



**UNIVERSITY OF IOANNINA
SCHOOL OF HEALTH SCIENCES
FACULTY OF MEDICINE**

NERVOUS SYSTEM AND SENSORY ORGANS SECTOR
DEPARTMENT OF NEUROLOGY

**Technology solutions and online training in the care
of Parkinson's disease and related movement disorders**

Dimitrios Gatsios

Information Technology Consultant

PhD Thesis

IOANNINA 2022



**ΠΑΝΕΠΙΣΤΗΜΙΟ ΙΩΑΝΝΙΝΩΝ
ΣΧΟΛΗ ΕΠΙΣΤΗΜΩΝ ΥΓΕΙΑΣ
ΤΜΗΜΑ ΙΑΤΡΙΚΗΣ**

**ΤΟΜΕΑΣ ΝΕΥΡΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ ΚΑΙ ΑΙΣΘΗΤΗΡΙΩΝ
ΝΕΥΡΟΛΟΓΙΑ**

**Σύγχρονες Τεχνολογίες και online εκπαίδευση στη φροντίδα
της νόσου Πάρκινσον και συναφών κινητικών διαταραχών**

Δημήτριος Γάτσιος
Πληροφορικός

ΔΙΔΑΚΤΟΡΙΚΗ ΔΙΑΤΡΙΒΗ

ΙΩΑΝΝΙΝΑ 2022

«Η έγκριση της διδακτορικής διατριβής από το Τμήμα Ιατρικής του Πανεπιστημίου Ιωαννίνων δεν υποδηλώνει αποδοχή των γνωμών του συγγραφέα Ν. 5343/32, άρθρο 202, παράγραφος 2 (νομική κατοχύρωση του Ιατρικού Τμήματος)».

Ημερομηνία αίτησης του κ. Γάτσιου Δημήτριου: 07-05-2018

Ημερομηνία ορισμού Τριμελούς Συμβουλευτικής Επιτροπής: 867α/25-09-2018

Μέλη Τριμελούς Συμβουλευτικής Επιτροπής:

Επιβλέπων:

Κονιτσιώτης Σπυρίδων, Καθηγητής Νευρολογίας

Μέλη:

Αλεξίου Γεώργιος, Επίκουρος Καθηγητής Νευροχειρουργικής

Αστρακάς Λουκάς, Επίκουρος Καθηγητής Ιατρικής Φυσικής

Ημερομηνία ορισμού θέματος: 18-10-2018

«Σύγχρονες Τεχνολογίες και online εκπαίδευση στη φροντίδα της νόσου Πάρκινσον και συναφών κινητικών διαταραχών»

«Technology solutions and online training in the care of Parkinson's disease and related movement disorders»

ΟΡΙΣΜΟΣ ΕΠΤΑΜΕΛΟΥΣ ΕΞΕΤΑΣΤΙΚΗΣ ΕΠΙΤΡΟΠΗΣ 996α/08-02-2022

1. Κονιτσιώτης Σπυρίδων, Καθηγητής Νευρολογίας του Τμήματος Ιατρικής του Πανεπιστημίου Ιωαννίνων
2. Αλεξίου Γεώργιος, Επίκουρος Καθηγητής Νευροχειρουργικής του Τμήματος Ιατρικής του Πανεπιστημίου Ιωαννίνων
3. Αστρακάς Λουκάς, Αναπληρωτής Καθηγητής Ιατρικής Φυσικής του Τμήματος Ιατρικής του Πανεπιστημίου Ιωαννίνων
4. Κούτρας Βασίλειος, Καθηγητής Αγωγής Υγείας του Παιδαγωγικού Τμήματος Νηπιαγωγών του Πανεπιστημίου Ιωαννίνων
5. Φωτιάδης Δημήτριος, Καθηγητής Βιοϊατρικής Τεχνολογίας του Τμήματος Μηχανικών Επιστήμης Υλικών του Πανεπιστημίου Ιωαννίνων
6. Τσάμης Κωνσταντίνος, Επίκουρος Καθηγητής Φυσιολογίας του Τμήματος Ιατρικής του Πανεπιστημίου Ιωαννίνων
7. Ξεάρχος Θεμιστοκλής, Επίκουρος Καθηγητής Μοντελοποίησης Δεδομένων και Συστημάτων Υποστήριξης Αποφάσεων του Τμήματος Πληροφορικής του Ιόνιου Πανεπιστημίου

Έγκριση Διδακτορικής Διατριβής με βαθμό «ΑΡΙΣΤΑ» στις 02-03-2022

Ιωάννινα 24-05-2022

ΠΡΟΕΔΡΟΣ ΤΟΥ ΤΜΗΜΑΤΟΣ ΙΑΤΡΙΚΗΣ

Άννα Μπατιστάτου

Καθηγήτρια Παθολογικής Ανατομίας



Acknowledgements

Throughout the writing of this dissertation, I have received a great deal of support and assistance.

I would first like to thank my supervisor, Professor Spyridon Konitsiotis, whose expertise was invaluable in formulating the research questions and methodology. His insightful feedback pushed me to understand the needs of patients with Parkinson's and systematically try to address them.

I would also like to thank Professor Dimitrios Fotiadis. Our collaboration over the years sharpened my thinking and brought my work to a higher level.

I would like to acknowledge my colleagues from the PD_manager, PRIME and PD_Pal projects for their wonderful collaboration.

I would particularly like to single out Dr. Piret Paal and thank her for her comprehensive guidance in palliative care topics and the opportunity I was given to co-develop the "Best Care for People with Late-Stage Parkinson's Disease" curriculum toolkit.

Moreover, I would like to thank my other two co-supervisors, Professor Lucas Astrakas and Professor George Alexiou who guided me to the right direction to successfully complete my dissertation.

Special thanks to Spyridoula Koutsouki without which many practical issues would never be solved.

Credits to my business and science partner Dr. George Rigas for his wise counsels and sympathetic ear, as well as for our stimulating and constructive discussions.

Last but, most certainly, not least, I would like to say a big "Thank you" to my family for their continuous support. Christine, Apostolos and Thanos gave me the time and space that I needed to complete this work.

Preamble

Parkinson's disease (PD) is a neurodegenerative condition affecting more than 10 M people worldwide. Parkinson's is progressive, which means symptoms appear gradually and slowly get worse. Parkinson's is life-altering, but not life-threatening.

Patient – caregiver – health team communication and information sharing, as well as the increasingly acknowledged, health literacy are of paramount importance since they can positively influence the course of the disease and enhance the quality of life. Medical informatics can be of great help for these aspects. Specifically, e-health can provide an ecologically valid monitoring of the disease status and progress and inform therapy decisions, while online training can increase patients' and caregivers' health literacy and decision-making capacity at all stages. Massive open online courses can also improve clinicians' attitude, knowledge and skills in palliative care provision.

This thesis essentially contributes to ehealth for Parkinson's concepts by systematically exploring the factors that affect compliance in using such systems in chapter 1. We also propose a novel clinical decision support system relying in medical devices, mhealth and clinical guidelines for the diagnosis and management of the disease in chapter 2. The thesis also contributes to the improved provision of care in the late-stage Parkinson's by introducing in chapter 4 a curriculum toolkit addressed to all stakeholders after exploring the views of Greek clinicians (chapter 3).

Table of Contents

Acknowledgements	1
Preamble	3
Table of Contents.....	5
1 Feasibility and Utility of mHealth for the Remote Monitoring of Parkinson Disease: Ancillary Study of the PD_manager Randomized Controlled Trial.....	7
1.1 Introduction.....	7
1.2 Aims and objectives.....	11
1.3 Methods	11
1.3.1 Study population	11
1.4 Study design.....	12
1.4.1 The PD_manager study	12
1.4.2 The mhealth platform	14
1.4.3 Outcome definitions and statistical analysis	17
1.5 Results.....	18
1.5.1 Recruitment.....	18
1.5.2 Compliance.....	19
1.5.3 Sample characteristics and bivariate correlations	19
1.5.4 Determinants of compliance.....	21
1.5.5 Clinically meaningful data with ecological validity	23
1.6 Discussion.....	25
1.6.1 Principal Results.....	25
1.6.2 Comparison with Prior Work	26
1.6.3 Limitations.....	27
1.7 Conclusions	27
2 Design of a clinical decision support system powered by mhealth for the management of Parkinson’s disease	28
2.1 Introduction.....	28
2.2 Aims and objectives.....	28
2.3 Methods	29
2.4 Results.....	29
2.4.1 PRIME CDSS overview	29
2.4.2 Defining the PRIME CDSS Functionality	30
2.4.3 PRIME CDSS Dashboard Requirements	32
2.4.4 PRIME platform overview	33
2.5 Discussion – Future work	35
3 Exploring the knowledge and views of Greek Neurologists regarding Palliative Care Topics...	36

3.1	Introduction.....	36
3.2	Aims and objectives.....	37
3.3	Methods	37
3.3.1	Presentation of the preliminary version of the educational toolkit.....	37
3.4	Study Design	41
3.4.1	Study setting and feedback collection	41
3.4.2	Study population	42
3.5	Results.....	44
3.6	Discussion.....	46
3.7	Conclusions	47
4	Education on Palliative care for Parkinson patients: the "Best Care for People with Late-Stage Parkinson's Disease" curriculum toolkit	48
4.1	Introduction.....	48
4.2	Aims and objectives.....	48
4.3	Methods	49
4.4	Results.....	52
4.5	Discussion.....	59
4.6	Future work	61
4.7	Conclusions	61
	Executive Summary	62
	Περίληψη στην Ελληνική	64
	References.....	66
	Appendix I: Author's publications.....	74
	Appendix II: MOOC Quick Guide	78
	Appendix III: The PD_Pal Curriculum Toolkit (available online at https://www.pdpal.eu/courses) ..	87

1 Feasibility and Utility of mHealth for the Remote Monitoring of Parkinson Disease: Ancillary Study of the PD_manager Randomized Controlled Trial

1.1 Introduction

Parkinson's disease (PD) is a progressive disorder with patients having heterogeneous symptoms and progression rates. Presently, there is no cure for the condition and treatment aims at controlling symptoms by optimizing medication plans. Optimization and personalization of the treatment is currently based on clinical interview, diaries and scales, though in the future it may benefit from information on symptoms and medication adherence collected away from the clinic while the patients perform their normal daily activities.

Technology, even with the existing regulatory limitations and barriers, offers the possibility for improved care, self-assessment options, and overall improved healthcare outcomes (1). The recent pandemic crisis further emphasized the need for telemedicine solutions for PD patients (2-5). Wearable sensors and mobile apps, i.e. mhealth solutions, have been extensively used to monitor and evaluate mainly motor symptoms and motoric complications of PD patients also in their home environments (6-9) and are expected to soon replace diaries (10). However, reliable and unobtrusive solutions for non-motor symptoms are still lacking (1).

In order to get an overview of the mhealth systems for Parkinson's management field, a narrative review was conducted. I have searched articles in PubMed with queries using quotes such as mhealth, Parkinson, treatment etc. and the abstracts of more than 300 articles were screened. 15 articles qualified for full text assessment and the 12 most relevant to this part of the thesis articles are included in the analysis.

In the REMPARK study (11), 41 patients with moderate to severe idiopathic PD were recruited according to the UK Parkinson's Disease Society Brain Bank criteria. Patients with motor fluctuations, freezing of gait and/or dyskinesia and who were able to walk unassisted in the OFF phase, were included in the study. Patients used the REMPARK System consisting of a sensor and a smartphone for 3 days and completed a diary of their motor state once every hour. The record obtained by the REMPARK System, compared with patient-completed diaries, demonstrated 97% sensitivity in detecting OFF states and 88% specificity (i.e., accuracy in detecting ON states).

mPower (12) (<https://github.com/Sage-Bionetworks/mPower>) was an observational, smartphone-based study developed using Apple's ResearchKit library (<http://researchkit.org/>) to evaluate the feasibility of remotely collecting frequent information about the daily changes in symptom severity and their sensitivity to medication in PD. These data provide the ability to explore classification of control participants and those who self-report having PD, as well as to begin to measure the severity of PD for those with the disease. mPower aimed at a 6-months data collection period, but the findings clearly indicate that the 150 participants were adherent for up to 2 weeks with minimal data contribution afterwards.

The Clinician Input Study (CIS-PD) study (13, 14) assessed the feasibility and clinical utility of data obtained using a mobile health technology from PD patients. In this observational, exploratory study, PD participants wore a smartwatch and used the Fox Wearable Companion mobile phone app to stream movement data and report symptom severity and medication intake for 6 months. Between June and August 2017, 51 PD patients were recruited at four US sites, and 39 (76%) completed the 6-month study. Patients streamed 83,432 h of movement data from their smartwatches (91% of expected). Reporting of symptoms and medication intake using the app was lower than expected, 44% and 60%, respectively, but did not differ according to baseline characteristics.

The Parkinson@home study (15) showed that it is feasible to collect objective data using multiple wearable sensors in PD during daily life in a large cohort. The Parkinson@home study was an observational, two-cohort (North America, NAM; The Netherlands, NL) study. Main enrolment criteria were self-reported diagnosis of PD, possession of a smartphone and age ≥ 18 years. Participants used the Fox Wearable Companion app on a smartwatch and smartphone for a minimum of 6 weeks (NAM) or 13 weeks (NL). Sensor-derived measures estimated information about movement. Additionally, medication intake and symptoms were collected via self-reports in the app. A total of 953 participants were included (NL: 304, NAM: 649). Enrolment rate was 88% in the NL ($n = 304$) and 51% ($n = 649$) in NAM. Overall, 84% ($n = 805$) of participants contributed sensor data. Participants were compliant for 68% (16.3 hours/participant/day) of the study period in NL and for 62% (14.8 hours/participant/day) in NAM. Daily accelerometer data collection decreased 23% in the NL after 13 weeks, and 27% in NAM after 6 weeks. Data contribution was not affected by demographics, clinical characteristics or attitude towards technology, but was by the platform usability score in the NL ($\chi^2(2) = 32.014$, $p < 0.001$), and self-reported depression in NAM ($\chi^2(2) = 6.397$, $p = .04$).

Fischer et al. (16) based on the analysis of the data collected from 34 study participants wore bilateral wrist-worn sensors for 4 h in a research facility and then for 1 week at home, further confirmed that short-term monitoring with wrist-worn sensors is acceptable to PD patients.

In Ellis et al.(17) an mHealth-mediated exercise program (walking with a pedometer plus engagement in planned exercise supported by a mobile health application) was compared over 1 year with an active control condition (walking with a pedometer and exercise only). There were 51 participants in a community setting with mild-to-moderately severe (Hoehn and Yahr stages 1-3) idiopathic PD. Both groups improved, and additionally an improvement in the PDQ39 mobility score favored mHealth in the overall comparison and was statistically and clinically meaningful in the less active subgroup.

Horin et al. (18) investigated the usability of a mobile health (mHealth) smartphone application to treat gait, speech and dexterity in people with PD. The participants either used an mHealth application (17 completed the intervention) or maintained their normal routine (20 controls) for 12 weeks and were evaluated at baseline and post-test time points for primary outcome measures of adherence, gait, speech and dexterity. Adherence was moderate and there were no significant group, time or interaction effects for any outcome measures. Correlations between adherence and outcomes were weak and negative. These data suggest that usability of this mHealth application was limited as indicated by low adherence. The application alone in its present form was not adequate to treat symptoms of gait, speech or dexterity in people with PD.

On the other hand in the study of Heijmans et al. (19) , during a period of two consecutive weeks, 20 participants had to wear three wearable sensors and had to complete questionnaires at seven semi-random moments per day on their mobile phone. Wearable sensors collected objective movement data, and the questionnaires containing questions about amongst others Parkinson's disease symptoms served as parallel ground truth. Results showed that participants wore the wearable sensors during 94% of the instructed timeframe and even beyond. Furthermore, questionnaire completion rates were high (79,1%) and participants evaluated the monitoring system positively. A preliminary analysis showed that sensor data could reliably predict subjectively reported OFF moments. These results show that the suggested Parkinson's disease monitoring system is a feasible method to use in a diverse Parkinson's disease population for at least a period of two weeks. For longer use, the monitoring system may be too intense and wearing comfort needs to be optimized.

Heldman et al. (20) assessed the impact of motion sensor-based telehealth diagnostics on PD clinical care and management. 18 adults with PD were randomized to control or experimental groups. All participants were instructed to use a motion sensor-based monitoring system at home 1 day per week for 7 months. The system included a finger-worn motion sensor and tablet-based software interface that guided patients through tasks to quantify tremor, bradykinesia, and dyskinesia. Data were processed into motor symptom severity reports, which were reviewed by a movement disorder neurologist for the experimental group participants. After 3 months and 6 months, the control group

participants visited the clinic for a routine appointment, while the experimental group participants had a videoconference or phone call instead. Home-based assessments were completed with a median compliance of 95.7%. For a subset of participants, the neurologist successfully used information in the reports, such as quantified responses to treatment or progression over time, to make therapy adjustments. Changes in clinical characteristics from study start to end were not significantly different between the groups. Individuals with PD were able and willing to use remote monitoring technology. Patient management aided by telehealth diagnostics provided comparable outcomes to standard care. Telehealth technologies combined with wearable sensors have the potential to improve care for disparate PD populations or those unable to travel.

