difficulties such as monitoring and assistance for patients at night, improvement of support interventions on wards or improvement of comfort perceived by patients during hospitalization.
5. **Automation of clinical workflows leveraging clinical care workflows and AI technologies:** Clinical workflows are complex, expensive, labor intensive and error prone. These inefficiencies and delays are higher when trials are run at a large number of sites. This Use Case aims to implement and validate a workflow-driven solution supporting the automation of the clinical research execution processes by enabling clinical care workflows, data collection processes and sources.
6. **Inpatient remote rehabilitation, follow up and home hospitalization:** Remote monitoring technologies are well developed and commercially available but they miss a unique platform that allows an efficient communication of these different technologies with the hospital in an easy, automatic, and secure way. ODIN platform will work as a smart information hub creating a structured data flow between homes and hospitals. ODIN will be a multi-sensing platform (named transparent robot) with flexible data communication capabilities. This Use Case will deploy a robotic element collecting patient's data from homes and helping healthcare personnel (clinicians and nurses) to monitor patient's lifestyle remotely from hospitals.
7. **Disaster preparedness:** Leveraging on partners' COVID-19 experience, ODIN will use its advanced technology in order to support the hospital in rapidly adapting to face disasters, properly considering the safety requirements for medical locations, medical devices, patient safety and workers' safety. Unfortunately, the complexity of hospitals is such that it requires scientific simulation before implementing any change. For instance, in order to adapt a space to ICU, hospitals needs to verify the adequacy of underlying, safety requirements of medical devices and workers´ skills. ODIN, through the combination of WASP platform, eWorkers, eRobots and eLocation will introduce a shift into the current approach to hospital disaster preparedness.

ODIN Hospital Use Cases are designed to demonstrate the validity of the proposed solutions in different settings and healthcare systems. The above-discussed AI based smart hospitalization solutions will be applied and put in practice in the following 6 Hospital Pilots:

UMC Utrecht

University Medical Center Utrecht (UMCU) Utrecht, NETHERLANDS.

UMCU is one of the leading and largest medical centers in the Netherlands and ranks among the best European academic hospitals in international rankings. Core business of UMCU is to provide healthcare for which special knowledge is required, provide leading research and offer excellent education to students, medical doctors, researchers and other healthcare providers. UMCU has a strong track record in both pre- and clinical research and forges strong links with companies and scientific institutions across the world.

Hospital Clínico San Carlos (HCSC) Madrid, SPAIN.

HCSC is a reference centre at national and international level for its facilities and its professionals. The Hospital has over 5,000 employees and 900 beds and is the main referral centre in the training of health professionals at the Universidad Complutense in Madrid. HCSC's vision is to transform the hospital in an international technology centre of reference, seeking excellence for its patients and society through the integration of the available knowledge and technological solutions in advanced and comprehensive clinical settings.

University Hospital Campus Bio-Medico (UCBM) Rome, ITALY.

UCBM is a young yet rapidly developing, private academic institution, devoted to undergraduate and postgraduate education, advanced research and provision of high-quality healthcare services with the Research Hospital. Established in 1992, today the University runs the School of Medicine and Surgery, the School of Engineering, the School of Science and Technology for Humans and the Environment and PhD in “Integrated Biomedical Sciences and Bioetics” and “Science and Engineering for Humans and the Environment”. Moreover, the Centre for Integrated Research (CIR), the Institute of Philosophy of Scientific and Technological Practice (FAST), the Campus Bio- Medico Hospital and the Centre for the Health of the Elderly are also associated to the University. The University hosts 40+ multidisciplinary Research Units.

CHARITÉ
UNIVERSITÄTSMEDIZIN BERLIN

Charité University Hospital (CUH) Berlin, GERMANY.

