SIEMENS Healthineers

Innovation Think Tank
Proactively drive innovation to improve human life

MULTIPLE SCLEROSIS

FACTS & FIGURES

PAIN FROM SPASTICITY
IMPAIRED AMBULATION
DEPRESSION
ATAXIA AND TREMOR
BLADDER DYSFUNCTION
COGNITIVE IMPAIRMENT

TOTAL ECONOMIC BURDEN OF MULTIPLE SCLEROSIS IN THE UNITED STATES IN 2019 WAS $85.4 BILLION, INCLUDING $63.3 BILLION IN DIRECT MEDIAL COSTS

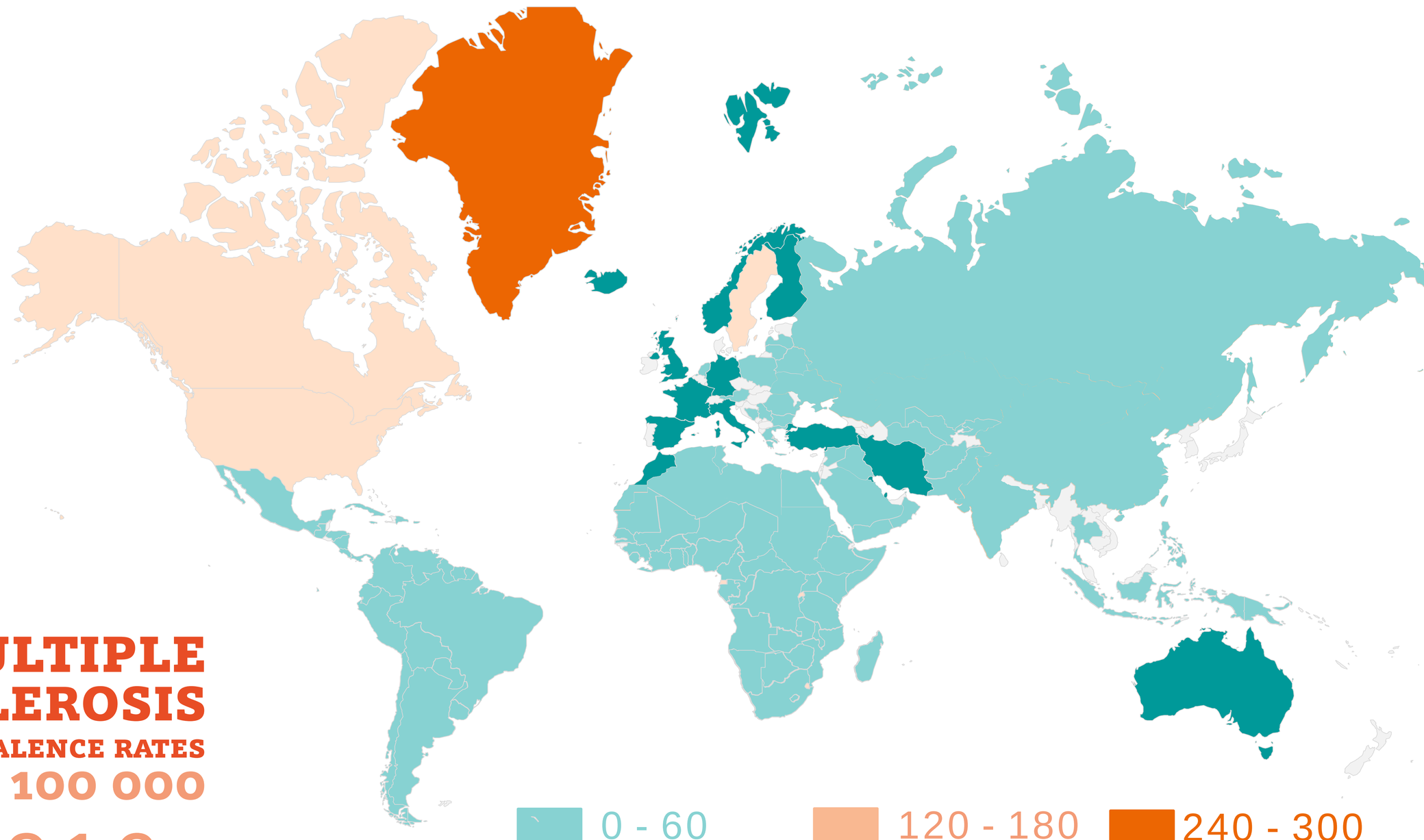
WOMEN
APROXIMATELY
2 TIMES MORE
AFFECTED
THAN
MEN

2020

RISK FACTORS
- VITAMIN-D DEFICIENCY
- HYPERTENSION
- MIGRAINE
- CIGARETTE SMOKING

highest prevalence of multiple sclerosis 2020 north america, europe, australia

estimated number of people with multiple sclerosis worldwide has increased to 2.8 million (2020)



MULTIPLE SCLEROSIS
PREVALENCE RATES PER 100 000
2016

0 - 60
60 - 120
120 - 180
180 - 240
240 - 300
NO DATA AVAILALE

1.New insights into the burden and costs of multiple sclerosis in Europe" Gisela Kobelt, Alan Thompson, Jenny Berg, Mia Gannedahl and Jennifer Eriksson; the MSCOI Study Group" and the European Multiple Sclerosis Platform Multiple Sclerosis Journal 2017, Vol. 23(8) 1123–1136
2.Multiple sclerosis" Thompson AJ, Baranzini SE, Geurts J, Hemmer B, Ciccarelli O, Lancet. 2018 Apr 21;391(10130):1622-1636. doi: 10.1016/S0140-6736(18)30481-1. Epub 2018 Mar 23
3.NIH U.S. National Library of Medicine/MS, retrieved from: https://medlineplus.gov/multiplesclerosis.html
4.Rising prevalence of multiple sclerosis worldwide: Insights from the Atlas of MS, third edition, 202, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7720355/
5.Multiple sclerosis, 2018, https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(18)30481-1/fulltext

Website:
https://www.siemens-healthineers.com/careers/ innovation-think-tank

SIEMENS Healthineers

MULTIPLE SCLEROSIS

Disease pathway analysis with painpoints and solution examples

Innovation Think Tank
Proactively drive innovation to improve human life