In the study conducted by Arora et al. (21), 20 participants underwent baseline in-clinic assessments, including the Unified Parkinson's Disease Rating Scale (UPDRS), and were provided smartphones with an Android operating system that contained a smartphone application that assessed voice, posture, gait, finger tapping, and response time. Participants then took the smart phones home to perform the five tasks four times a day for a month. Once a week participants had a remote (telemedicine) visit with a Parkinson disease specialist in which a modified (excluding assessments of rigidity and balance) UPDRS performed. The participants performed an average of 2.7 tests per day (68.9% adherence) for the study duration (average of 34.4 days) in a home and community setting and the authors concluded that measuring PD symptoms via a smartphone is feasible and has potential value as a diagnostic support tool.

Lakshminarayana et al. (22) conducted a multi-centre (7 centres) randomised controlled trial in England and Scotland to assess the impact of using a smartphone-based Parkinson's tracker app to promote patient self-management, enhance treatment adherence and quality of clinical consultation. At 16 weeks Parkinson's tracker app significantly improved adherence, compared to treatment as usual (mean difference: 0.39, 95%CI 0.04–0.74; $p = 0.0304$) with no confounding effects of gender, number of comorbidities and age. Among secondary outcomes, Parkinson's tracker app significantly improved patients' perception of quality of consultation (0.15, 95% CI 0.03 to 0.27; $p = 0.0110$).

The feasibility and usability of the commercial mKinetikos system (<https://kinetikoshealth.com/mkinetikos>) was assessed with 17 patients recruited within a 7-month clinical study(23). Patients were asked to answer a daily survey, to perform three weekly active tests, and to perform a monthly in-person clinical assessment. Sixteen participants (94.1%) showed a medium-to-high level of compliance with the mKinetikos system. A 6-point drop in the total score of the Post-Study System Usability Questionnaire was observed.

The review confirms the feasibility of the concept and the acceptability to patients as well as the clinical usage of such systems. Despite the potential benefits of the use of technologies, various important aspects of its feasibility remain to be explored. Only a few studies have rigorously investigated the feasibility and utility of using technology-based platforms. Moreover, apart from three (12, 15, 22), most prior studies remained limited by the small sample sizes (samples of up to 51 PD patients in varying disease stages) (11, 14, 16, 19, 21). Evidence of mhealth utility for the clinicians is in its early days even for commercial grade systems (20, 24). None of these studies has systematically explored the role of caregivers in compliance with mhealth.

1.2 Aims and objectives

In the current analysis, we investigated, first-hand, the feasibility of using an mhealth platform (25, 26), described from now on as the PD_manager system, comprising a smartphone, a smartwatch and pair of smart insoles. The study focuses on participants' compliance and their determinants. The study also validates the system's utility to collect clinically meaningful data with ecological validity.

1.3 Methods

1.3.1 Study population

Between May 2017 and March 2018, a total of 136 consenting patients with Parkinson's disease (Hoehn and Yahr stage "off" ≥ 3 , experiencing motor fluctuations at least 2 h per day based on UPDRS-IV score), with a live-in caregiver, were recruited in three countries (50 Rome, 44 Venice, Italy; 21 in Ioannina, Greece and 21 in Surrey, England) (25). Four of them were excluded from the study, two because they withdrew and two because they were not eligible at reassessment, leaving a total 75 patients assigned to the PD_manager group and 57 to the control group. The PD_manager group characteristics are summarized in Table 1.

Table 1: PD_manager group characteristics.

Variable	
Gender (% of females)	40
Age	67.73 (8.72)
Years since diagnosis	9.21 (4.41)
H&Y (% of stage 3 patients)	93.30

BMI%	26.04 (3.95)
MMSE	28.60 (1.74)
MDS-UPDRS III	28.15 (15.06)
NMSS	45.17 (38.55)

Values are mean (SD), unless otherwise noted

In this work we are focusing on the actual system usage and compliance as depicted in the data collected from the patients and their caregivers vis-à-vis data collected via the respective PD_manager devices, i.e. we are analyzing only the PD_manager group. Focus is on compliance metrics as well as the factors affecting the compliance. Moreover, we provide evidence that the data are clinically meaningful since they can be used for accurately monitoring and evaluating symptoms and specifically tremor.

1.4 Study design

1.4.1 The PD_manager study

The PD_manager trial (25) was an open label parallel group randomized study. It was conducted to assess the feasibility, usability and the trends of effectiveness of the PD_manager system, compared to traditional practices of using a symptom diary, for the management of people with Parkinson's disease.

Following informed consent, baseline information was gathered, including the following: age, gender, education, attitudes to technology (patient and caregiver), time since Parkinson's diagnosis, symptom status (with NMSS and UPDRS), comorbidities (patient only), caregiver burden (Short Zarit), patient's self-assessment of the disease (EQ-5D-5L) and patient's self-assessed quality of life (PDQ-8).

The patients were asked to use the system for 14 days continuously during 12 hours daytime. The 14 days duration for the wearing of study devices (wristband and smartphone) by participants, was defined for a number of reasons. First, it was based on analysis of user needs, safeguarding ethics and privacy, as well as the burden on study participants. Second, it was considered enough for collection of sufficient data to provide clinically meaningful information. Finally, findings of previous larger studies (12), with similar investigation concepts, indicated that around 70% of the patients were compliant for up to 15 days.

During the 14-days period the system passively and automatically captured raw sensor data (from the smartphone, the wristband and the insoles) to be used for the evaluation of motor symptoms, aggregated data on sleep and activity (wristband proprietary software), speech, cognitive status and emotional state using the smartphone apps (with scheduled prompts-notifications for the user to perform specific tasks). The smartphone was used for storing the data locally. Automatic transmission of the data to a cloud backend was possible but not used during the pilot for privacy and security purposes. Control group participants were asked to keep a motor symptom diary for 3 days and complete the Parkinson's Well-Being Map. After a minimum of two weeks, a specialist doctor reviewed the data gathered. Participants, caregivers and clinicians were asked for feedback on the acceptability and utility of the data collection methods. Data collection for the whole pilot study is summarized in Table 2.

Table 2: Summary of PD_manager group data collection at each stage.

Participant group	Data capture at each stage		
	Baseline	During intervention, PD_manager group from devices	Post-intervention, 2-week follow-up
Patient	Age, gender, education, disease duration, disease stage (Hoehn and Yahr score), main symptoms (tremor, bradykinesia, rigidity, dyskinesia), more affected side, UPDRS scores, current medications, comorbidities, views on technology (with the Technology Assessment Model). Outcomes: EQ-5D-5L; PDQ-8; NMSS, UPDRS.	Motor symptoms (gait, freezing of gait, bradykinesia, dyskinesia, activity); non-motor symptoms (cognition, sleep, mood).	Interviews on acceptability and ease of use of PD_manager or symptom diary. Data collected in the smartphone and in the backend from smartphone and wristband sensors, data from insoles stored in the backend.

Participant group	Data capture at each stage		
	Baseline	During intervention, PD_manager group from devices	Post-intervention, 2-week follow-up
Caregiver	Age, gender, education, views on technology (with the Technology Acceptance Model). Outcome: Zarit Caregiver Burden Scale (using short version).	No information is collected from caregivers in the PD_manager group.	Interviews on acceptability and ease of use of PD_manager or symptom diary.
Clinician	Technophobia, previous experience with monitoring technology, socio-demographics, clinical experience	-	System Usability Scale (SUS), Post-Study System Usability Questionnaire (PSSUQ), Technology Acceptance Modified Model (TAMM).

1.4.2 The mhealth platform

The mhealth platform depicted in Figure 1 has been described in detail in a previous work (26) and consists of a wristband (Microsoft Band, Microsoft Corporation, Redmond, WA, USA), a pair of sensor insoles (Moticon GmbH, Munich, Germany), a smartphone (Aquaris M and U models, BQ, Madrid, Spain) with dedicated mobile Android apps (see Figure 2) and a knowledge platform (hosted by Biotronics 3D, London, UK) serving as the cloud backend of the platform. The Microsoft Band SDK allowed us to access data from the Band's sensors. The wristband and the smartphone provided raw data from the 3-axis accelerometer and the gyroscope at a sampling rate of 100 Hz that were used for building motor symptoms' assessment methods. The Band could also be used for collecting heart rate, galvanic skin response and skin temperature data. Moreover, the accompanying Microsoft Health App provided aggregated data for sleep (sleep duration, number of wakeups, ratio of time asleep to total sleep, total length of restless and restful sleep in minutes) and activity (type e.g. Run, Sleep, Bike, summary of calories burned, summary of heart rate data). With the insoles we collected

pressure distribution and accelerometer data enabling us to evaluate weight-bearing, balance and motion sequences and study gait.

Data from devices were transferred and stored in a web-based cloud, NoSQL database in anonymised and encrypted format. The servers storing the information in the cloud platform are based on Biotronics 3D's 3DnetMedical platform in an ISO27001-accredited data centre located in London. They are operated in accordance with the Data Protection Act.

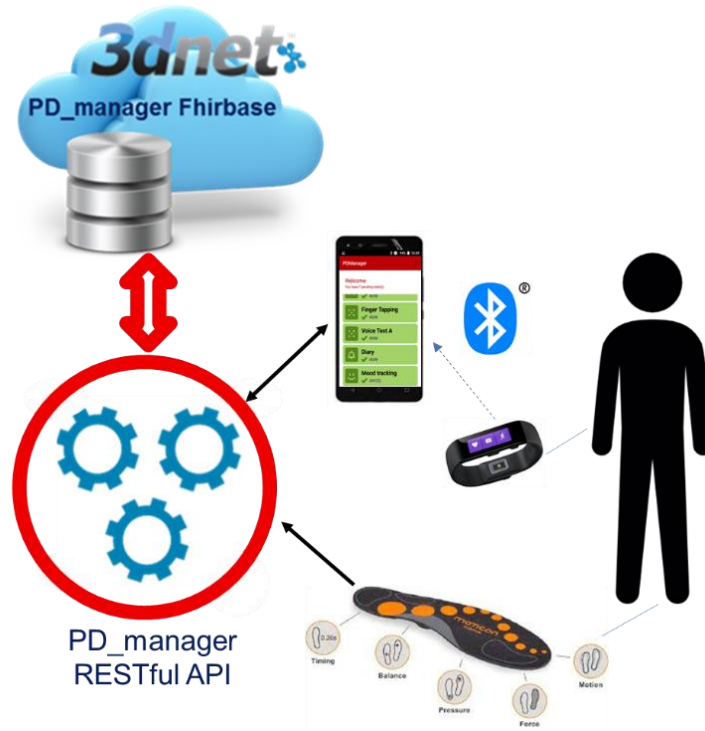


Figure 1: PD_manager mhealth platform overview.

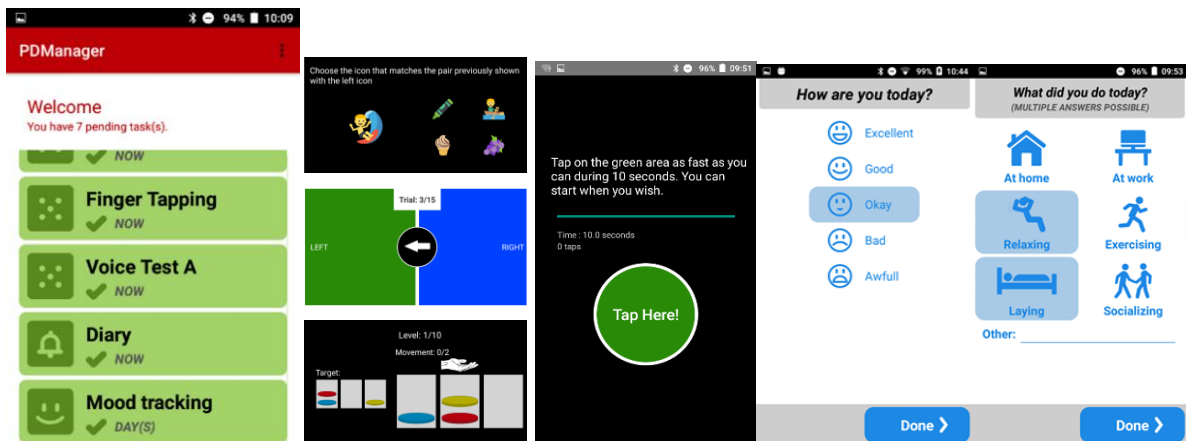


Figure 2: Screenshots from the patients' mobile application. From left to right: the list with the tasks the patient has to perform, some cognitive tests, the finger tapping test, mood monitoring diary.

During the pilot study, the participants were instructed to always carry the smartphone with them since the wristband needs to be paired with the phone through the Bluetooth connection for

transmitting and storing wristband data. Two optimization strategies were applied in order to reach the desired MS Band battery daily duration of 12-14 hours and address battery drain issues: a) by default, the application acquires data for a period of 5 minutes and then disconnects from MS Band (closing Bluetooth and therefore reducing significantly the MS Band power consumption) for a period of X minutes, where X is estimated based on the hours of the required recording interval which is customized in the application settings; b) when the patient removes the MS Band (detected with HR quality value) then the data acquisition is postponed. Moreover, study participants were instructed to use the system as much as possible during the waking day while performing daily activities and charge it just before going to sleep. The insoles had their internal storage capability.

The devices are unobtrusive. Their wearability, sensitivity and reliability were tested as part of an earlier proof of concept study (27) with 20 patients (5 Rome, 10 Venice, Italy; 5 Ioannina, Greece). This proof-of-concept study was supervised by neurologists in an in-hospital setting and involved short sessions (154 in total, each one lasting around 30') following a common protocol that included simulation of daily activities such as opening a door, drinking water, walking a few meters, rising from a chair and rising from the bed. The nutrition and physiotherapy modules were evaluated in separate studies (28).

The clinicians had their dedicated mobile app (see Figure 3) that enabled them to check the demographic and clinical information, assess the overall status of the patient, evaluate symptoms monitored during the pilot period and get decision support functionalities (29) on patients mobility.

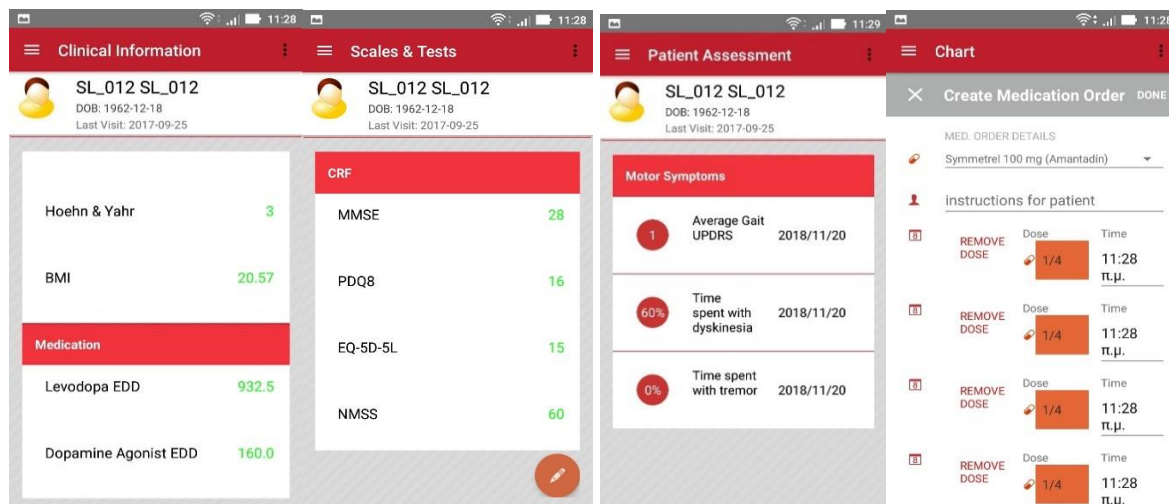


Figure 3: Screenshots from the clinicians' mobile app. From left to right: Overview of clinical information, scores from scales and tests, overview of motor symptoms as assessed by the PD_manager methods for the whole day and creating new medication orders. To ensure that there are no risks for the participants, we omitted the medication adherence module (both the mobile app and the pillbox) from the pilot.

1.4.3 Outcome definitions and statistical analysis

Feasibility assessment includes recruitment, compliance and evaluation of the processed sensor data utility for answering clinically meaningful questions. Recruitment success was analyzed by the total number of enrolled, consenting participants that completed the pilot study against drop-outs. Compliance was calculated as the total hours where band and smartphone sensors data were collected during the 14 days period, as well as number of days during which the participants used the system for at least one hour.

The statistical analysis investigates the effects of the patient demographics (age, gender, education), clinical symptoms (as depicted in NMMS and UPDRS), self-rated quality of life (PDQ8 and EQ-5D-5L), caregivers' demographics (age, gender, education) and burden (as captured with the short version of Zarit) on the system usage as reflected in the total usage hours over the 14 days data collection period by the devices for each participant. In this targeted analysis we have included only the 65 of the originally recruited 75 participants, for which duration of data collected is at least one day of the pilot period. The study data were analyzed by SPSS software (version 23, IBM Corporation, Armonk, NY, USA).

Compliance was not normally distributed. Correlations between compliance and the available at-baseline information for the participants were explored with Spearman's rank-order and Kendall's tau-b. Participants were then divided in low-moderate-high usage groups using the quartiles (the first quartile was the cut-off for the low compliant group and third quartile for the high compliant group) and taking into account qualitative information, mainly band usage - which was another metric available for compliance evaluation - for confirming the grouping. Significant differences in the distributions of usage between compliance groups were investigated with Kruskal-Wallis H test for the low-moderate-high groups.