CUH is one of the largest university hospitals in Europe with 13.000 employees and more than 1 billion Euro annual turnover. The Centre of Sleep Medicine represents an interdisciplinary medical and research unit with internists, neurologists, psychiatrics, otorhinolaryngologists, clinical pharmacologists and psychologists. The sleep center is a division of the department of pneumology. The sleep center studies about 3000 patients each year with attended cardiorespiratory polysomnography in 10 sleep lab beds. Research focuses on the development of devices for ambulatory investigation of sleep and sleep disorders, and the development of new algorithms to detect sleep disorders. Sleep apnea, insomnia, and sleep related breathing disorders are the most common disorders diagnosed.

Medical University of Lodz (MUL) Lodz, POLAND.

MUL is a higher state school with 5 faculties, 3 teaching hospitals and 80 clinics. The University is strongly committed to scientific research in a number of health-related disciplines as well as national and international scientific cooperation. MUL has reached the leading position in various research areas, and particularly, in patient adherence and healthy ageing. In response to demographic challenge in Europe, the Healthy Ageing Research Centre (HARC) was founded in 2011. The Development Strategy of the Medical University of Lodz focuses on four strategic areas: education, research, development, and collaboration in the development of the health care service. MUL plays the key role in facilitation of collaboration between academia

and industry, initiating creation of dedicated businesses cluster. Serving over 86.000 patients yearly, MUL is also ono of the major local healthcare providers, active in each and every area of modern medicine.

Amiens-Picardie UH (APUH) Amiens, FRANCE.

APUH is one of the two referral public health establishments of the Hauts de France region. As such, it offers university hospital care, teaching and research of high level, ensuring the three key missions of a University Hospital.

Junta de Andalucía

Consejería de Salud y Consumo

Servicio Andaluz de Salud

Servicio Andaluz de Salud (SAS) SPAIN.

Servicio Andaluz de Salud-SAS (the Andalusian Health Service) is a public body providing all healthcare services to the 8.4 million inhabitants in Andalusia. It is an autonomous "arms-length" organisation, attached to the Ministry of Health of the Government of Andalusia. SAS provides a wide range of healthcare services from preventive and public health activities to highly specialized services, in a system with universal coverage and funded by taxes, through a network of integrated healthcare facilities organized to ensure the accessibility of the population: 1,500 primary care centres, 52 hospitals and over 100,000 employees.

Two hospitals pertaining to SAS will participate in the project: Hospital Virgen del Rocío (Seville) and Hospital Virgen de las Nieves (Granada).

ODIN Hospital Pilots will be a federation of multicentre longitudinal cohort studies, demonstrating the safety, effectiveness and the cost-effectiveness of AI, big-data, robots and IoT Key Enabling Technologies (KER) for the enhancement of hospital safety, productivity and quality. Each Hospital Use Case protocol, will be approved by the local hospital ethical committees, in order to assure the maximal quality of the study while providing a pragmatic solution for the scaling-up of the ODIN technological solutions and business models in a variety of local ecosystems.

University Medical Center Utrecht (UMCU) Utrecht, NETHERLANDS.

- **AI based support system for Diagnosis:**
  - Instrumented nurses and porters will collect relevant information on the use, position and status of medical devices in the hospital and will support patient examinations under the supervision of the ODIN platform.
  - Smart vision of ODIN robots will be used for automatically locate medical devices in the different wards. Remote deep-learning services will process the video and automatically identify the medical devices.
  - Instrumented medical locations will collect in real time information on the medical devices presence and use in their premises. This will enable the interrogation of remote services for AI, aiming at verifying whether the use of a specific medical device is compatible with the medical location infrastructures (e.g., pipes, gases, equipotential node…).

- **Inpatient remote rehabilitation, follow up and home hospitalization:** Large-scale deployment of home hospitalization units, to monitor patients with chronic diseases and elderlies. This type of non-invasive monitoring is very useful to deploy assistance services and to support care assistance services. The successful integration of data could benefit the integrated care gaps and support the continuity in care patients as well as the transition from hospital to home after a complex medical episode.