An extensive research-based analysis from 40+ scientific articles and journals in combination with hospital workflow experience allowed the identification of painpoints and solutions

These solutions were proposed based on AI, IoMT, AR/VR, Biosensors, nanorobotics and smart wearable technologies

THROUGH THIS CAREPLAN WE HIGHLIGHT DATA FROM A COLLECTION OF

35 painpoints

41 respective solutions

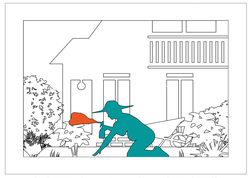
19 are connected to different stakeholders

1 PRENATAL

HOME

STAKEHOLDERS

- **The patient** — *Affected with chronic neurodegenerative disease*
- **The family** — *Environmental and socio-economic factors of family members affect the patient*
- **General practitioner** — *Provide care relating to general medical problems, initiate diagnosis and treatment*
- **Obstetrician** — *Physicians who provide medical care related to pregnancy or childbirth*
- **Hospital administration** — *Redefines hospital workflow in order to deliver efficient and high quality care across all patient services*
- **Pharmaceutical companies** — *Research, produce, market and distribution of drugs/ medications*



A diabetic woman during her pregnancy practices gardening and using pesticide-based products

1 PAINPOINT — *Lack of Vitamin D during pregnancy*
→ SOLUTION — Digitilization
→ **Sensor for monitoring**
Pregnant women could use sensors which alerts them to control their vitamin D levels.

2 PAINPOINT — *Constant anxiety affects fetal health. This may lead to adverse pregnancy outcomes.*
→ SOLUTION — Digitilization
→ **Relaxation app**
An App that provides guidance to the patient through breathing exercises, meditation and motivation sessions.

3 PAINPOINT — ***Late** initiation of **prenatal care during pregnancy***
→ SOLUTION — Digitilization
→ **Medical device for risk assessment**
An IOT enabled device which would enable risk assessment of fetus and ensures well being of the mother and the child.