To further investigate the factors affecting compliance, regression analysis was applied. Linear Regression determined how much of the variation in the usage is explained by the caregiver burden. Multiple Linear Regression determined how much of the variation in the system usage is explained by the caregivers' burden, Motor Aspects of Experiences of Daily Living and patients' self-rated health status. Binary Logistic Regression explored the effects of the same parameters on the likelihood of usage, predicting the moderate-high groups.

Validation of the tremor method was done with bivariate correlations between UPDRS items scored by the clinicians at baseline and the tremor score with our method were calculated with Pearson's. A Welch t-test was also run to determine if there were differences in scores between the no-tremor and tremor groups.

The statistical methods used in the analysis are depicted in Figure 4.

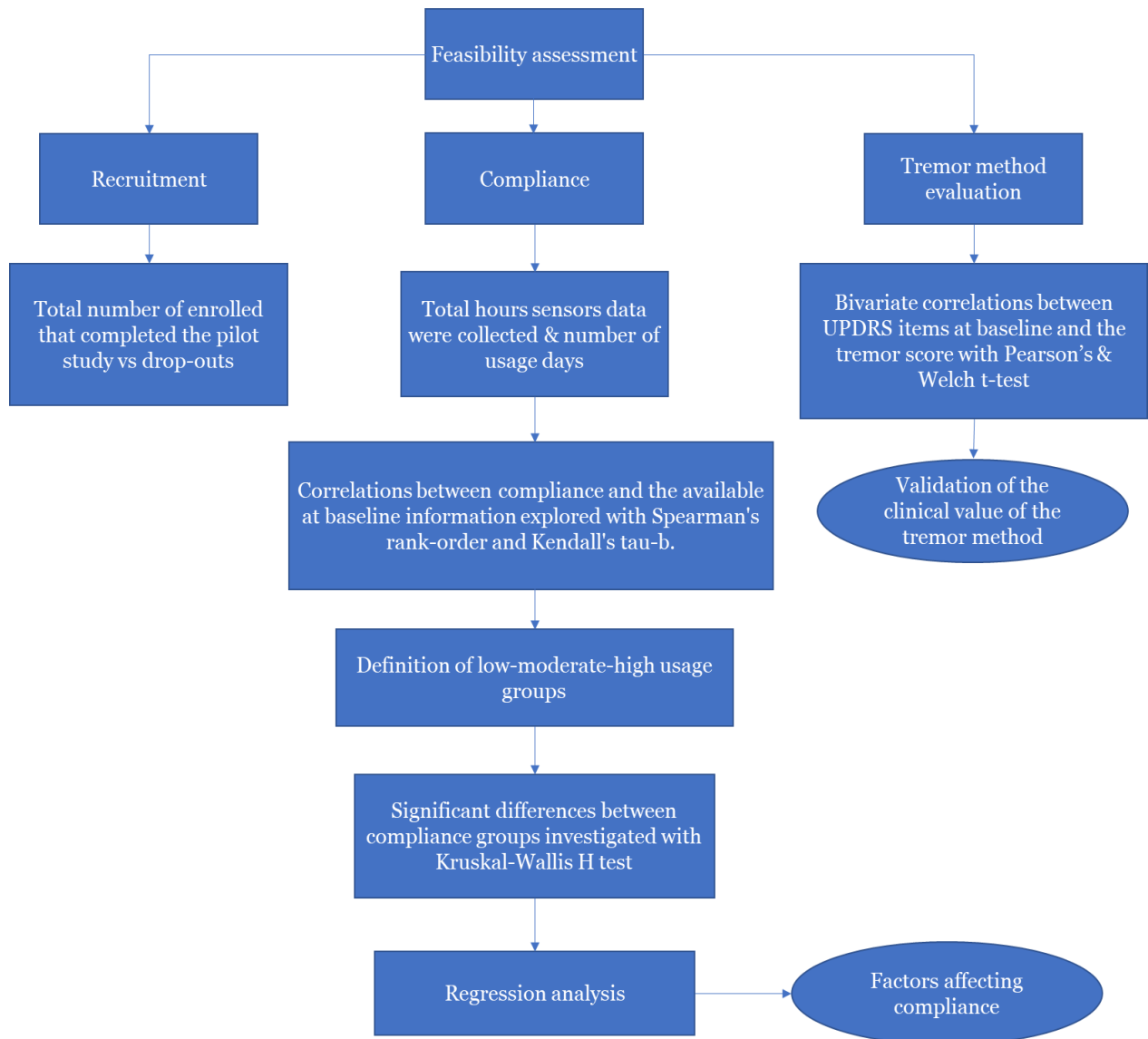


Figure 4: Outcome definitions and statistical analysis.

1.5 Results

1.5.1 Recruitment

From the 75 patients that were eligible and consented to participate in the study and were randomly assigned to the PD_manager group, 65 (87% of the group), were data providers with at least one day of system usage. The other 10 either chose not to use the system or due to technical reasons (Bluetooth disconnection) were unable to use it.

1.5.2 Compliance

The 65 data-contributors collected data for a median of 63,37 (Std. dev. 42,17) hours totally in the 14-days study period. i.e. 4,53 hours on average per day. They used the system for a median 11,57 days (Std. dev. 3,15). Only two of the study participants used the system for one day. All others used it for more than 6 days with 30 using it for the whole 14 days study period.

1.5.3 Sample characteristics and bivariate correlations

The study sample characteristics are presented in Table 3. Most participants had many symptoms as reflected in UPDRS total and sub-scores. Most study participants were men (almost 2:1), while for caregivers the reverse was observed (women 2:1). Caregivers were slightly more educated (11.96 years) compared to study participants (10.18), which can be explained from the fact that 27% were children or nephews. For the same reason the caregivers were younger (mean 60). UPDRS score (mean 56,45) is consistent with the severity of the condition. Participants did not have dementia (based on MMSE and iADL).

Table 3: Analysis of distributions between groups.

	High Group (N = 21)		Moderate Group (N = 28)		Low Group (N = 16)		Distribution $\chi^2(2)$, p (Kruskal Wallis)
	Mean (Std Dev.)	Correlation Coefficient, p (Spearman)	Mean (Std Dev.)	Correlation Coefficient, p (Spearman)	Mean (Std Dev.)	Correlation Coefficient, p (Spearman)	
Usage hours	108.29 (37.50)		58.93 (18.47)		19.19 (7.63)		-
Days of usage	13.52 (1.03)	0.103 (0.658)	11.21 (2.59)	-0.030 (0.880)	9.63 (4.40)	0.340 (0.198)	14.843 (0.001)
Caregiver age	60.00 (13.09)	0.188 (0.427)	58.38 (12.06)	0.171 (0.403)	63.50 (10.83)	-0.151 (0.639)	2.138 (0.343)
Caregiver education	10.89 (4.90)	-0.263 (0.276)	12.50 (5.02)	0.127 (0.536)	12.60 (4.20)	0.091 (0.802)	0.677 (0.713)
Caregiver gender	14 female, 7 male		14 female, 11 male, 3 missing		10 female, 4 male, 2 missing		1.057 (0.590)
Patient age	67.24 (6.71)	-0,232 (0.312)	67.67 (11.45)	0.186 (0.352)	67.69 (6.02)	-0.457 (0.075)	0.105 (0.949)
Patient gender	5 female, 16 male		14 female, 14 male		4 female, 12 male		
Patient education	9.50 (4.87)	-0.419 (0.066)	10.48 (4.23)	0.002 (0.992)	10.50 (5.07)	0.068 (0.803)	0.274 (0.872)

	High Group (N = 21)		Moderate Group (N = 28)		Low Group (N = 16)		
	Mean (Std Dev.)	Correlation Coefficient, p (Spearman)	Mean (Std Dev.)	Correlation Coefficient, p (Spearman)	Mean (Std Dev.)	Correlation Coefficient, p (Spearman)	Distributio n $\chi^2(2)$, p (Kruskal Wallis)
Disease duration	8.90 (5.04)	0.044 (0.854)	9.18 (4.67)	-0.080 (0.685)	8.44 (3.08)	-0.338 (0.200)	0.005 (0.998)
MMSE	28.32 (1.70)	0.577 (0.010)	28.79 (2.13)	0.174 (0.375)	28.40 (1.24)	-0.264 (0.343)	0.876 (0.645)
EQ-5D-5L Total	9.48 (3.63)	-0.203 (0.378)	10.54 (3.42)	0.056 (0.778)	9.87 (2.70)	-0.132 (0.640)	0.988 (0.610)
NMSS Total	42.09 (29.43)	-0.163 (0.480)	44.00 (34.85)	0.210 (0.292)	39.07 (17.62)	0.296 (0.305)	0.195 (0.907)
PDQ8 Total	41.25 (18.41)	-0.098 (0.681)	43.29 (23.95)	0.190 (0.343)	39.58 (17.30)	0.324 (0.239)	0.179 (0.914)
UPDRS I Total	10.81 (6.65)	-0.053 (0.818)	11.11 (5.42)	0.119 (0.547)	11.00 (4.40)	-0.170 (0.561)	0.280 (0.869)
UPDRS II Total	13.14 (9.14)	-0.039 (0.867)	10.54 (7.39)	0.349 (0.068)	8.36 (6.01)	-0.313 (0.276)	2.425 (0.297)
UPDRS III Total	29.67 (17.46)	-0.079 (0.733)	28.85 (15.28)	0.199 (0.319)	25.67 (13.93)	0.083 (0.768)	0.540 (0.763)
UPDRS IV Total	5.76 (3.90)	0.232 (0.312)	5.93 (4.60)	0.074 (0.710)	5.58 (3.44)	0.441 (0.115)	0.053 (0.974)
UPDRS Total	59.38 (30.74)	0.022 (0.924)	56.70 (28.10)	0.213 (0.286)	51.57 (24.67)	-0.076 (0.795)	0.682 (0.711)
Zarit Total	14.67 (9.90)	0.283 (0.213)	8.92 (6.93)	0.206 (0.313)	10.64 (7.22)	-0.202 (0.489)	4.290 (0.117)
EQ-5D-5L item 4 (pain/ discomfort)	1.81 (0.87)	-0.072 (0.758)	2.64 (0.95)	-0.110 (0.579)	2.33 (0.90)	0.112 (0.692)	8.519 (0.014)
NMSS item 11 (flat moods)	1.33 (1.96)	0.105 (0.650)	1.07 (2.22)	0.179 (0.371)	0.071 (0.27)	-0.069 (0.815)	7.353 (0.025)

	High Group (N = 21)		Moderate Group (N = 28)		Low Group (N = 16)		Distribution $\chi^2(2)$, p (Kruskal Wallis)
	Mean (Std Dev.)	Correlation Coefficient, p (Spearman)	Mean (Std Dev.)	Correlation Coefficient, p (Spearman)	Mean (Std Dev.)	Correlation Coefficient, p (Spearman)	
NMSS item 26 (problems having sex)	2.24 (4.19)	-0.308 (0.174)	0.82 (3.14)	0.115 (0.569)	0.36 (1.08)	0.094 (0.749)	6.192 (0.045)
PDO8 item 7 (painful cramps or spasms)	1.7 (1.22)	-0.005 (0.985)	2.59 (1.48)	0.026 (0.896)	2.27 (1.23)	0.510 (0.52)	6.164 (0.046)
UPDRS item 21 (speech)	1.43 (1.03)	-0.092 (0.693)	0.75 (0.93)	0.140 (0.479)	0.57 (0.76)	0.134 (0.649)	8.433 (0.015)
UPDRS item 33a (rigidity)	1.19 (0.98)	0.362 (0.106)	0.54 (0.64)	0.074 (0.707)	0.73 (0.80)	-0.037 (0.895)	6.489 (0.039)
Zarit item 8 (social life suffered)	1.29 (1.19)	0.239 (0.296)	0.62 (0.80)	0.159 (0.439)	0.43 (0.76)	-0.127 (0.664)	7.319 (0.026)

1.5.4 Determinants of compliance

A Kruskal-Wallis H test was run to determine if there were differences in usage between patients' groups (low, moderate and high usage) based on demographics and total scores as well as on their scoring in the ordinal variables which are indicating symptoms (NMSS and UPDRS items), quality of life aspects (PDO8 and EQ-5D-5L items) and caregiver burden reasons (Zarit items). The distributions of usage were significantly different between groups for specific items of the scales and not for the total scores (Table 3).

A linear regression was run to understand the effect of caregivers' burden on system usage. Linearity was assessed with a scatterplot of Zarit_total against system usage in which the regression line was plotted. Visual inspection of these two plots indicated a linear relationship between the variables. There was homoscedasticity and normality of the residuals. There were no outliers.

The prediction equation was: usage = 48.31 + 1,51 * Zarit_total. Zarit_total statistically significantly predicted usage, $F(1, 59) = 5.86$, $p < .019$, accounting for 30% of the variation in usage with adjusted $R^2 = 7.5\%$, a small size effect according to Cohen.

A multiple regression analysis was run to determine how much of the variation in the system usage can be explained by the caregivers' burden (Zarit total), Motor Aspects of Experiences of Daily Living (M-EDL, UPDRS-PART II) and patients self-rated health status (EQ-5D-5L).

There was linearity as assessed by partial regression plots and a plot of studentized residuals against the predicted values. There was independence of residuals, as assessed by a Durbin-Watson statistic of 1.855, and homoscedasticity, as assessed by visual inspection of a plot of studentized residuals versus unstandardized predicted values. There was no evidence of multicollinearity, as assessed by tolerance values greater than 0.1. There were no studentized deleted residuals greater than ± 3 standard deviations and values for Cook's distance above 1 as well as Leverage values greater than 0.2 (outliers). The assumption of normality was met, as assessed by a Q-Q Plot. The multiple regression model statistically significantly predicted Usage, $F(3, 56) = 5.650$, $p = .002$. R for the overall model was 48.2% with an adjusted R^2 of 19.1%, a medium size effect according to Cohen. All three variables added statistically significantly to the prediction, $p < .05$. Regression coefficients and standard errors can be found in Table 4.

Table 4: Summary of Multiple Regression Analysis.

Model	B	Std. Error B	Beta	p (Significance)
(Constant)	89.084	16.345		.000
EQ_5D_5L_Total	-6.022	1.925	-.465	.003
Zarit_Total	1.651	.687	.331	.020
UPDRS_II_Total	1.757	.847	.326	.043

B = Unstandardized Regression Coefficient, Std. Error_B = Standard error of the coefficient, Beta = Standardized Coefficient

A binomial logistic regression was performed to ascertain the effects of caregivers' burden (Zarit total), Motor Aspects of Experiences of Daily Living (M-EDL, UPDRS-PART II) and patients' self-rated health status (EQ-5D-5L) on the likelihood of high system usage. Linearity of the continuous variables with respect to the logit of the dependent variable was assessed via the Box-Tidwell procedure. A Bonferroni correction was applied using all eight terms in the model resulting in statistical significance being accepted when $p < .00833$. Based on this assessment, all continuous independent variables were found to be linearly related to the logit of the dependent variable. There was one standardized residual. The logistic regression model was statistically significant, $\chi^2(3) = 13.464$, $p = .004$. The model explained 33.3% (Nagelkerke R^2) of the variance in usage and correctly classified

74.5% of cases. Sensitivity was 80.8%, specificity was 66.7%, positive predictive value was 75.0% and negative predictive value was 73.3%. Of the three predictor variables, two were statistically significant: caregivers' burden and patients' self-rated health status as shown in Table 5. Users with increasingly worsening self-rated health status had 1,5 times higher odds to exhibit higher system usage. Moreover, increasing caregivers' burden was associated with a reduced likelihood of higher system usage.

Table 5: Summary of Binary Logistic Regression.

	B	Std. Error B	Wald	df	p (Significance)	Odds ratio
EQ_5D_5L_Total	.396	.158	6.252	1	.012	1.485
UPDRS_II_Total	-.088	.057	2.395	1	.122	.916
Zarit_Total	-.122	.053	5.186	1	.023	.885
Constant	-1.294	1.119	1.338	1	.247	.274

B = Unstandardized Regression Coefficient, Std. Error_B = Standard error of the coefficient, Wald = Wald chi-square test, df = degrees of freedom for the Wald chi-square test

1.5.5 Clinically meaningful data with ecological validity

The method for the evaluation of tremor was presented in (30). The limitation of this method was that the validation of accuracy was done with annotations by clinicians over specific, short periods in the controlled environment of a clinic, following a specific protocol (27). In this first data collection study, the sessions were filmed in order to validate the annotations with external observers. With the data collected in the pilot study presented here, we were able to evaluate whether the method works for patients performing daily activities. Video at home was excluded due to study participants' privacy concerns. The annotation was the perceived tremor as depicted in UPDRS item 2.10 (which indicates how the patient experienced tremor over the past week), the rest tremor amplitude in the left and right upper extremity as depicted in UPDRS item 3.17 (which allows the rater to gather observations on rest tremor that may appear at any time during the exam) and the constancy of rest tremor as depicted in UPDRS item 3.18 (which focuses on the constancy of rest tremor during the examination period when different body parts are variously at rest). All UPDRS items were assessed at the baseline visit, i.e. before the pilot usage of the system. Maximum of 3.17a and 3.17b referring to rest tremor amplitude in upper extremities was also estimated as part of the analysis.