- **Disaster preparedness:** The combined use of ODIN platform and the three intervention areas will support hospital resiliency and capability to adept their services in response to further COVID-19 waves, or future disasters of different nature.
  - WASP will support hospital multidiscipline teams (hospital engineers, managers, clinicians, nurses, logistic) to reorganise hospital wards basing on evidence and data.
  - eRobots will support staff and interact with patients to ensure the adherence to social measures (e.g., distance, avoid crowds, forward-flow principle).
  - eLocation will estimate in real time the number of people in each room and trigger the intervention of eWorkers and eRobots to dismiss unnecessary risky crowds.

Hospital Clínico San Carlos (HCSC) Madrid, SPAIN.

- **Aided logistic support:** Enhanced logistics approach for:

  - eWorkers: instrumented porters will support and optimize patient services assistants and porters work.
  - eRobots: a swarm of robots will compensate staff shortages, offer better logistics management and reduce the risk of contamination.

- **Inpatient remote rehabilitation, follow up and home hospitalization:** Large-scale deployment of home hospitalization units, to monitor patients with chronic diseases and elderlies. This type of non-invasive monitoring is very useful to deploy assistance services and to support care assistance services. The successful integration of data could benefit the integrated care gaps and support the continuity in care patients as well as the transition from hospital to home after a complex medical episode.
- **Disaster preparedness:** The combined use of ODIN platform and the three intervention areas will support hospital resiliency and capability to adept their services in response to further COVID-19 waves, or future disasters of different nature.

  - WASP will support hospital multidiscipline teams (hospital engineers, managers, clinicians, nurses, logistic) to reorganise hospital wards basing on evidence and data.
  - eRobots will support staff and interact with patients to ensure the adherence to social measures (e.g., distance, avoid crowds, forward-flow principle).
  - eLocation will estimate in real time the number of people in each room and trigger the intervention of eWorkers and eRobots to dismiss unnecessary risky crowds.

University Hospital Campus Bio-Medico (UCBM) Rome, ITALY.

- **Aided logistic support:** Enhanced logistics approach for:

  - eRobots will be able to navigate in the hospital environment autonomously and safely distribute disposable materials, drugs, food in an efficient way and with a negligible start-up delay.
  - eRobots will be able to face activities in highly contaminated environments, thus reducing biological risks for the operators and the patients and minimizing further contamination, due to easy sterilization.
  - eRobots will optimize procedures, improve working conditions of the healthcare operators, taking care of repetitive tasks and increase hospital efficiency and workflow.

- **Clinical Tasks and patient experience:** Deployment of mobile robotic manipulators to support nurses care of patients with limited autonomy, who need monitoring and physical guidance or support in motor and personal tasks. A flexible exoskeleton will be used for supporting nurses, assistants and porters with patient movements.

Charité University Hospital (CUH) Berlin, GERMANY.

- **Clinical Tasks and patient experience:** Deployment of mobile robotic manipulators to support nurses care of patients with limited autonomy, who need monitoring and physical guidance or support in motor and personal tasks. A flexible exoskeleton will be used for supporting nurses, assistants and porters with patient movements.
- **Disaster preparedness:** The combined use of ODIN platform and the three intervention areas will support hospital resiliency and capability to adept their services in response to further COVID-19 waves, or future disasters of different nature.

  - WASP will support hospital multidiscipline teams (hospital engineers, managers, clinicians, nurses, logistic) to reorganise hospital wards basing on evidence and data.
  - eRobots will support staff and interact with patients to ensure the adherence to social measures (e.g., distance, avoid crowds, forward-flow principle).
  - eLocation will estimate in real time the number of people in each room and trigger the intervention of eWorkers and eRobots to dismiss unnecessary risky crowds.

Medical University of Lodz (MUL) Lodz, POLAND.

- **Clinical Tasks and patient experience:** Deployment of mobile robotic manipulators to support nurses care of patients with limited autonomy, who need monitoring and physical guidance or support in motor and personal tasks. A flexible exoskeleton will be used for supporting nurses, assistants and porters with patient movements.
- **Disaster preparedness:** The combined use of ODIN platform and the three intervention areas will support hospital resiliency and capability to adept their services in response to further COVID-19 waves, or future disasters of different nature.