4 PAINPOINT — ***Diabetes** during pregnancy: Type 1 diabetes is a risk factor for having MS*
→ SOLUTION — *clinical innovation*
→ **Non-invasive retinopathy screening**
Screening for diabetes for early pregnancy, using non-invasive retinopathy would show improvement potential in the long run.
Source

5 PAINPOINT — *Muscle weakness and coordination problems may increase the likelihood for falls*
→ SOLUTION — *digitalization*
→ **Electrical muscle stimulation technology(EMS)**
EMS helps in fast muscle recovery. without the need of heavy frequency loading, making this a useful tool to reduce muscle weakness during pregnancy.
**Source*

2 PREVENTION

PUBLIC AREA

STAKEHOLDERS

- **The patient** — *Does exercise, maintains a healthy lifestyle and diet*
- **The neurologist** — *Neurologist can check the medical history of the patient and look for any signs of nerve or brain damage.*
- **Pharmaceutical companies** — *Involved in the development of vitamins and supplements for prevention of Multiple Sclerosis.*
- **Diagnostic centers** — *Diagnostics centers can identify an individual with this disorder and educate the patient about the consequences*
- **Tech startups** — *Startups can play a major role in tracking a patient and keeping them fit throughout the day.*

Female patient in her mid-30s running in a sunny park, maintaining a healthy lifestyle and increasing the natural intake of vitamin D

1 PAINPOINT — *Overcrowded hospitals and long waiting times*
→ SOLUTION — *clinical innovation*
→ **Low cost diagnostic tests**
Private testing companies specializing in providing low-cost diagnostic test and can handle larger mass resulting in lesser overcrowd at hospitals
Source

2 PAINPOINT — *Patients are unaware of their **genetic history** and they don't take **preventive** measures against the disease*
→ SOLUTION — *digitalization*
→ **DNA analyser**
A DNA analyzer is a supercomputer that checks all complementary bases of a DNA strand and mark any complementary base pair with gene. It could be used for genealogical and bio-historical investigations.

3 PAINPOINT — *MS symptoms are similar to other neurologic disorders*
→ SOLUTION — *digitalization*
→ **Epilepsy alarm watches**
Smart watches for people with epilepsy can detect movements that may indicate whether a person is having a seizure and would also help in preventing them.

4 PAINPOINT — *Vitamin D deficiency can lead to a loss of bone density, which can contribute to osteoporosis and fractures (broken bones). Severe vitamin D deficiency can also lead to other diseases.*
→ SOLUTION — Digitilisation
→ **Vitamin D sensing bands**
Vitamin D monitoring sensor can be used to make patient aware of their vitamin D level since Multiple Sclerosis has a direct relationship with vitamin D levels of an individual.
Source

→ SOLUTION — Digitilisation
→ **Supplement dosage tracker**
Both D2 (ergocalciferol) and D3 (cholecalciferol) are available as dietary supplements to prevent Vitamin D deficiency. A single dose of 50,000 IU of D2 or D3 produces a similar increase in the total 25(OH)D concentration, but the apparent longer half-life of D3 suggests that less frequent dosing may be needed. It would helpful to track the correct dose of the supplement to prevent MS.
Source

3 SYMPTOMS

AT WORK

STAKEHOLDERS

- **The patient** — *Receives care services From providers*
- **Receptionist** — *Scheduling appointments and handling patients' documents and guidance through the hospital departments*
- **Radiologist** — *Diagnosis and interpreting medical images like CT, PET and MRI scans*
- **IT department** — *Responsible for the integration and maintenance of the technology infrastructure and patient's medical history*
- **Neurologist** — *Specialized in neurology, diagnosis and treats the disease*

The patient is experiencing symptoms such as vision problems, fatigue and weakness during her normal workday

1 PAINPOINT — *In 90% of patients, MS begins with a relapsing course. It gets difficult for the doctor to classify the stage of the disease*
→ SOLUTION — *automation*
→ **AI time series pattern**
This technology eases time, increases the accuracy of analysis through classification.