50 cases were included in tremor analysis since for these cases more than 30 hours of sensor data were available from the pilot study and the results can be considered as reliable. The tremor was constantly evaluated at any moment data were available from the system with the method presented

in (30) and this is the score depicted in Table 6. Bivariate correlations between UPDRS items scored by the clinicians at baseline and the tremor score with our method were calculated with Pearson's.

We notice that the mean score for no tremor is close to zero. This is due to the fact that some daily movements can simulate tremor and, as explained, the score was constantly calculated. Consistently, we noticed a small increase of mean score for slight tremor and a more significant increase for mild and moderate tremor.

A Welch t-test was run to determine if there were differences in scores between groups and statistically significant differences confirm the discrimination between the no-tremor and tremor groups.

Moreover, there is a statistically significant, strong positive correlation between the tremor score and amplitude and constancy of tremor as evaluated at baseline by the clinicians and a moderate positive correlation with tremor as perceived by the patient.

Table 6: Correlations between UPDRS tremor related items and our tremor method scores.

	2.10 (tremor as perceived by the patient)	3.17-a (rest tremor amplitude – right upper extremity)	3.17-b (rest tremor amplitude – left upper extremity)	Max 3.17
# of cases with UPDRS=0	21	39	38	32
Mean Score for UPDRS=0 with our method	0.038	0.073	0.066	0.037
Std. Dev. for UPDRS=0 cases	0.034	0.156	0.116	0.032
# of cases with UPDRS=1	18	8	8	12
Mean Score for UPDRS=1 with our method	0.123	0.184	0.22	0.128
Std. Dev. for UPDRS=1 cases	0.226	0.248	0.329	0.172
# of cases with UPDRS>1	11	3	4	6
Mean Score for UPDRS>1 with our method	0.267	0.538	0.421	0.54
Std. Dev. for UPDRS>1	0.33	0.383	0.383	0.377
AUC	0.643	0.887	0.783	0.871
Welch's T-test, p-value for UPDRS=0 and UPDRS >1	0.005	<0.001	<0.001	<0.001

Welch's T-test, p-value for UPDRS=0 and UPDRS =1	0.108	0.117	0.03	0.008
Pearson Correlation	0.378	0.544	0.468	0.711
Pearson p-value	0.007	<0.001	<0.001	<0.001

1.6 Discussion

1.6.1 Principal Results

The most important finding of our study is that patients with moderate PD, regardless of their age, gender, education, severity of symptoms, specific symptoms, perceived quality of life, caregiver burden etc. were compliant with the use the system for 1-2 weeks. Overall, 87% of study participants (65 of the enrolled 75) were data contributors for 4,53 hours on average per day. They used the system for a median 11,57 days (Std. dev. 3,15).

Regarding the compliance determinants, the regression analysis suggests that the best predictor associated with system usage was caregiver burden. The higher the burden the higher the usage, a finding emphasizing the role of caregivers in adherence to mHealth solutions including wearables. Moreover, the deterioration of caregiver's social life seemed to be the most influential factor among Zarit items. The implication of these findings is that the moderate usage group demonstrated the lower caregiver burden.

Motor Aspects of Experiences of Daily Living (M-EDL, UPDRS-PART II) also affect the usage of the system with users facing several motor problems in their ADL belonging to the high usage group and the rest decreasingly in the moderate and low groups. Especially speech problems seem to discriminate groups. Moreover, patients self-rated health status seems to predict high and moderate usage. Feeling pain/discomfort was the strongest individual predictor.

Another objective of the study was to collect data that are clinically meaningful, i.e. data that the clinicians can use for the monitoring and the evaluation of symptoms when the patient is in his or her home environment. In this study we provide evidence of clinical validity and ecological effect of an algorithm derived from a single sensor on the wrist for detecting tremor in PD patients. The applications of such monitoring methods include patients that cannot properly report their symptoms either because they are newly diagnosed or because they find it difficult to characterize tremor or even differentiate tremor from dyskinesias.

Following the paradigm of recent studies, PD_manager has built a large database for future development and testing of novel algorithms applied to sensor-derived data from PD patients during

daily functioning. In total more than 2.700 hours of useful sensor data from the smartphone and MS band were collected and can be used for evaluating gait, freezing of gait, bradykinesia, tremor and dyskinesia or monitoring and evaluation of fluctuations in future studies.

1.6.2 Comparison with Prior Work

This study contributes to the growing evidence about the feasibility of mhealth for PD patients. It is aligned with the findings that there are no noteworthy variances in baseline characteristics (age, gender, education, disease duration and severity) that can explain compliance even in larger studies (15). Findings such as highest compliance of older participants in one study (14), which can be attributed to more severe disease status and increased need for better management, and a negative impact of patients' and caregivers' education in this study, which can be the result of the lack of direct feedback from the system leading to limited self-management value, are worthy of further exploration.

By including patients with moderate disease severity (H&Y was 3) and by exploring the determinants of their compliance, PD_manager complements most prior studies that recruited mostly the patients mildly affected (H&Y was 2 or less) (14-16, 19, 20). The high level of system usage and compliance of these more affected patients, as in previous studies, can be linked to factors including the simple and passive design of the patient's app, which was basically providing a series of reminders for short motor and non-motor tasks, the insight in the condition that the patients and their caregivers expect as a result of using the system and the fact that the technology is considered as an extension of prescribing clinicians and thus as very important for better care. PD_manager was used as a "PD-Holter", i.e. in a similar context as (11, 16, 20) and it complements the findings from previous studies (12, 14, 15, 22) which suggest that mhealth systems could be used both for short (1-2 weeks) and for long (6 months) term monitoring of PD patients.

Moreover, our findings are consistent with the recent studies (31) showing patients' attitude to technology use (32). Our mhealth platform, as relevant studies suggest, can be an effective tool for the passive, unobtrusive monitoring and evaluation of symptoms (33), for defining new phenotypical biomarkers (34), for the detection of serious events such as falls (35), for the detection of worsening in the overall health status of the patients as well as for the provision of better disease management and improved care (36), the latter being already extensively studied in ongoing clinical trials (e.g. NCT03741920 and NCT02657655). Mobile health may also help rehabilitation (17, 18) and facilitate telemedicine since it enables home-based (37), multidisciplinary (38) approaches for the management of PD. Complemented by video calls mhealth medical devices seem to be very efficient

for the management of patients (39). Moreover, the system could be used for connecting and sharing health data promoting research in Parkinson's (40), in line with EU priorities for enabling the digital transformation of health and care. Empowering citizens and promoting self-management is another important benefit of mhealth for PD patients (22). Finally, mhealth can be used to provide decision support on the need for advanced treatments and their titration when they are applied (41).

1.6.3 Limitations

Limitations include the number of patients that used the system which, despite their excellent stratification that was preferred in this study over extended recruitment, should be increased in future studies to further establish the findings. The relatively preserved cognitive condition of study patients could be considered a limitation since cognitive deficits are common in advanced PD. Compliance was not calculated as the median percentage of the study period where accelerometer data were collected as in previous studies because the designs are different, and the technology limitations imposed a rather personalized usage of the system during the waking day. Another limitation is that compliance should also be assessed in repeated 10-14 days periods, at least twice a year, as the clinically meaningful use would demand, to evaluate the long-term effects in patients' care. Finally, more workshops with clinicians for improving the use of the system in clinical practice are required.

1.7 Conclusions

mhealth for monitoring of PD patients' symptoms is feasible, at least for a period of 2 weeks. With the data collected with mhealth, ecologically valid, accurate and objective monitoring and evaluation of tremor and other symptoms is feasible and future studies should confirm its efficiency to support clinical decisions and improve patients' management. Future mhealth systems should take into consideration and address the determinants of mhealth usage which include the subjective caregiver burden and especially the impact on social life, the self-evaluation of the activities of daily life (ADLs) including speech and the overall patients' self-rated health status with emphasis in pain and discomfort.

2 Design of a clinical decision support system powered by mhealth for the management of Parkinson's disease

2.1 Introduction

The management of Parkinson's disease is largely symptomatic and relies, apart from the clinical examination to the reporting of symptoms by the patients and their relatives during the visits which take place every 3 to 6 months in most European healthcare systems. Thus, the ability to continuously report symptoms and assess the response to medication is of paramount importance for a personalized and optimized treatment.

Fortunately, it is anticipated that within a few years, most PD patients will use patient portals (42-45) especially as the security and user friendliness barriers are addressed. Moreover, interoperable and substitutable mhealth technology that can also interact with their Electronic Health Records (EHR) (46) in order to update the information about their symptoms in daily basis thus enabling individualized treatment approaches (47) is gaining interest (48, 49). Specifically for patients with Parkinson's, the feasibility of mhealth has been extensively discussed and established in chapter one of this thesis.

Clinical decision support systems (CDSS) (50) on the other hand are tools developed for clinicians. CDSS are intended to improve healthcare delivery by enhancing medical decisions with targeted clinical knowledge (deriving from clinical practice Guidelines, as well as machine learning for instance for identifying similar cases from the EHR repository), patient information (monitoring and evaluation of motor symptoms with medical devices, self-reporting of non-motor symptoms with patient portals), and any other relevant health information (e.g. medication, adherence to treatment plans, self-perceived health disease status etc. also through the patient portal).

2.2 Aims and objectives

Herewith, we present the process for the design of the powered by mhealth, CDSS PRIME. The primary objective of PRIME is to provide a personalized medicine approach for the management of Parkinson's disease that complements symptomatic treatment by adopting a holistic strategy which takes into account genes, clinical subtypes, neuroimaging, lifestyle, co-morbidities etc. The secondary goal is to use mhealth, mainly a patient portal implemented as a mobile app and Internet of Things devices (medical and non-medical) to improve the knowledge about the individual course of the disease and the response to treatment so as to support tailored self-management approaches. PRIME will demonstrate that mHealth together with clinical decision support are feasible and can be

combined in order to improve disease management and care. In this thesis we present mainly how PRIME was designed.

2.3 Methods

For the CDSS definition a narrative literature review took place, within which more than 100 articles were screened with only one being qualified as most relevant to PRIME since the others concerned decision support for specific symptoms and not a system. Then the findings were analyzed by a Movement Disorders Expert (Prof Konitsiotis who supervised this thesis) and two experienced software engineers (Dr G. Rigas and PhD candidate D. Gatsios) and a consensus on the core requirements of the PRIME CDSS functionality and dashboard was reached. Accordingly, the information flow was defined, and the main components were designed and developed.

2.4 Results

2.4.1 PRIME CDSS overview

The clinical decision support system (CDSS) is intended to improve healthcare delivery by enhancing medical decisions with targeted clinical knowledge (with clinical Guidelines, as well as machine learning for identifying similar cases from the EHR repository), patient information (monitoring and evaluation of motor symptoms, self-reporting of non-motor symptoms), and other health information (e.g. medication, adherence to treatment plans etc.). PRIME can be characterized as a traditional CDSS in the sense that it is comprised of software designed to be a direct aid to clinical-decision making, in which the characteristics of an individual patient (deriving from EHRs, mobile devices and self-reported data) are matched to a computerized clinical knowledge base (derived from Guidelines) and patient-specific assessments or recommendations are then presented to the clinician for a decision through a dedicated user interface (51). PRIME will primarily be used at the point-of-care, for the clinician to combine their knowledge with information or suggestions provided by the CDSS. CDSS will also have the capability to leverage data and observations otherwise unobtainable or uninterpretable by humans and produce appropriate alerts for the end users.

PRIME will make use of web-applications and integration with electronic health records (EHR), as well as devices that may or may not produce outputs directly on the device or be linked into EHR databases in agreement with recent development in the field (52).

PRIME will be a hybrid knowledge-based or non-knowledge based CDSS. It will include:

- knowledge-based modules (using literature-based and practice-based evidence), with rules (such as IF-THEN statements), with the system retrieving data to evaluate the rule, and producing an action or output
- non-knowledge based modules in which the decision leverages sensor data processing and machine learning (ML) to follow expert medical knowledge, especially for the monitoring and assessment of motor symptoms.

Both types of CDSS have anyway common components a few differences as illustrated in Figure 5.

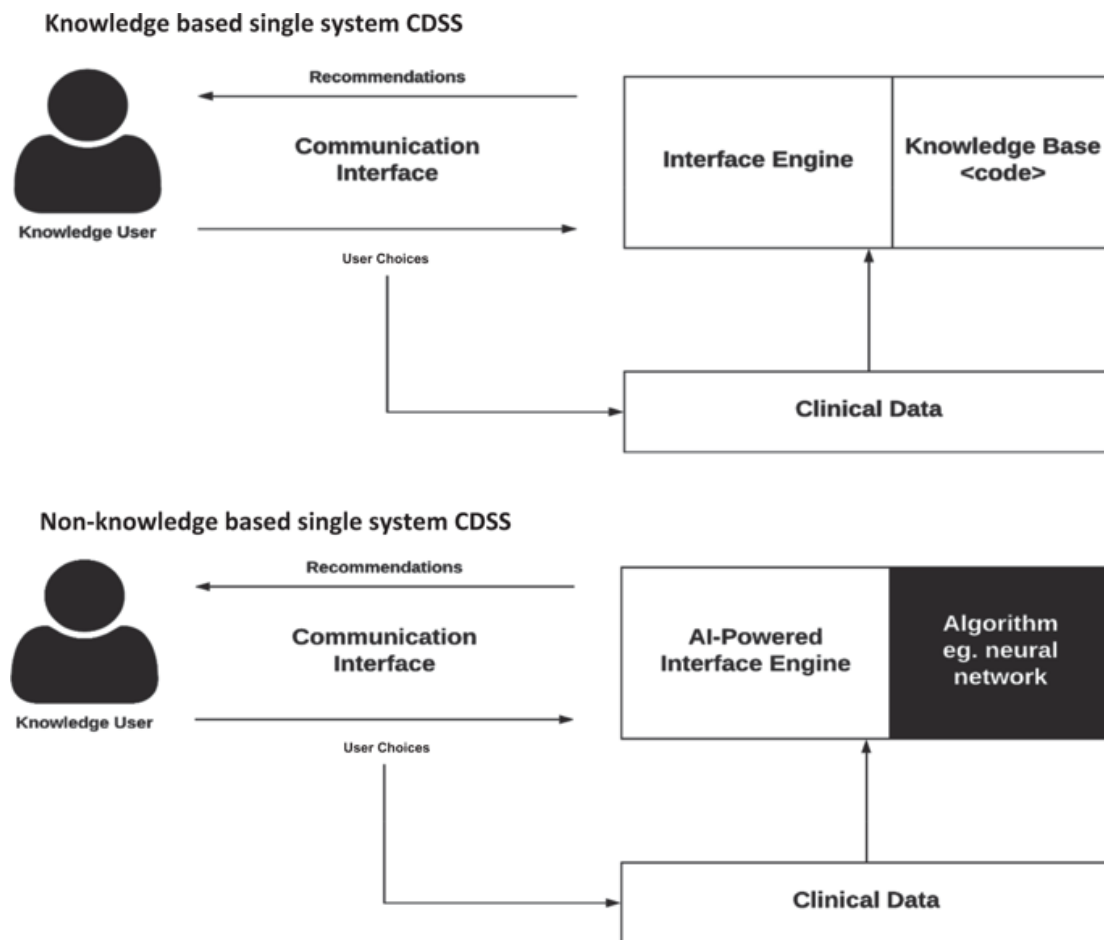


Figure 5: Diagram of key interactions in knowledge-based and non-knowledge based CDSS (copied from Sutton et al., 2020).

2.4.2 Defining the PRIME CDSS Functionality

PD_manager (25, 26, 53), to the best of our knowledge, is the only holistic mHealth CDSS for PD as the other systems target specific symptoms. The design of PD_manager (54) which was based on three different studies of user needs and requirements with users from Greece, Slovenia, Italy and the UK, constitutes the main source of requirements and design also for PRIME. In fact, the resulting

treatment DSS (29), apart from indicating that the experts-based models are applicable for making "second-opinion" suggestions to clinicians, provided important lessons for the design of PRIME. The required functionality of any CDSS as comprehensively presented by Sutton et al. (50), complemented the other methods adopted for the definition of the PRIME CDSS the main functionality of which is included in Table 7.

Table 7: PRIME CDSS Functional Requirements.