  - WASP will support hospital multidiscipline teams (hospital engineers, managers, clinicians, nurses, logistic) to reorganise hospital wards basing on evidence and data.
  - eRobots will support staff and interact with patients to ensure the adherence to social measures (e.g., distance, avoid crowds, forward-flow principle).
  - eLocation will estimate in real time the number of people in each room and trigger the intervention of eWorkers and eRobots to dismiss unnecessary risky crowds.

Amiens-Picardie UH (APUH) Amiens, FRANCE.

- **Disaster preparedness:** The combined use of ODIN platform and the three intervention areas will support hospital resiliency and capability to adept their services in response to further COVID-19 waves, or future disasters of different nature.

  - WASP will support hospital multidiscipline teams (hospital engineers, managers, clinicians, nurses, logistic) to reorganise hospital wards basing on evidence and data.
  - eRobots will support staff and interact with patients to ensure the adherence to social measures (e.g., distance, avoid crowds, forward-flow principle).
  - eLocation will estimate in real time the number of people in each room and trigger the intervention of eWorkers and eRobots to dismiss unnecessary risky crowds.

- **Clinical engineering, medical device locations real-time management and disaster preparedness:**

  - Instrumented nurses and porters will collect relevant information on the use, position and status of medical devices in the hospital while performing routinely tasks. These data will feed the hospital medical device management systems, via the ODIN platform.
  - Smart vision of ODIN robots will be used for automatically locate medical devices in the different wards. Remote deep-learning services will process the video and automatically identify the medical devices. instrumented medical locations will collect in real time information on the medical devices presence and use in their premises. This will enable the interrogation of remote services for AI, aiming at verifying whether the use of specific medical device is compatible with the medical location infrastructures (e.g., pipes, gases, equipotential node…).

- **Clinical Tasks and patient experience::** Deployment of mobile robotic manipulators to support nurses care of patients with limited autonomy, who need monitoring and physical guidance or support in motor and personal tasks. A flexible exoskeleton will be used for supporting nurses, assistants and porters with patient movements.

Servicio Andaluz de Salud (SAS) SPAIN.

SAS will lead two pilot sites in the Andalucian Region. Both of them will be developed under

- Clinical Tasks and patient experience: Deployment of mobile robotic manipulators to support nurses care of patients with limited autonomy, who need monitoring and physical guidance or support in motor and personal tasks. A flexible exoskeleton will be used for supporting nurses, assistants and porters with patient movements.

- Disaster preparedness: The combined use of ODIN platform and the three intervention areas will support hospital resiliency and capability to adept their services in response to further COVID-19 waves, or future disasters of different nature.
  - WASP will support hospital multidiscipline teams (hospital engineers, managers, clinicians, nurses, logistic) to reorganise hospital wards basing on evidence and data.
  - eRobots will support staff and interact with patients to ensure the adherence to social measures (e.g., distance, avoid crowds, forward-flow principle).
  - eLocation will estimate in real time the number of people in each room and trigger the intervention of eWorkers and eRobots to dismiss unnecessary risky crowds.

– Clinical Tasks and patient experience:

· *FISEVIs (Hospital Universitario Virgen del Rocio) proposed use case will be a comprehensive solution for the digitization of care plans and care processes will be implemented to improve the management of the clinical condition of peri-surgical patients and promote their active participation in their self-care from the diagnosis phase to their post-surgical recovery.*

· *FIBAOs (Hospital Universitario Virgen de las Nieves) use case will be a comprehensive solution for the digitization of care plans and care processes will be implemented to improve the management of the TAVI patient's and promote the patient's active participation in self-care from the diagnostic phase through to post-procedure recovery.*

The technology solution to be implemented in these use cases for pathway digitalization.

EXTRA NOTE DRAFT

ODIN aims to cover each of the daily activities of a hospital, including all involved actors. The proposed use cases address the following domains and operations:

- Care, including diagnosis, treatment, rehabilitation, follow up and research.
- Logistic and External Relationships in both clinical and managerial and relations with external providers.
- The initial set of operations will be extended during open calls, including new operations and services.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nº 101017331