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GE HEALTHCARE
SPECIAL SUPPLEMENT

Cover Story:

The Future is Digital

Novel Interventions for Early Parkinson Detection

Summary: An award-winning ICT-based early detection of Parkinson's Disease aims to support healthcare sustainability and more personalised care for at-risk adults.

Population ageing, which entails an increasing share of older persons in the population, is a major global demographic trend, which will intensify during the twenty-first century (United Nations 2013). Increasing life expectancy raises the question of whether longer life spans result in more years of life in good health (expressed via the quality-adjusted life years [QALYs]), or whether it is associated with increased morbidity and more years spent in prolonged disability and dependency (expressed via the disability-adjusted life years [DALYs] (Ezzati et al. 2006).

Parkinson's Disease (PD) is one of the commonest neurodegenerative diseases, affecting approximately 1% of individuals older than 60 years and 2-4% over than 75 years,

early PD symptoms detection and early intervention in older adults' everyday lives, promoting active and healthy ageing, by introducing new ways of health self-managing tools, set within a collaborative care context with health professionals. The main aim of i-PROGNOSIS is to create an ICT-based behavioural analysis approach for capturing the appearance of PD symptoms as early as possible, and to apply ICT-based interventions countering identified risks based on early PD detection, relating to progressive frailty, falls and emotional shift towards depression.

Regarding early PD detection, i-PROGNOSIS proposes a radically novel approach to capture the risk of transition from healthy status towards PD, by unobtrusive behav-

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causing progressive disability that results in a burden of about 2.2 million DALYs, exhibiting the greatest loss of QALYs among 29 major chronic conditions (Dorsey et al. 2007; Tanner et al. 2008). For patients with PD, there is a reduction in the brain dopamine, which controls movement and mood, so simple activities like walking, talking and writing, along with emotional stability can be negatively impacted. PD is a progressive and chronic neurological disease that often begins with mild symptoms that advance gradually over time. Symptoms can be so subtle in the early stages that they go unnoticed, as there are no PD-related biomarkers (eg blood tests) and findings on routine magnetic resonance imaging and computed tomography scans are unremarkable, leaving the disease undiagnosed for years.

Motivated by the aforementioned, i-PROGNOSIS (i-prognosis.eu) proposes an intelligent ICT-based approach for

ioural sensing and large-scale collection of seniors' data, acquired from their use of smartphones (with their permission) via a corresponding mobile application, namely iPrognosis App. This data (GData) is drawn from the population of older adults (55-60 plus years) and refers to voice/motion/typing-handwriting patterns, socialisation/life-style behaviour and selfies.

Selected seniors who, according to noticeable changes in their GData patterns, exhibit initial indications towards PD, follow more guided and controlled testing scenarios, producing additional data (SData), acquired from their interaction with the everyday Internet-of-Things (IoT) through mHealth. These include ECG/gate patterns change, bowel immobility related to increased constipation identification, food-intake curve alterations related to depression identification, and daily/nocturnal health status alterations. GData/SData-based features, ensuring users' privacy

protection, are anonymised and securely stored in the Cloud for processing by advanced big data analytics and machine learning techniques in a distributed and privacy aware manner, so as to produce reliable early PD symptoms detection alarms.

Three large European PD clinics (KCL, TUD, AUTH), and Age Platform Europe (AGE) representing more than 40 million older people in Europe have so far engaged

living room. The proposed platform includes peer mentoring and supports real-time analysis and positive feedback on the employed interaction using MentorAge sensor. Sensed data (ie GData and SData) are continuously aggregated and used as the basis for analysis to adapt and personalise the patient's PGS programme over time, with abstracted summaries provided as feedback to both the older adult and his/her attending clinician. This serves as a motiva-

i-PROGNOSIS interventions assist older adults with PD to better understand and deal with their own health status in a more effective way

more than 2,000 individuals that are offering their GData for system development and validation purposes. This campaign is actively supported and channelled by the three participating companies with high a societal footprint (MICROSOFT, COSMOTE, PLUX). A selected subset will offer SData.

The core pipeline of i-PROGNOSIS applies novel information processing algorithms on all GData and SData cues in order to extract PD indicators that are used to instantiate our PD Behavioural Model. The latter encapsulates all the available evidence for PD prediction by means of machine learning algorithms.

Regarding the PD-related risks interventions, i-PROGNOSIS proposes a series of innovative ICT-based interventions applied to those identified by the analysis of GData/SData and confirmed by clinical data as potential or early stage PD patients according to the related PD scores (eg MDS-UPDRS, PIF, 10MW, GAS, PDQ39, GDS, BDI) (Kadastik-Eerme et al. 2015). The objective is to target as early as possible the elimination of their risks for frailty, falls and depression, as it has been proven from epidemiological studies that early intervention could have an inverse relation with the PD-related risks.