FUNCTIONS OF CDSS	HOW THEY ARE ADDRESSED IN PRIME
Patient decision support	<p>PRIME will integrate certified devices that are passively monitoring patients' symptoms and practically the patients will only need to activate them and then only charge them. Based on the lessons learnt from the PD_manager study, it was decided to integrate for the needs of the CDSS only medical devices, i.e. devices certified and having as intended use the monitoring of symptoms. Integration of IoT devices (IMUs, smart insoles, iwatch) for the research needs of other neurological conditions, will also be implemented but with lower priority and for future research studies.</p> <p>Patient Reported Outcomes (PROs) ranging from Activities of Daily Life (ADL) to adherence to medication, will be asked with notifications in the mobile app that the patients will access with one-click and will then have drop down menus so that it is clear what kind of data are expected. PROs will include the UPDRS portion which assesses the non-motor impact of Parkinson's disease (PD) on patients' experiences of daily living and specifically Part IB which is the self-administered component consisting of seven questions. Part II - Motor Aspects of Experiences of Daily Living (13 questions), also self-reported will be implemented as well.</p> <p>Moreover, PRIME will enable shared decision making with visualizations that the patients and caregivers can understand that will be used during visits.</p>
Patient Safety	<p>Polypharmacy is very common in PD. Medical treatment targeting the dopaminergic system alone may include up to five different compounds: L-DOPA (in combination with a DOPA decarboxylase inhibitor), a catechol-O-methyltransferase (COMT) and a monoamine oxidase (MAO-B) inhibitor and a dopamine agonist. Particular motor and non-motor symptoms may require additional specific therapeutics, such as drugs aimed at tremor control and to treat depression, dementia and orthostatic and autonomic dysfunction.</p> <p>Possible drug interactions, especially in patients with comorbidities, will be explored on the valid and up to date DrugBank (www.drugbank.ca) which is a unique resource of bioinformatics and cheminformatics that combines detailed data on drugs and their interactions. Possible drug-gene interactions will be checked with databases such as DGIdb (www.dgldb.org). These mechanisms will also work offline and will be updated regularly.</p>

FUNCTIONS OF CDSS	HOW THEY ARE ADDRESSED IN PRIME
Clinical management & Diagnostics support	<p>It will be implemented with Guidelines and ontologies. The ontology of PD, named PDON (55), represents the relevant terminology for Parkinson's disease in a standard, compact, computer-readable format that can be further processed, be enriched and also used for the construction, representation and automatic expansion of the PRIME CDSS. The medical knowledge will be derived primarily from the Guidelines of the International Parkinson and Movement Disorder Society (MDS) (56, 57), as well as from NICE Guidelines.</p> <p>Moreover, similar cases extracted with machine learning methods from the EHR repository will indicate possible diagnosis and prognosis based on patients' baseline (or current) characteristics.</p>
Interoperability	<p>PRIME will establish repeatable conventions with a FHIR API (see the specification in www.hl7.org/fhir) in order to enable the exchange of data between the EHR and the CDSS and to expose the recommendations from the backend to the EHR. Additionally, historical data, imaging, previous diagnoses, treatments, etc. will be available from the connection with any FHIR compliant EHR and the integration with DICOM compliant RIS and PACS.</p>
Administrative function/automation	<p>The adopted EHR on top of which the CDSS will be implemented will be integrated with the Greek e-Prescription system.</p> <p>Moreover, the EHR suite provides administrative support and integration with public insurance, it uses ICD10 coding etc. Availability of the FHIR API ensures expandability.</p>
Workflow improvement	<p>Iterative evaluations of usability and pilot testing are planned before the release since the integration in the current clinical workflow is a must for the adoption of PRIME.</p> <p>The CDSS adopts as fundamental principles reportability, auditing, interoperability and access (availability as a web service).</p>

2.4.3 PRIME CDSS Dashboard Requirements

After defining the main functionality, we have also analyzed and reported the dashboard requirements which are included in Table 8 and are expected to be further adapted and enriched during the development process and after iterations with clinicians. Empowerment of shared decision making, addressing the varying needs and approaches of clinicians and integration of heterogeneous information are the main design principles.

Table 8: Dashboard requirements.

Nr.	The dashboard shall:
UR1	Offer discrete and standardized neurologic examination documentation options

Nr.	The dashboard shall:
UR2	Enable tracking of changes to neurologic examination findings or severity (summary)
UR3	Automatically integrate patient portals and import patient reported outcomes (PROs)
UR4	Incorporate PD specific clinical data (neuroradiology, neurophysiology)
UR5	Present to the clinicians similar to the one being assessed patients' cases
UR6	Provide clinicians with suggestions based on Guidelines (MDS, NICE) to guide their diagnosis, visualizing relevant historical data, e.g. from motor fluctuations
UR7	Show non-motor and motor symptoms in common and informative graphs, whenever possible
UR8	Provide drill down capabilities to enable the clinicians get insight in specific timeframes, e.g. using a calendar-like module, also supporting comparisons
UR9	Present in a single view info for symptoms and medication adherence to enable the prescribing clinicians correlate them
UR10	Present the specific symptoms, comorbidities and timeframes of interest for each patient instead of providing standardized views
UR11	Provide a tool with medication options based on MDS and other evidence-based clinical Guidelines to support their treatment decisions
UR12	Include drug-drug interactions, drug -gene interactions (whenever data on genetics is available) to support prescribing
UR13	Include the up-to-date list of the prescribed pharmacotherapy and supporting therapy plans
UR14	Include adherence to pharmacotherapy and supporting therapy plans
UR15	Enable the monitoring and evaluation of changes in the pharmacotherapy and supporting therapy plans to provide an improved treatment plan
UR16	Provide (optionally) ecologically valid summary activity and sleep data
UR17	Enable data sharing among clinicians involved in the multidisciplinary care of patients (where applicable)

2.4.4 PRIME platform overview

As depicted in Figure 6, the platform consists of an IoT API that fetches data from different mhealth medical and experimental devices for the evaluation of motor symptoms. The collected data are temporarily stored in the mobile app along with patient reported data. The aggregated information is permanently stored in the backend and are available in the EHR. The CDSS component provides the described in Table 7 functionality which is available for the clinicians in their dashboard (see Table 8).

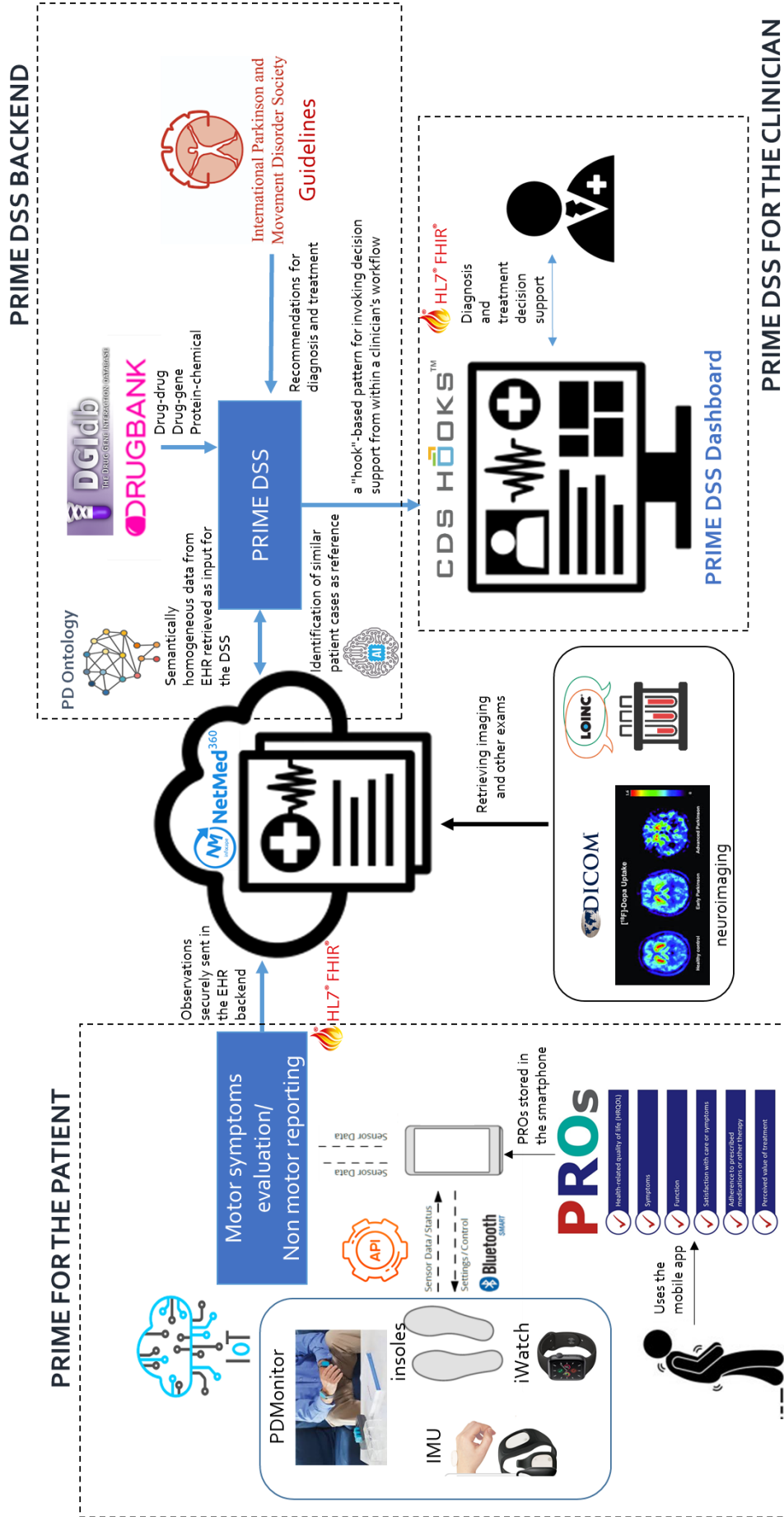


Figure 6: PRIME platform main components.

2.5 Discussion – Future work

From the neurologist's perspective, the interoperable (FHIR compliant) PRIME aims to support decisions related to the confirmation and revision of diagnosis and the optimization of pharmacological treatment. The EHR, a patient portal and wearable medical devices are the sources of heterogeneous information on the patient. Machine learning methods and the clinical evidence (derived from Clinical Guidelines) are the basis of the DSS backend. Integration with e-prescription systems incorporating drug interaction DBs further ensure the safety of the patient. Patient-specific recommendations are then presented to the clinician through a well-designed dashboard developed to support decisions.

Future work includes the finalization of the backend and of the interfaces, i.e. the patient portal and the clinicians' dashboard. Then, the main hypothesis, which is that mhealth and CDSS are feasible and acceptable to end users and can improve the management of Parkinson's, will be evaluated within a proof-of-concept study.

3 Exploring the knowledge and views of Greek Neurologists regarding Palliative Care Topics

3.1 Introduction

Although there is a growing awareness of palliative care for neurological and other chronic disability-related disorders, there remains a substantial unmet need in most parts of the world. As the scale of life expectancy and the ageing population increases globally, so is the proportion of patient with neurological disorders associated with disability. Unfortunately, patients with chronic neurological disorders have no hope of a cure, as the disease progresses. Thus, there is an impending need to apply palliative care, and symptom management approaches from the disease's early stages. According to the Lancet's call for action (2019) "As the world population ages, comorbidity also increases. A shift from a health system centered in medical specialties to person-centered care is required (58).

PD is a complicated, unpredicted, and debilitating disease. Patients living with PD, along with their caregivers, need guidance for decision making and planning throughout the course of the disease (59). Patients need to be treated substantially, based on their profiles, and adapting the information according to the disease's stage and the mentality of each patient. Thus, care must respect and meet the preferences and values of individual patients (60). Healthcare services should aim to improve patients' and caregivers' quality of life and to provide emotional support and information as the disease progresses (61).

People who provide care to PD patients and support them for an extended period play a vital role in their lives. Carers have never received formal training and inevitably they lack skills and knowledge. For this reason, they should have at their disposal all the means deemed necessary to handle the difficulties of the disease. Furthermore, they need to be regularly informed and have access to relevant information so that they can learn to deal with stressful situations that are more common in the later stages of the disease (62).

On the other hand, the needs of healthcare providers require more specialization. Due to insufficient knowledge of palliative care, their training should include understanding of the principles of palliative care and learning fundamental palliative care skills (63, 64). It is also important for health care professionals to develop their communication skills due to sensitive conversations with their patients concerning the diagnosis and issues such as discussing a patient's wishes, or symptoms' management (65).

3.2 Aims and objectives

To explore Greek neurologists' knowledge of Palliative care, based on a preliminary version of a curriculum toolkit for Palliative Care education in Parkinson's disease and to use their feedback for revising the curriculum topics. The toolkit aims to benefit patients in need of palliative care through promoting health literacy and further educating healthcare providers. The final toolkit (presented in Chapter 4) provides all the necessary information that can become sufficient knowledge and ultimately translate into clinical practice skills.

3.3 Methods

3.3.1 Presentation of the preliminary version of the educational toolkit

The toolkit development was led by Dr Piret Paal, as part of the EU-funded project 'Palliative Care in Parkinson's Disease' – PD-PAL. This initial curriculum design was largely based on the results of a recent, relevant survey conducted among European palliative care educators and clinicians (66). The evaluation of the resulting training content and course modules which demonstrated performance gain on all items considered (67) as well as the assessment of palliative care education related recommendations and publications (68-71) and the results of previous projects on education for PD (72, 73) led to the first version of the curriculum.

Initially, it covers three key topics/fields starting with Introduction to Palliative Care, continuing with Parkinson's Disease and finally covering Late-Stage Parkinson's Disease & Palliative Care.

For Palliative Care (Table 9), an effort was made to cover critical concepts like its' philosophy, policy, and definitions, as well as the ability to demonstrate the complex symptom assessment and management competencies. Continuing with designing care plans tailored to patients and families wishes seeking to incorporate multi-professional and interdisciplinary approaches and ultimately the use of communication strategies.

Table 9: Preliminary toolkit version: INTRODUCTION TO PALLIATIVE CARE topics.

Learning Objectives	Knowledge and Understanding	Practical Skills	Personal Competencies
Palliative care philosophy, policy and definitions	Palliative care principles. Multi-dimensionality of human-being.	Accepting death. Acceptance of non-ideal outcomes.	Palliative care offers comfort.
Ability to demonstrate the complex symptom assessment and	Assessment, control and management.	Symptom management skills.	Assisting the patient and caregivers.

Learning Objectives	Knowledge and Understanding	Practical Skills	Personal Competencies
management competencies	Use of validated tools, such as Zarit. Shared decision-making.		
To design care plans accordingly to patients' and families' wishes integrating multi-professional and interdisciplinary approaches	Communication. Patient and caregiver support. Juridical/Ethical consideration (country specific)	Care Planning based on needs assessment. Advanced Care Directives.	Acceptance of autonomy. Value the roles of all interdisciplinary team members.
Using communication strategies	Taking care of self.	Communication skills. Self-reflection skills.	Willingness to develop oneself as a helper.

About Parkinson's Disease (Table 10), the toolkit addresses the issues of the disease and related disorders starting from some global facts about PD, its symptoms, its causes. Follows the diagnosis and timely integration of Palliative Care. Later the management of PD, meaning the drug treatment for the disease, pumps at an advanced phase and even in the last days. Also, includes complementary therapies for PD, surgery and refer patients and carers to valuable information sources. Continuing with providing care for caregivers, referring to a care unit, caregivers rights, the importance of eliminating prophylaxes, and finally, the use of validated tools and scales, such as the Zarit scale. Eventually mentions the disease's confrontations, which deals with emotions, stress, depression, coping with problems with thinking, reasoning, and memory of patients with PD, besides, handling anxiety or depression, sleeping disorders and social needs.

Table 10: Preliminary toolkit version: PD topics.

Learning Objectives	Knowledge and Understanding	Practical Skills	Personal Competencies
Parkinson's Disease and related disorders	Global facts about PD. The symptoms of Parkinson's disease. The cause of Parkinson's disease.	How to diagnose the PD. The differences for PSP, MSA and CBD. Use of validated tools and scales. Parkinson's disease expected influence on patient's and carer's life.	Encouraging the patients and carers to ask the right questions. Being respectful towards patients and carers need for information.

Learning Objectives	Knowledge and Understanding	Practical Skills	Personal Competencies
Diagnosis	<p>Telling the Diagnosis.</p> <p>Early integration of Palliative Care.</p>	<p>Sharing information. Talking with patients and carers.</p>	<p>Being proactive to answer questions about PD.</p>
PD and its management	<p>Drug therapy for Parkinson's disease, use of pumps in advanced phase and even in the last days.</p> <p>Complementary therapies for Parkinson's disease.</p> <p>Surgery for Parkinson's disease.</p> <p>Directing patients and carers to good sources of information.</p>	<p>Being open to answer frequent questions about Parkinson's disease.</p> <p>Referral to the PD Nurse Specialist Physiotherapy to help with movement, posture and balance.</p> <p>Speech and Language Therapy to help with communication and swallowing.</p> <p>Occupational Therapy for practical advice and aids for keeping independent.</p> <p>Spiritual Counsellor/ Healthcare Chaplain to get advice on spiritual issues and needs.</p>	<p>Recognising the importance of multi-professional, interdisciplinary and continuous management of PD.</p> <p>Being able to understand one's professional limits and decide, who/what is the best source to give/get sufficient answers.</p>
Providing Care for Caregivers	<p>Unite of Care</p> <p>Rights as a carer.</p> <p>Importance of burn out prophylaxes.</p> <p>Use of validated tools and scales, such as Zarit scale.</p>	<p>Basic caring skills for people looking after someone with PD.</p> <p>Helping with lifting and moving the person with PD.</p> <p>Practical aids and adaptations to help with caring for the person with PD.</p> <p>Psychosocial and spiritual counselling</p>	<p>Being aware of stress and managing one's emotions as a carer.</p> <p>Grasping the importance of looking after oneself as a carer: accepting outside help and sharing the caring tasks.</p>
Getting on with life?	<p>Coping with Parkinson's disease (dealing with emotions, stress and depression).</p> <p>Problems with thinking, reasoning and remembering in people with PD.</p> <p>Anxiety/Depression.</p>	<p>Practical tips around the house for people with Parkinson's disease.</p> <p>Getting a good night's sleep with Parkinson's disease.</p> <p>Psychosocial and spiritual counselling</p>	<p>Perception of PD as a problem that affects the entire family (unit of care).</p> <p>Respecting family caregivers, who are the greatest support of patients in PD especially when they wish to be cared for at home.</p>

Learning Objectives	Knowledge and Understanding	Practical Skills	Personal Competencies
	Sleeping disorders. Social needs. Spiritual needs.		