→ SOLUTION — *digitalization*
→ **IOT**
This technology can be used to collect patient parameters can be send from multiple medical devices

→ SOLUTION — *digitalization*
→ **Wearables**
The better the sensor is placed to collect the measurements, increased accuracy would be a factor for enhanced classification

2 PAINPOINT — *Most patient associate fatigue as a normal issues of a normal day.*
→ SOLUTION — *digitalization*
→ **Big data analytics**
The measurement and modeling of fatigue can be performed through wearable sensors, incorporating big data. measurement and modeling of fatigue through wearable sensors, incorporating big data analytics and safety engineering. and safety engineering
Source

3 PAINPOINT — *Freezing of gait is an episodic inability to take effective steps turning off the motor symptoms of MS*
→ SOLUTION — *digitalization*
→ **Hololens**
Explaining the tests to the patient by displaying upcoming procedures and to disable motor symptoms of MS
Source

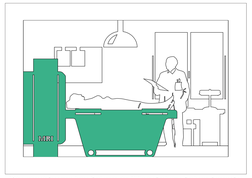
→ SOLUTION — *digitalization*
→ **Online database(Patient's account)**
Relevent pre-prepared videos can be sent to patient's mobile to make the patient pre-pared

4 DIAGNOSIS

HOSPITAL

STAKEHOLDERS

- **The patient** — *Consult with doctors Tests and diagnostic methods performed*
- **Neurologist** — *Performs neurological examination and diagnose the affected parts*
- **Radiologist** — *Diagnosis and MRI images*
- **Nurse** — *Take patient history and details about physical conditions*
- **Tech startups** — *Manufacture the wearable devices for different application with innovative technologies*



After a neurological exam, the patient undergoes MRI scanning to examine the brain and spinal cord

1 PAINPOINT — *Lack of medical history or unknown family history and unknown paralled diseases*
→ SOLUTION — digitalization
→ **RFID card & reader**
Doctor can scan the RFID card containing patient history and all medical details

2 PAINPOINT — *The accuracy of questionnaires related to physical conditions depends on the patient's answers*
→ SOLUTION — digitalization
→ **Interactive robot**
A robot can go to the patient and ask questions to patients. The robot would simultaneously record the feedback from the patient...

3 PAINPOINT — *Patient does not feel comfortable during MRI scan*
→ SOLUTION — *clinical innovation*
→ **Patient monitoring sensor array**
It helps in continuously monitoring the patient and if any discomfort is detected, it would send an alarm to the operator and also cease the scan

4 PAINPOINT — *Sometimes during neurological analysis, it is necessary to some movement analysis due to patient's condition*
→ SOLUTION — *digitalization*
→ **3D camera**
Capture the movements during test and analyze it later

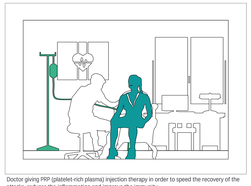
→ SOLUTION — *digitalization*
→ **AI algorithm integrated with camera data**
AI based diagnosis system based on a database of collected diagnosis

5 TREATMENT

HOSPITAL

STAKEHOLDERS

- **The patient** — *Receives treatment and therapies from the specialists*
- **Pathologist** — *For taking care of plasma matching and blood tests*
- **Neurologist** — *Decides which organs or body areas are affected due to attacks*
- **IT Departments** — *Take care of patient's database to make it useful if plasma replacement is required*
- **Tech startups** — *To manufacture the wearable devices for different application with innovative technologies*



Doctor giving PRP (platelet-rich plasma) injection therapy in order to speed the recovery of the attacks, reduces the inflammation and improve the immunity:

1 PAINPOINT — *There is no permanent cure for multiple sclerosis*
→ SOLUTION — *digitalization*
→ **AR/VR**
VR provides visual, auditory, and somatosensory stimuli to assist in improving gait.

2 PAINPOINT — *There is a need to track the patient's location and to detect any sort of disability*
→ SOLUTION — *clinical innovation*
→ **Wearable biosensors arrays**
Sensor data measurement from patient over a week and track his activity to find if there is disability and find a suitable treatment

→ SOLUTION — *digitalization*
→ **Gait and balance tracker**
Track the limb movements using gait analysis

3 PAINPOINT — *Side effects of corticosteroids are body fluid retention, insomnia and mood swings*
→ SOLUTION — *digitalization*
→ **Edemeter wearable**
To continuously monitor the body fluid retention and send the alert if attention is required