The Components

Personalised Game Suite (PGS): i) ExerGames for muscle tension reinforcement, walking pattern/posture reestablishment, ii) DietaryGames for dietary habits adaptation for reduction of constipation/depression, towards the increase of quality of life, iii) EmoGames for expressive face encouragement, natural blinking reestablishment and depression/anxiety treatment, and iv) H/VGames for handwriting pattern correction/reestablishment and hypophonia reduction.

The i-PROGNOSIS Platform is realised as an Internet-enabled sensor-based home game platform that allows remote users' participation in all aforementioned PGS programmes at any time, from the comfort of their own

tion to the older adult and helps the clinician to make more informed decisions.

Assistive interventions referring to voice enhancement and gate rhythm guidance (via vibration/metronome cueing) mobile applications that facilitate their interaction with others and foster their socialisation, as reflected to the relevant acquired daily data. In general, i-PROGNOSIS interventions assist older adults with PD to better understand and deal with their own health status in a more effective way, by reducing as early as possible the PD-related risks and increasing their QALYs. The aforementioned PD Behavioural Models are used for monitoring the effectiveness of intervention leading to possible readjustments.

The i-PROGNOSIS project undertakes initiatives that increase the awareness for the PD-related risks in a social scale, through social interventions (via the mobile phone/Internet users) for raising awareness for active and healthy ageing, fostering: a) the participation of as many as possible to volunteer as i-PROGNOSIS app users to participate in the "early PD detection initiative," further enriching the GData, and b) the construction of behavioural and socio-economic models for new cost-effective ICT-based early PD detection and intervention practices and policies, establishing appropriate recommendations to all engaged stakeholders.

In summary, the main innovative elements of i-PROGNOSIS are: i) the introduction of new early diagnostic tests for PD symptoms based on features extracted from securely Cloud-stored behavioural and sensorial data, collected by smart devices (eg smartphone, smartwatch), wearable biosensors and IoT-based everyday living sensorial artefacts, and processed by advanced big data analytics and machine learning techniques, ii) design and implementation of novel ICT-based adaptive, gamified, and personalised interventions, along with assistive interventions, taking into account older adults' physical and psychological status, promoting his/her health self-management at the family setting by providing dynamic feedback towards the

improvement of older adults' skills and functionalities for reduction of the PD-related risks of frailty, depression and falls, and iii) fostering of social awareness for volunteerism in early PD detection and construction of socio-economic and informed behavioural models for new cost-effective ICT-based PD early detection and related risks-reduction intervention practices and policies for the sustainability of health and care systems and the benefit of the older adults.

i-PROGNOSIS leverages and extends state-of-the-art technology in a number of different areas, such as behavioural, physiological and lifestyle monitoring, motion capture, physical activity evaluation, personalised gaming, home-based human computer interfaces, multi-parametric data modelling and decision support systems. ■

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✓ Key Points

- Population ageing and related pressure on healthcare systems is a major global trend.

- Parkinson's Disease (PD) is one of the most common neurodegenerative diseases in seniors.

- An ICT-based approach can assist with early PD symptoms detection and early intervention.

- i-PROGNOSIS deploys state-of-the-art technology in PD behavioural, physiological and lifestyle monitoring and decision support systems for improved care and use of healthcare resources.

REFERENCES

United Nations, Department of Economic and Social Affairs, Population Division (2013). World Population Ageing 2013.ST/ESA/SER.A/348

Lopez AD, MathersCD, Ezzati M, Jamison DT, Murray CJL (2006) Global Burden of Disease and Risk Factors. Oxford University Press and The World Bank.

Dorsey ER, Constantinescu, R Thompson, JP Biglan, KM Holloway, RG Kieburtz, Tanner CM (2007) Projected number of people with Parkinson disease in the most populous nations, 2005 through 2030. Neurology, 68(5): 384-386.

Tanner CM, Brandabur M, Dorsey E (2008) Parkinson Disease: A Global View. PARKINSON Report, 9-11.

Kadastik-Eerme L, Rosenthal M, Paju T, Muldmaa M, Taba P (2015) Health-related quality of life in Parkinson's disease: a cross-sectional study focusing on non-motor symptoms. Available from ncbi.nlm.nih.gov/pmc/articles/PMC4474578/

A Winning Consortium

i-PROGNOSIS won the innovation pitch for "digital solutions" at the commercial senior health congress AgeingFit held in Nice, France in January.

The project is the result of a consortium of individuals and organisations as listed below:

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