Regarding the Late-Stage Parkinson's Disease & Palliative Care topics (Table 11) deal with the advanced PD, death and dying, referring to some global facts relatively to Late PD Stage, falling out of care and gender gap. It then follows the importance of the advanced death directive in PD, decision making when patient's ability reduces, the importance and accessibility of a valid advanced directive, power of attorney, will, brain bank and research. Next is the treatment, incorporating Palliative Care guidelines, stiffness, hypoactive delirium, breathing dysregulation, dopaminergic crisis, obstipation and severe vomiting, emergencies and Palliative sedation and closing with the nutrition in advanced Parkinson's Disease, ethical and social implication of feeding tubes. Ultimately is the loss, the management of grief and bereavement, as a process of each person concerned.

Table 11: Preliminary toolkit version: Late PD and palliative care topics.

Learning Objectives	Knowledge and Understanding	Practical Skills	Personal Competencies
Advanced PD, death and dying	Global facts about Late Stage PD. Falling out of care. Gender gap.	Starting palliative care in patients with PD. Prognostication in PD. Recognising the final phase of PD.	Notion of home as a "safe place". Considering all alternative settings for being cared for in advanced PD, e.g. respite care opportunities, day hospices and so on.
Importance of Advanced directive	Dying in PD. Decision making, when patient's capacity decreases. Importance and accessibility of valid advanced directive. Power of attorney. Will. Brain bank and research.	Care Planning based on needs assessment. Discussing Advanced Care Directives.	Respecting patient's and caregivers' wish not to discuss death and dying or any other aspect of care. Comprehending what should not happen in dying phase.

Learning Objectives	Knowledge and Understanding	Practical Skills	Personal Competencies
Therapy /Integrated Palliative Care Guidelines	Stiffness/Rigidity Hypoactive delirium Breathing dysregulation/ Chayne-Stokes Breathing patterns. Dopaminergic crisis. Obstipation and severe vomiting. Emergencies. Palliative sedation (timeframe, etc).	Discussion of decision-making process, particularly withdrawal or withholding of a treatment. Symptom control and management. Specific emergencies which might occur in the final phase, for example, how to manage the dopaminergic crisis and vomiting. Availability of scheduled analgesics & analgesics on demand (PRN).	Being open to answer frequent questions about late stage of Parkinson's disease. Being aware of the need for accurate nursing care, for example, to prevent bed sores and pneumonia. Comprehending that the patient and caregivers might need extra support in the final phase.
Nutrition in advanced Parkinson's Disease	Ethical and social implication of feeding tubes (e.g.) PEG-tubes	Nutrition and Hydration in advanced stage of PD.	Understanding the concept of comfort. Comprehending the social importance of food.
Loss, Grief management and Bereavement	Grief and bereavement as a process of each concerned person. Anticipatory mourning.	Identification of helpful and not helpful strategies when working with the patient's and relatives' mourning, including children. Support for professionals.	Understanding the relevance of grief management at the beginning of the disease, during disease, when patient is dying and after patient's death.

3.4 Study Design

3.4.1 Study setting and feedback collection

The proposed toolkit was presented to 40 neurologists who participated in the 9th Winter Clinical Training on movement disorders on November 15-17, 2019 in Volos, Greece. Participants were asked to answer two basic types of questions and choose between five different answers. The first question was "how much do you know about this topic" and the answers ranged from one to five as follows:

1. I have never heard of it
2. I know a few things
3. my knowledge is at a good level

4. my knowledge is advanced
5. I am a specialist

The second question was "How relevant is this topic for your current work", and again the answers ranged between one to five as follows:

1. Irrelevant
2. Slightly relevant
3. Moderately relevant
4. Relevant
5. Very relevant

3.4.2 Study population

Most of the participants are neurologists (Figure 7), working in General Hospitals (Figure 8), aged between 30 and 39 years old (Figure 9). Another interesting statistic is that most of our sample does not have sufficient experience, especially in a ratio of 2/3 with less than ten years of practising Neurology (Figure 10).

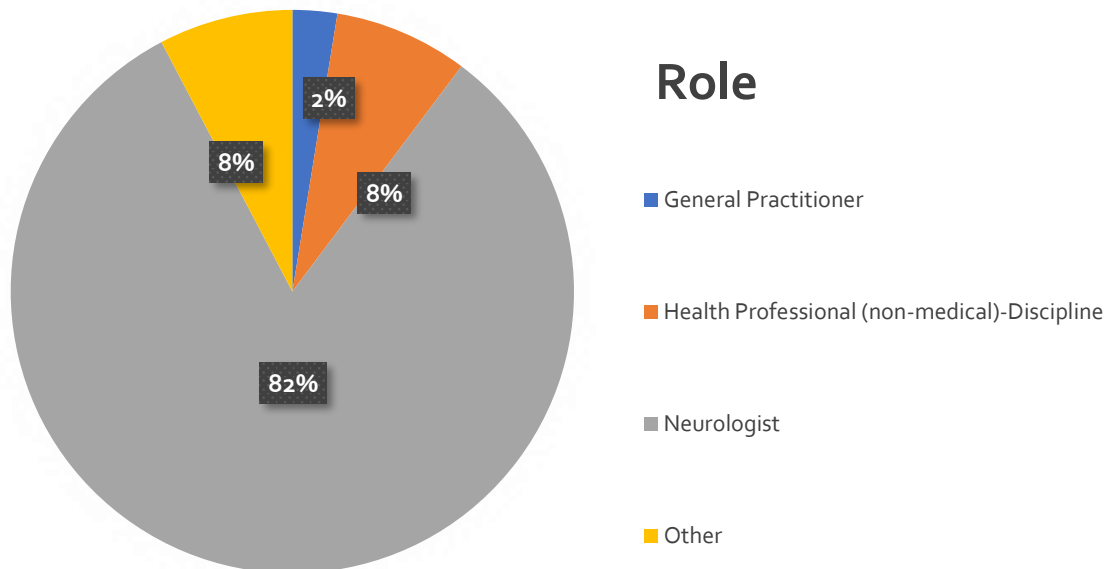


Figure 7: Participants' roles.

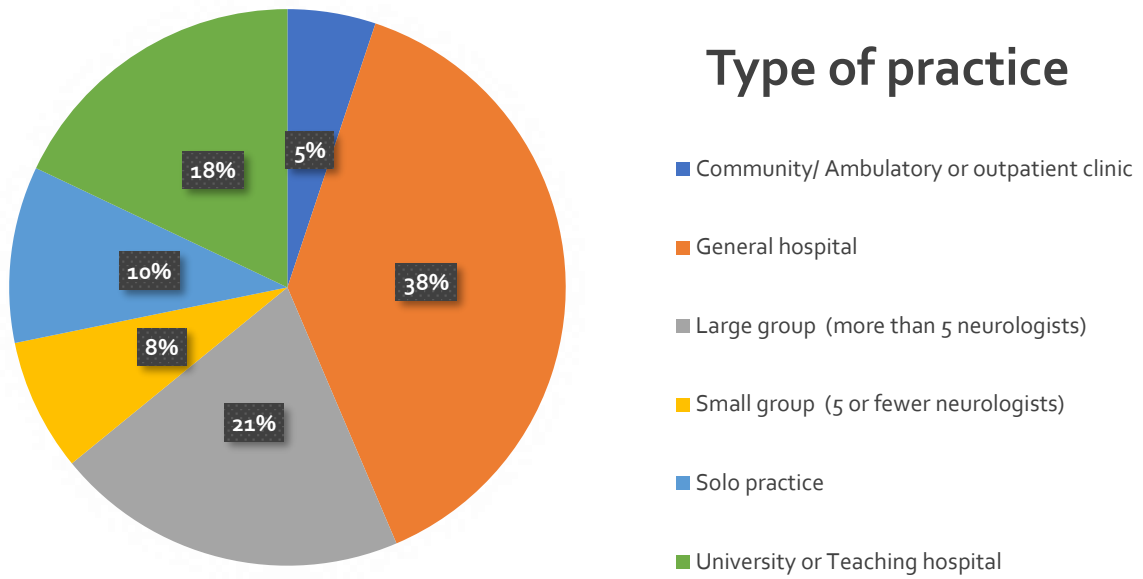


Figure 8: Participants' practice features.

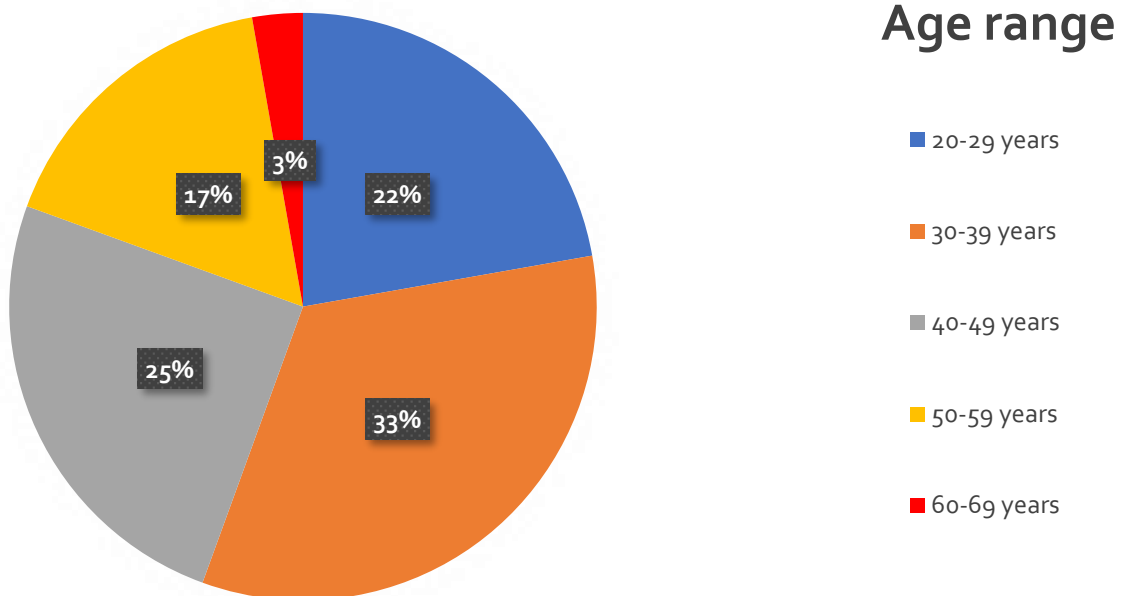


Figure 9: Participants' ages.

Years of practising Neurology

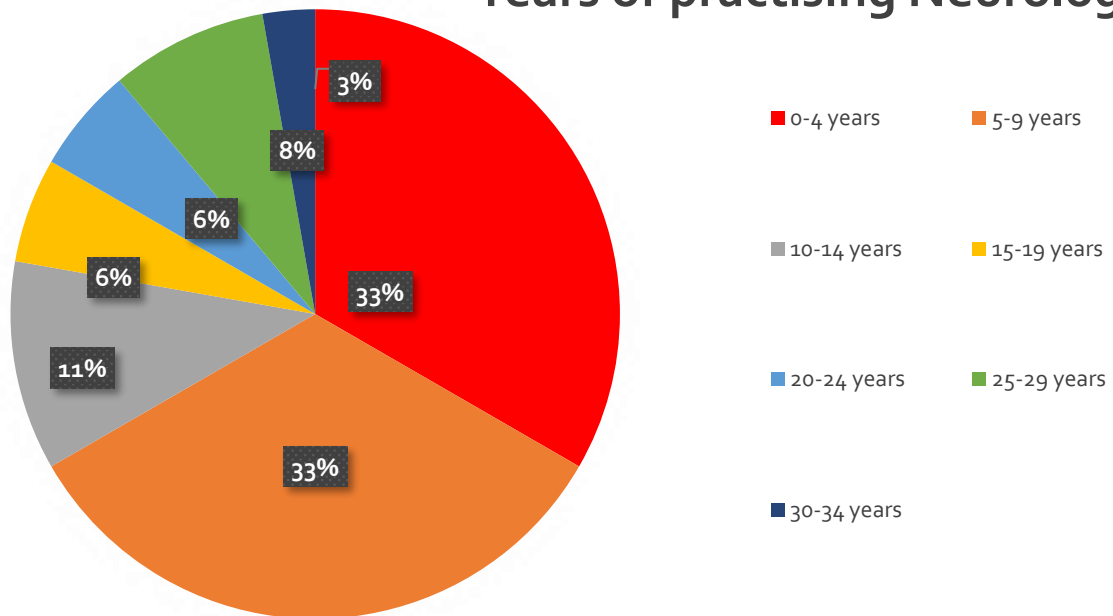


Figure 10: Participants' years of practicing Neurology.

3.5 Results

Remarkably, each participant's means of knowledge of the topic and their perceived relevance to their current practice were moderately correlated (Pearson), as shown in Table 12.

Table 12: Pearson correlation of average knowledge and relevance scores.

		Average relevance
Average knowledge	<i>Pearson Correlation</i>	.419 ^{**}
	<i>Sig. (2-tailed)</i>	.007
	<i>N</i>	40

According to the results (Figure 12), participants have limited knowledge of Palliative Care (it is worth noting that although they have poor knowledge of the subject, they believe that related topics with Palliative Care concept are very relevant to their work).

Unlike to Palliative Care, Parkinson's disease knowledge ranged from very good to an advanced level, and, according to the participants' comments, they claimed the relevance of the topics (Figure 12).

Another interesting point is the low relevance score indicated for the topics "providing care for caregivers" and "getting on with life" even if they have a high relevance score to their practice.

Regarding the 'Late-Stage Parkinson's Disease & Palliative Care' the results were similar to palliative care as participants were unaware of the topics (Figure 13).

It is worth noting that Advance Care Planning scored one of the lower average scores, which can be explained or even justified by the early stage of Palliative Care in Greece.

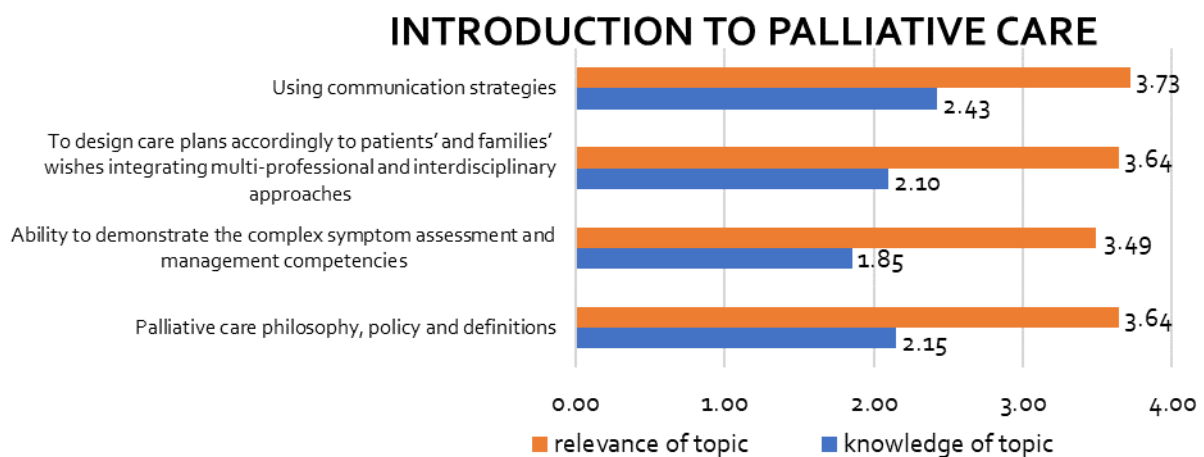


Figure 11: Feedback for the palliative care topics.

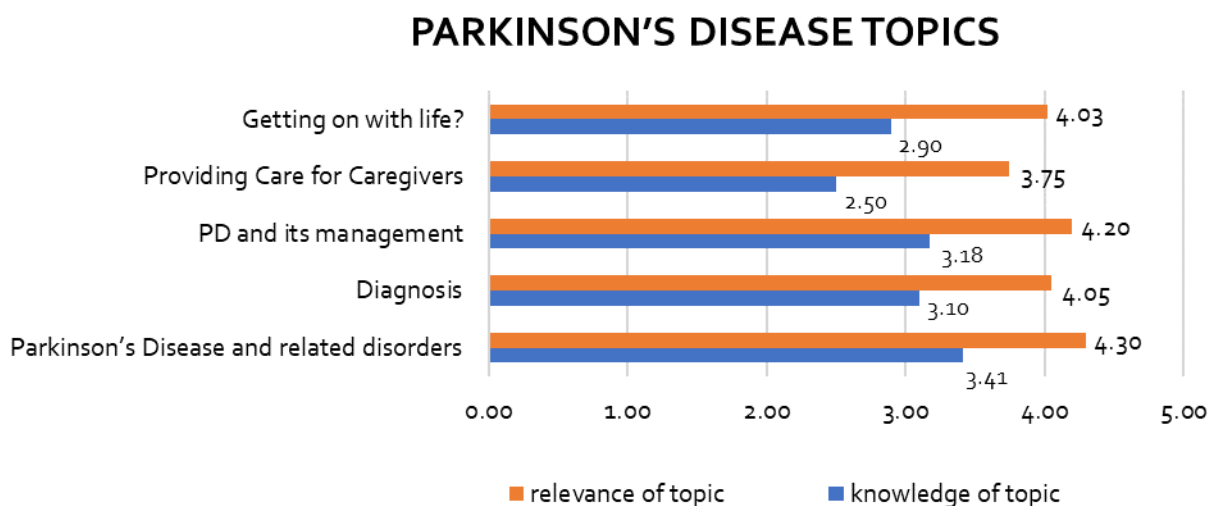


Figure 12: Feedback for the PD related topics.