4 PAINPOINT — *During treatment, patient's immunity is very low which increases high chances of infection*
→ SOLUTION — *clinical innovation*
→ **BioMEMS on bracelets or rings**
To detect a flu or epidemic and send the alerts accordingly.
Source

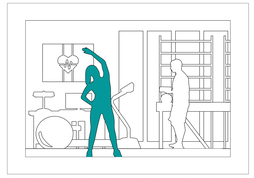
5 PAINPOINT — *Different attacks and treatment side effects cause decrement in white blood cells which would lead to low levels of immunity*
→ SOLUTION — *clinical innovation*
→ **Wearable white cell counter**
To monitor white blood cell counts at specified frequency

6 REHABILITATION

HOSPITAL

STAKEHOLDERS

- **Rehabilitation Therapist** — *Help patients to enhance and restore functional abilities through physical exercises*
- **Physiotherapist** — *Improving a patient's ability to perform movement*
- **Cognitive therapist** — *Helps patients to understand the thoughts and feelings that influence their behaviors and thought processes*
- **Tech startups** — *To manufacture different devices that can be use in rehabilitation*



Physical therapists monitor the mobility of the MS patient and helps regain mobility during and after a relapse.

1 PAINPOINT — *The prevalence of walking impairment in patients*
→ SOLUTION — *digitalization*
→ **Motion wearable Devices**
Devices that record user interactions and collect continuous high-density data related to range of movement and walking speed

2 PAINPOINT — *Muscle tightness or spasticity can interfere with gait and mobility*
→ SOLUTION — *digitalization*
→ **Soft-suit system for lower limb support**
An exoskeleton wear-able brace support with a computer-based control system, and motion sensors to provide support for the lower limb.

3 PAINPOINT — *A lot of data is generated by different therapists and can be difficult to manage.*
→ SOLUTION — *digitalization*
→ **Cloud data storage**
Therapist have different data and measurements. By using cloud storage this can be easily transferred to patient's database.

4 PAINPOINT — *Difficulty to track the recovery of patients after a follow up with the doctor*
→ SOLUTION — *digitalization*
→ **Implant biodegradable nano-chip**
A nano-chip monitor the recovery inside the body and degrade it by itself after the recovery

→ SOLUTION — *digitalization*
→ **Health tracker**
Health tracker can be useful to monitor patient's health after the treatment

IMPLEMENTED SOLUTION — digitilization
→ **DT enabled physical tracking**
Small, wearable sensor could capture limb dysfunction and subtle MS progression

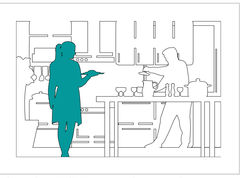
IMPLEMENTED SOLUTION — *digitalization*
→ **Voice recognition sensor**
Sensor module where the patient can say certain commands (infliction, pain, double vision, fatigue, non-movement) that are logged into a symptoms tracker

7 FOLLOW-UP

HOME

STAKEHOLDERS

- **The patient** — *Receives rehabilitation and attends appointments to track the progression of the disease*
- **Radiologist** — *Keeping track of the state of the patient, his disease progression through CT and MRI scans*
- **Rehabilitation therapist** — *Help patients enhance and restore functional abilities through physical exercises*
- **Palliative care and hospice center** — *Improve the patient's quality of life by providing relief from symptoms, pain and stress*
- **Pharmacy** — *Provides necessary drugs to slower the disease progression*



Patient has an independent lifestyle at home and continues to track the disease progression with support from neurologist and therapist.

1 PAINPOINT — *In some countries the therapy cost are not covered by the health insurance. The procedure is time consuming for the patient.*
→ SOLUTION — *digitalization*
→ **Sliding scale therapy**
One advantage of these therapy is it is that because they are training drives, they are likely to offer evidence-based psychotherapy, with some clinics utilizing more cutting-edge therapies. It makes these therapies much more affordable as the price per session is essentially negotiable based on the current in-come of the patient.
Source

Disclaimer: The Disease Pathways Framework could be used to elaborate on various diseases. The various pain points, solutions, and statistical data are examples only and cannot be taken as recommendations for the reader.

Website:
https://www.siemens-healthineers.com/careers/ innovation-think-tank