LATE STAGE PD & PALLIATIVE CARE

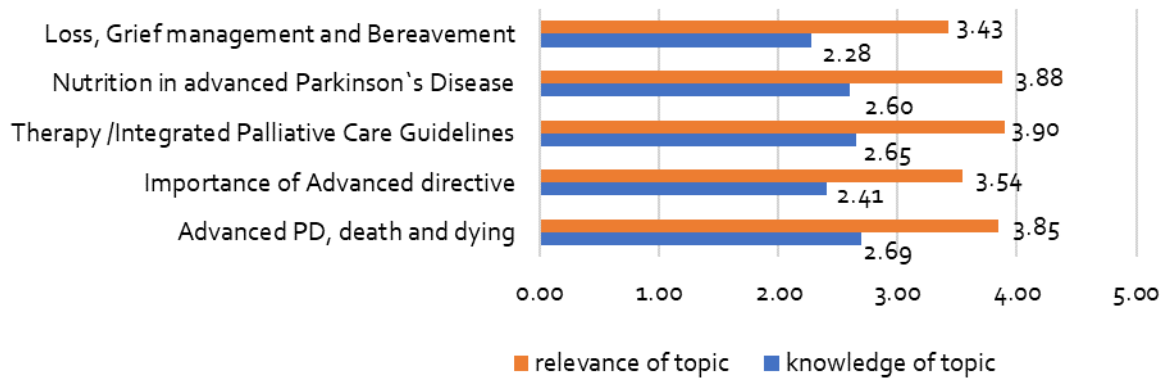


Figure 13: Feedback for the late-stage PD and palliative care topics.

3.6 Discussion

Despite the long history of Palliative Care in Greece, it has not evolved as much as in other economically robust European Union countries and the ability to provide Palliative Care today is insufficient compared to the needs. Several initiatives are needed to bridge the gap regarding access to Palliative Care in Greece. Quite a significant step among others is training young health professionals and training many health professionals already employed whose knowledge is insufficient according to the research findings (74). At the same time, it is immensely encouraging their interest in Palliative Care.

The toolkit's final configuration (presented in chapter 4) was based on the research findings and continuous guidance through consensus meetings with experts. Furthermore, we intend to soon deploy the toolkit in Open edX, a Massive Open Online Course (MOOC) platform and after a trial period, it will be reformed into an even more improved version based on the learners' comments. Undoubtedly the MOOC phenomenon has revolutionized the world of higher education through technological progress. Educational opportunities have expanded dramatically, mainly overcoming geographical and demographical challenges.

MOOCs are higher education courses that are, in most cases, free or meagre cost open for any Internet user. It is not only the advanced development of e-learning that imposes the need for this type of

learning, but also, due to the pandemic, the new conditions created reinforcing our proposal even more. It is a very promising proposal, especially for those countries where the concept of Palliative Care is still at an early stage. Besides, it is a comprehensive proposal and, most importantly, is made in collaboration with various institutions and universities and led by a team of experts in the field gives greater value and weight.

3.7 Conclusions

This paper aims to explore the knowledge and views of Greek neurologists on aspects of Palliative care. It also includes a qualitative assessment of a proposed curriculum toolkit for Palliative care education in Parkinson's. Moreover, it highlights the unmet needs for training in Palliative Care for Parkinson's disease globally. The proposed toolkit itself, presented in chapter 4 which was finalized also based on the feedback from this analysis, aims to provide useful, adequate, and sufficient information for those wishing to increase their knowledge of this field.

4 Education on Palliative care for Parkinson patients: the “Best Care for People with Late-Stage Parkinson’s Disease” curriculum toolkit

4.1 Introduction

The World Health Organization (WHO) has made a strong commitment towards developing palliative care structures as an important component of integrated treatment for young and old patients at any stage of illness (75). This commitment includes also Parkinson’s disease (PD) with patients and their caregivers having considerable (and mounting) unmet physical, psychosocial and spiritual needs, and experiencing great problems with coordination and continuity of care (76, 77). To ensure optimal responses to palliative care needs, educating healthcare professionals, patients and caregivers is of major importance.

The extension of life expectancy and ageing of populations globally predicts rise in the prevalence of neurological and other chronic disorders causing related disability. It has been demonstrated that patients with chronic neurologic disorders suffer from the burden of disease progression without the hope for a cure. Therefore, symptom management and palliative care approaches should be discussed from the beginning of the illness.

4.2 Aims and objectives

Accordingly, the PD_Pal project is working on a new model of palliative care and novel PD management Guidelines that can be easily implemented and integrated in modern healthcare systems. Within this context PD_Pal also addresses the identified gaps in stakeholders’ education by designing, implementing and evaluating a postgraduate course linking PD specific modules to palliative care. Herewith we present the development of the “Best Care for People with Late-Stage Parkinson’s Disease” curriculum toolkit which is addressed not only to all healthcare professionals caring for patients with PD but also to the patients and their caregivers who also have unmet educational needs and limited knowledge of palliative care and its potential benefits. We specifically present the methods for the development of the curriculum toolkit which, as a last step, included an evaluation from external experts. At the time of the manuscript submission the course implementation as a Massive Open Online Course (MOOC) was still ongoing with pilot testing and evaluation from learners being the main future activities.

4.3 Methods

The development of the toolkit consisted of several steps (see Figure 14). After identifying the lack of knowledge for palliative care and its interplay with advanced PD care as a problem to be addressed with a targeted educational intervention on international level, an initial needs' assessment defined patients and their caregivers along with health care professionals as target audience. The first version of the toolkit was largely based on recent surveys, recommendations and guidelines for palliative care education and training of healthcare professionals, as well as on content recently developed for educating patients and caregivers on PD. This first version was used for exploring the views of Greek neurologists as presented in chapter 3, with the findings feeding the next versions of the toolkit.

The needs of patients with PD, of their caregivers as well as of the healthcare professionals involved in the management of patients in the advanced stages of the disease were further analysed in respect to a narrative, yet targeted literature review in order to confirm the topics included in the curriculum and complete it as needed. The collection of the relative studies was not limited to a time range as palliative care education needs may be reported in older publications. We have utilized PubMed in which all relevant journals and conference proceedings are getting indexed. Within this context, a panel of three experts chose the most relevant quotes, which were used for querying. We chose quotes instead of keywords to ask a sufficiently focused research question. The selected quotes were 'palliative care education Parkinson's' 'Parkinson's palliative care' 'palliative care education caregiver Parkinson's' 'palliative care education patient Parkinson's' 'palliative care education healthcare professionals Parkinson's' 'advance care planning Parkinson's' and were used to produce the search terminology for this review, by considering all possible variations. Using these quotes, appropriate search queries were formulated, according to the specifications of PubMed. The research papers had to be written in English in order to be included in this review. The type of publication was not considered as a limitation, and all studies that were either published until October 2020 in international journals or conference proceedings were included.

After collecting the literature (in total 462 articles), and removing duplicates, the first and the last author screened the titles and the abstracts of all papers, aiming to apply a set of inclusion criteria which included reference to PD and palliative care or the advanced stage of the disease. 62 articles qualified for full text assessment, 23 of them were the most relevant. Two reviewers (the first and the last author) then went through the full text of the 23 manuscripts again and again to identify the educational gaps which informed the collection of patients', caregivers' and health care professionals' needs.

After this narrative literature review, the second version of the curriculum toolkit was drafted. This second version was further assessed by Dr. Piret Paal, Prof. S. Lorenz, Prof. S. Konitsiotis, Prof. P. Taba, Prof. A. Antonini during both physical and virtual consensus meetings. The third version of the toolkit was consequently released, and it was evaluated with an online survey involving consenting, according to the General Data Protection Regulation (GDPR) provisions, experts on the field. 40 experts were invited by email to participate in the survey and the 27 that completed it (a 67,5% response rate) constituted the convenience sample.

The statistical analysis of the open-ended questions for analysing the feedback collected with the online survey was performed using R 4.0.3 (R Core Team, 2018). The chi-square test of independence was used to analyse the frequency table (i.e. contingency table) formed by the distribution of frequencies of the survey responses for the importance, relevance and knowledge variables with respect to the different topics. The chi-square test evaluated whether there was a significant association between the categories of the responses and the topics. Residuals were calculated to assess each response value contribution to the topic, and then were turned into percentage contributions to the total chi-square score, for each cell. Pairwise z-test post hoc analysis with Bonferroni correction was performed to adjust standard residuals for multiple comparisons. The analysis of the online survey findings led to the final curriculum toolkit.

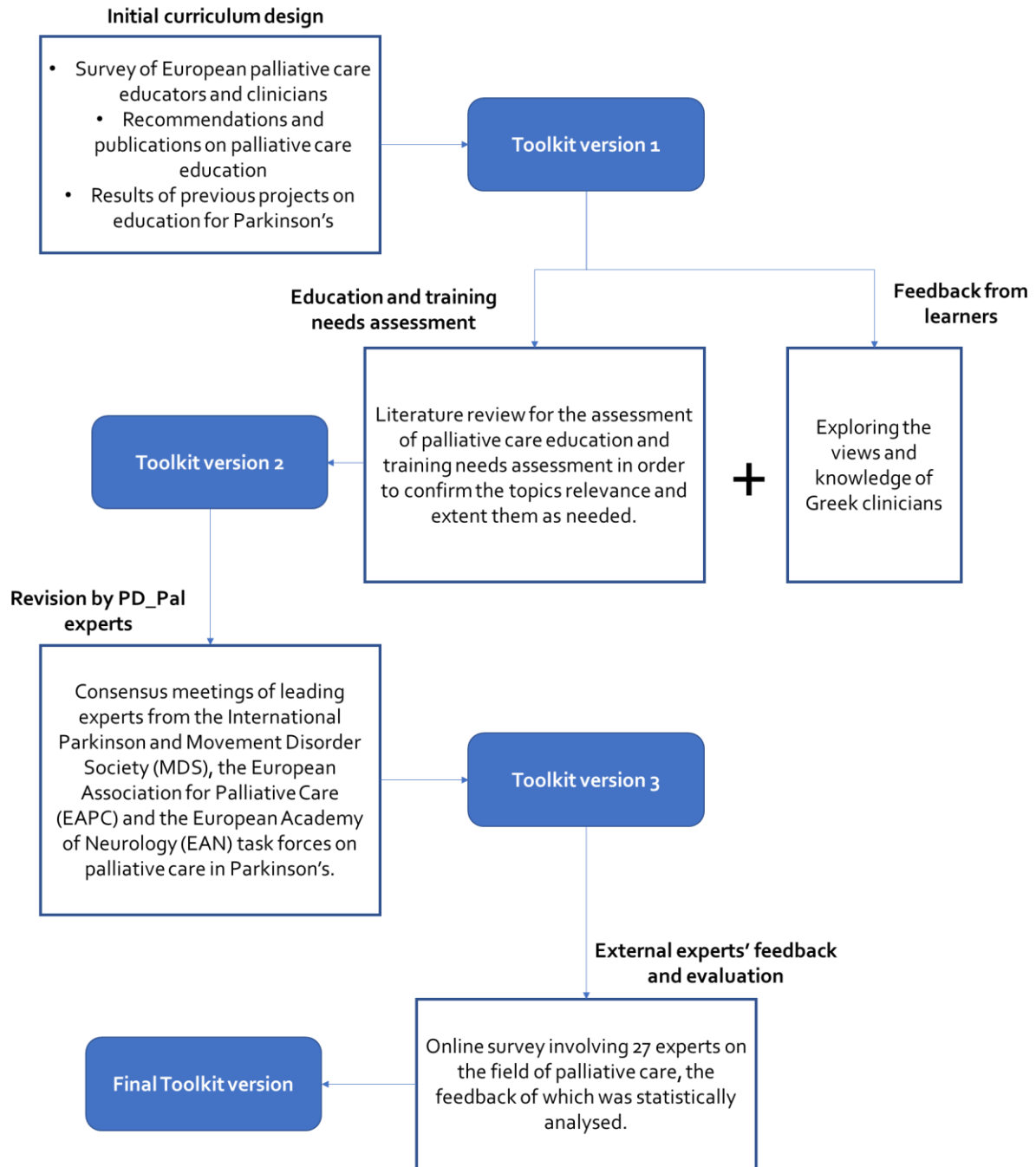


Figure 14: Curriculum toolkit development methodology.

4.4 Results

Education and training needs assessment

This first version of the toolkit was revised according to the findings of the literature review which are presented herewith and are summarised in Table 13.

The shared needs of patients and their caregivers include the availability of simple, yet comprehensive tools for future planning. Essentially, they need practical guidance to navigate the PD journey (78). They emphasize the personalization of the provided information and support (60). They are also in need of comparative information on the advantages of palliative care quality when provided as inpatient care, within palliative units in nursing homes or at home (79) and which preferences should guide decisions for the place of death (80). Patients indicated that improved education, shared decision making, and communication of Advanced Care Planning (ACP) (81) in order to be able to discuss advanced directives. Further education and emotional support, particularly regarding disease progression and their expectations, as well as advanced PD management (82) was also stressed as an important aspect.

The educational needs of caregivers include skills and support for coping with their difficulties when caring for their loved ones (62), increased knowledge of resources such as support groups programs and social services (83), learning how to cope with caregiver burden which rises significantly with disease progression (84). They also need to improve their know-how for handling the impact of the disease including social isolation, loss of self-identity, feelings of helplessness, lack of control and physical deterioration of the patient's and carer's health (85). Caregivers should also be better prepared to manage emergencies and learn how to anticipate physical challenges directly related to the debilitating course of the disease (86), be better prepared to speak as proxy for medical decisions (87) and comprehend the emotional, spiritual and bereavement domains (88), including how to deal with the death of the loved one (60) and how to manage pre-death grief (89).

The needs of healthcare providers caring for patients with PD, and eventually in need of palliative care, include training on communication (topics, timing, caregivers' needs and management) (90, 91), education on proper information sharing (92), training on primary palliative care skills (63, 64) and mastering pharmacotherapy (93). Healthcare professionals should also be able to build decision-making around advance directives and identify and manage symptoms of dying (65), as well as be trained on outpatient care models (94) and educated on the ethical challenges of ACP (87).

Table 13: Summary of educational and training needs identified with the narrative literature review.

STAKEHOLDERS	EDUCATIONAL AND TRAINING NEEDS (ATTITUDE, SKILLS, KNOWLEDGE)	LITERATURE
PATIENTS AND CAREGIVERS'	Learn how to navigate the PD journey	Jordan et al., 2020 (78)
	Being able to get personalized information	Fox et al., 2017 (60)
	Being able to choose the suitable palliative care setting	Sandsdalen et al., 2016 (79)
	Learn how to make decisions related to the place of death	Moens et al., 2015 (80)
PATIENTS	Become knowledgeable of Advanced Care Planning (ACP)	Connor et al., 2015 (81)
	Comprehend what to expect and what PD management includes in the advanced stages	van der Eijk et al., 2012 (82)
CAREGIVERS	Be trained to provide adequate care	McLaughlin et al., 2011 (62)
	Be informed about the availability and access to support groups and services	Olsson et al., 2016 (83)
	Learn how to cope with caregiver burden	Schrag et al, 2006 (84)
	Be taught how to handle the psychological impact	Hasson et al, 2010 (85)
	Be trained to manage emergencies	Goy et al., 2008 (86)
	Be informed in order to become a proxy for medical decisions	Sokol et al., 2019 (87)
	Get to understand the emotional, spiritual and bereavement domains	Aoun et al., 2010 (88)
	Comprehend death and be able to deal with it	Fox et al., 2017 (60)
	Be taught how to cope with pre-death grief	Carter et al., 2012 (89)

STAKEHOLDERS	EDUCATIONAL AND TRAINING NEEDS (ATTITUDE, SKILLS, KNOWLEDGE)	LITERATURE
HEALTHCARE PROVIDERS	Be capable to efficiently communicate with patients and caregivers	Tuck et al., 2015, Walter et al., 2019 (90, 91)
	Be competent at information sharing	Miyasaki et al., 2016 (92)
	Be adept to provide primary palliative care	Lum et al., 2020, Robinson et al., 2017 (63, 64)
	Become highly skilled in pharmacotherapy	Katz et al., 2018 (93)
	Be able to guide shared decision-making around advance directives	Robinson et al., 2018 (65)
	Be knowledgeable of outpatient care models	Tarolli et al., 2019 (94)
	Comprehend the ethical challenges of ACP	Sokol et al., 2019 (87)

The second version of the toolkit that was informed by the literature review and the feedback from Greek clinicians was further assessed during consensus meetings with experts that led to the definition of the third version which was assessed with an online survey from independent, external experts.

Online survey – experts’ feedback and evaluation of the toolkit

The experts who agreed to participate, filled out questionnaires and the informed consent form online, according to GDPR provisions. The study has been exempted by the Comitato Etico per la Sperimentazione Clinica della Provincia di Padova (CESC) as it doesn't involve patients or clinical procedures. It has been therefore addressed to the University of Padova Data Protection Officer (Legal Affairs Office, University of Padova) which has reviewed and produced a Data Protection Notice and Informed Consent for use of Personal Data, submitted to the study participants prior to their participation to the study.

A total of 27 experts participated to the survey. 89% of the sample was from Europe, 7.4% from Asia and 3.7% from North America. Neurologists accounted for 59.3% of the total sample, whilst Nurses for 11.1% and Palliative Care Physicians for 22.2%. 7.4% were Researchers. The age distribution of participants accounted for 62.9% of participants between 40 and 59, specifically 29.6% for age

range 40-49, and 33.3% for age range 50-59. Only 3.7% of participants were among 20-29 and 3.7% above 70.

Modal value of years of practice was 30-34 years (18.5%), however all the other intervals were similarly represented: 0-4 years, (14.8%); 5-9 years (7.4%); 10-14 years (14.8%); 15-19 years (14.8%); 20-24 years (7.4%); 25-29 years (14.8%); 30-34 years (18.5%); 35-39 years (3.7%); 40-44 years (3.7%).

No differences were found between the frequency distribution of the study participants' roles and age ($X^2 = 23.7234$, $df = 15$, $p = .0699$). No difference in proportion was found among the study participants' roles and years of practice ($X^2 = 26.1562$, $df = 24$, $p = .3453$).

A chi-square test of independence was performed to examine the relation between the relevance score and the topics of the curriculum. The relation between these variables was significant, ($\chi^2 = 67.0497$, $df = 44$, $p = .0141$). Specifically, topic 10 "Nutrition in advanced PD" was more likely to be assessed as "not relevant" than the other topics. The most contributing cells to the Chi-square are "Not relevant/ Topic 10 - Nutrition in advanced PD" (15.04 %), "Don't mind/ Topic 3 – PD and its management" (10.262 %), "Very relevant/ Topic 9 - Managing common symptoms in Late-Stage PD" (6%), "Very relevant/ Topic 5 - Getting on with life" (5.08%). These cells contribute about 31% to the total Chi-square score and thus account for most of the difference between expected and observed values (see Figure 15). A post-hoc z-test on the adjusted residuals with Bonferroni correction revealed a significant difference only for "Nutrition in PD" as "not Relevant", $p < .05$.

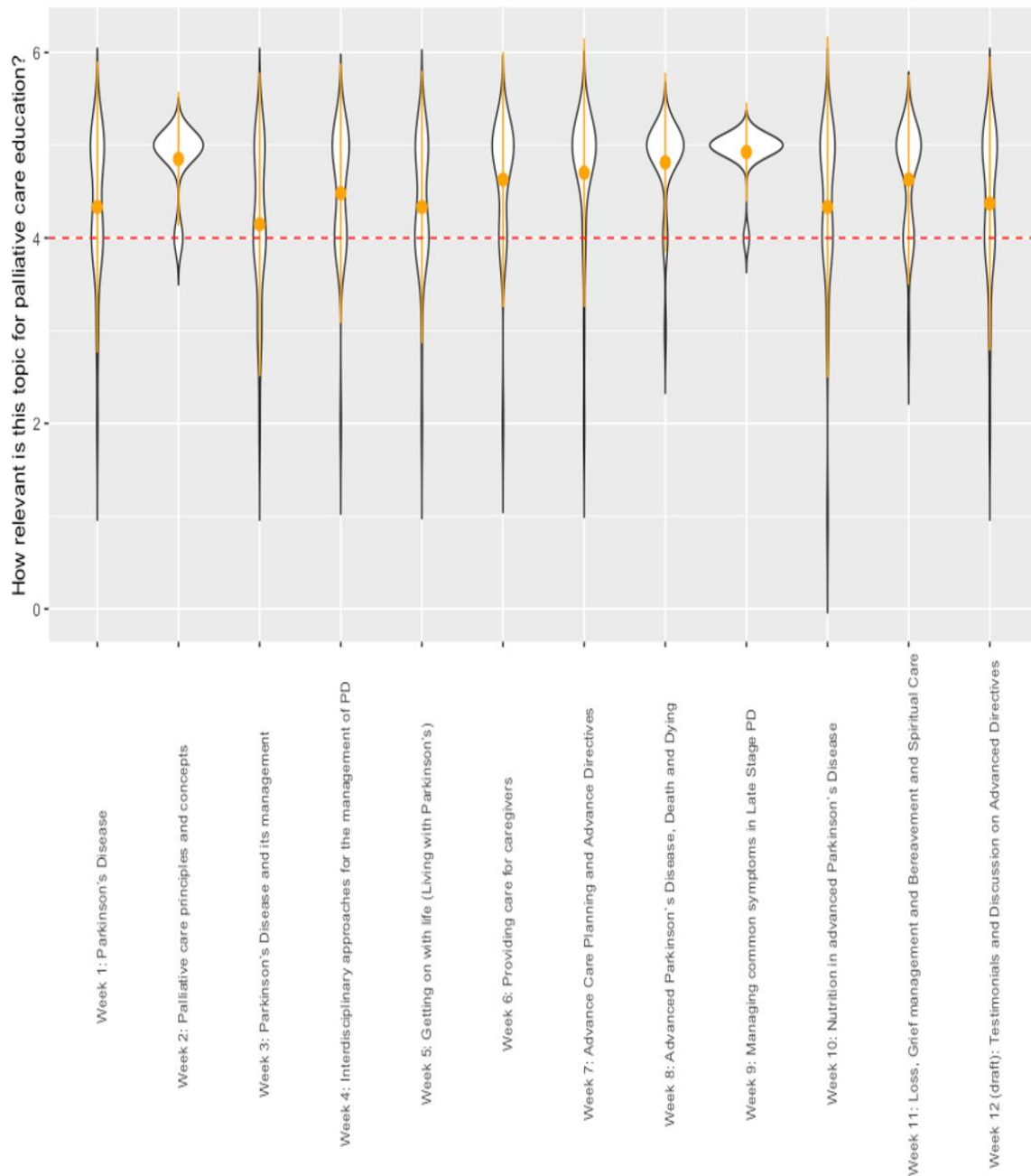


Figure 15: Relevance of topics constituting the Curriculum Toolkit.

Topics' importance results (Figure 16), obtained with chi-square test of independence showed a significant relation between importance and topics' variables, ($\chi^2 = 65.2004$, $df = 44$, $p = .0205$). Topic 10 - Nutrition in advanced PD, was more likely to be assessed as not important with residuals accounting for the 15.46% of the total χ^2 score. Topic 3 – PD and its management was assessed as "very important" and "highly important", with those cells contributing to the 15.24% of total chi square. The post-hoc z-test on the adjusted residuals with Bonferroni correction showed a significant difference only for "Nutrition in PD" as "not important", $p < .05$.

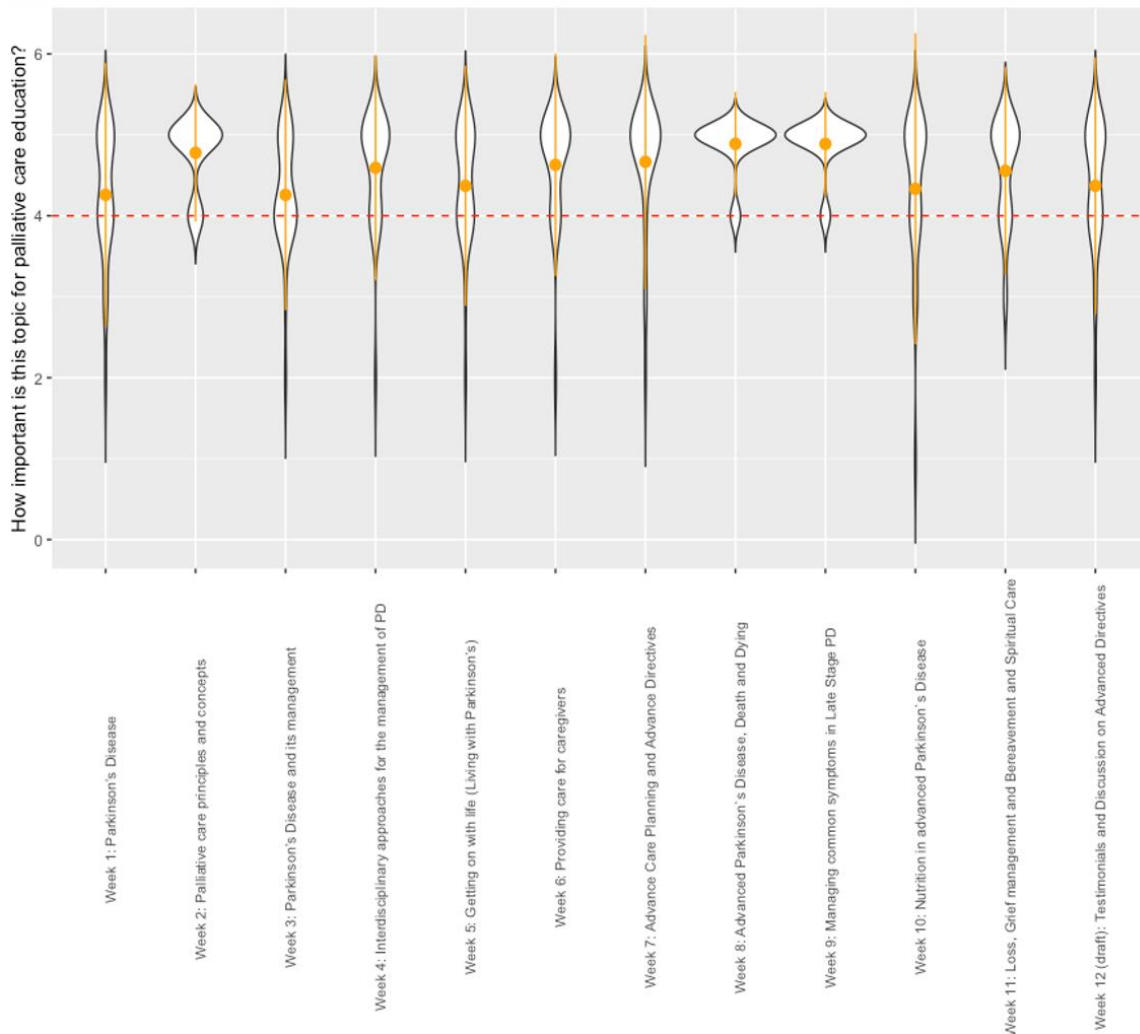


Figure 16: Importance of topics included in the Curriculum Toolkit.

Knowledge results (Figure 17), obtained with chi-square test of independence showed a significant relation between the topic knowledge and the contents variables, ($\chi^2 = 50.7118$ df = 33 p = .0251). Topic 10 was more likely to be evaluated as "low-medium knowledge" with residuals accounting for the 7.82 % of the total χ^2 score. Topic 3 showed a lack of answer "medium-high" (4), varying of 11.75% from the total chi-square score. Topic 12 showed polarized answers, which shifted from the expected χ^2 score by 4.43% for "low knowledge" values and a negative residuals variation of 5.88% for "very high knowledge" values. Topic 11, similarly, showed a gradual orientation of answers towards "low knowledge", though with smaller effect, for which "low knowledge" accounted with a residual shift of 1.97%, and "very high knowledge" with a negative residuals' shift of 3.69%. Topics 1, 7 and 9, were assessed as topics in which respondents considered themselves highly experienced, with "high" and

“very high” answer much more represented than expected value (contribution to total X^2 score ranging from 4.37% to 8.56%). The post-hoc z-test on the adjusted residuals with Bonferroni correction consistently highlighted a significant difference only for reduction of “medium-high knowledge” answer for Topic 3, $p < .05$.

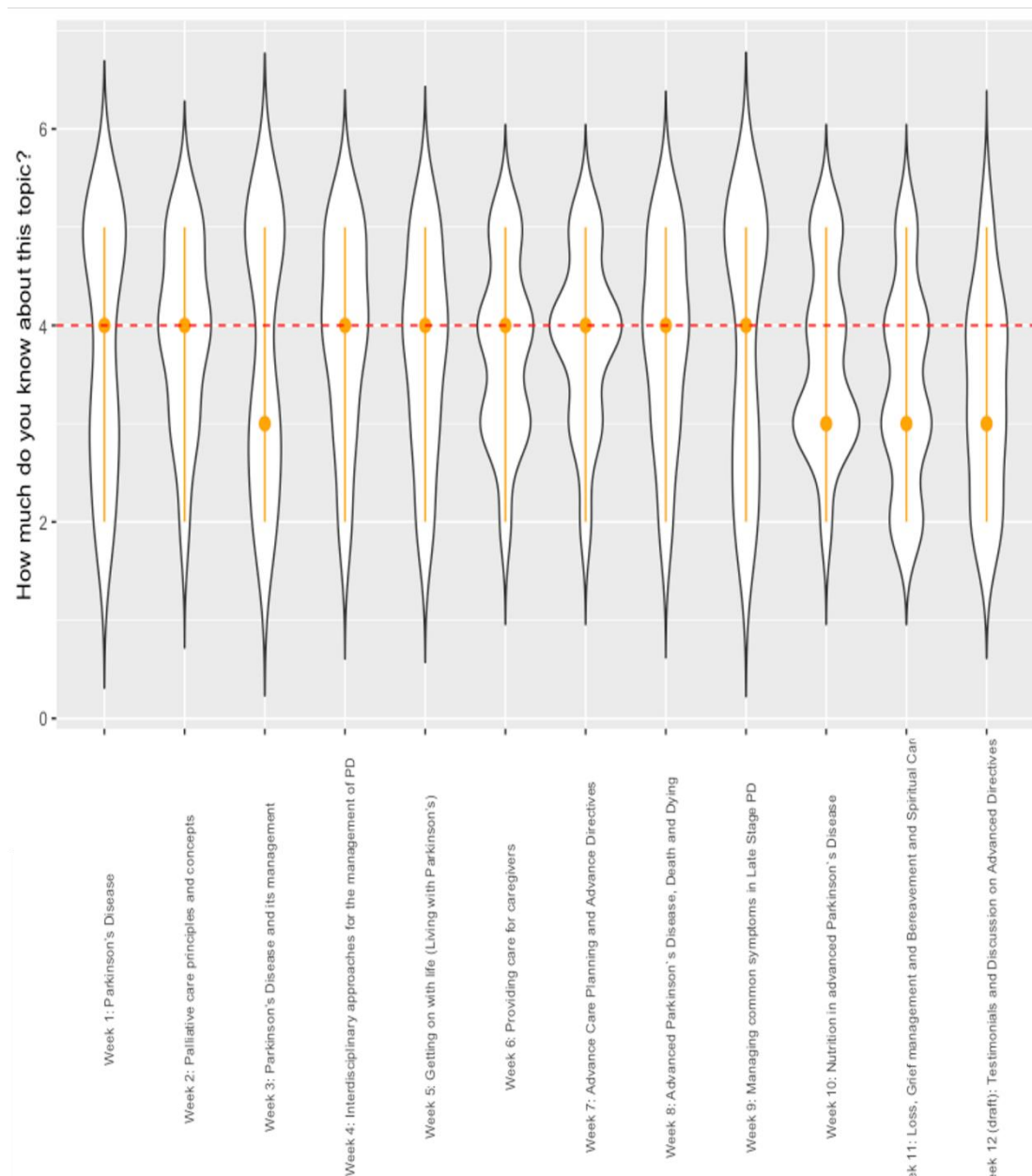


Figure 17: Experts' self-assessment of their knowledge of the topics.

According to the analysis of the experts' feedback, that complemented the statistical findings, the selected topics are important and relevant. Some palliative care experts indicated that there is

substantial overlap with geriatrics or palliative care curricula. Others, mainly neurologists, indicated that the PD_Pal curriculum could be expanded to discuss other neurological diseases as well.

In terms of including palliative care into healthcare professionals' education, a physician from general hospital suggested: *"For healthcare professionals these topics must part of their education. For patients and informal caregivers appropriate timing is important - not too early, not too late."* (ID_021) One expert pointed out that there might be some overlap with geriatrics or palliative care specialist training: *"General content is part of Geriatrics but specific features for PD patients are rather important, so these should be handled separately too"* (ID_023). Another expert suggested: *"[Palliative care] should be part of neurology education at every level"* (ID_015). In terms of improvements, experts suggested adding some different literature: *"The articles chosen may not be the most evidence-based or recent evidence."* (ID_015). One expert pointed out the need for discussing diversity in healthcare services: *"There should also be some discussion about care delivery in under-resourced settings"* and possible country-level differences in Advanced Care Planning: *"Is there a possibility to include some info on ACPs in different regions?"* (ID_011). Some experts were concerned about the symptom control: *"This is challenging and if education is directed to Palliative Care specialists, there are many meds and approaches that are not familiar to them."* (ID_015). The topic of spirituality *"needs more time."* (ID_013). Overall, positive feedback was given regarding including the patient and family experiences: *"Wonderful to include patient and family perspectives on this matter"* (ID_015).

This extensive analysis led to the final curriculum toolkit, which is available in <https://www.pdpal.eu/courses>.

4.5 Discussion

Our curriculum is compliant with Kern's foundational framework for curriculum development (95) which was recently adapted to online learning (96). Specifically, the identified lack of palliative care education among all stakeholders involved in the care of patients with late-stage PD is being addressed with an evidence-based curriculum toolkit. The initial assessment of educational needs is based on guidelines for palliative care education and previous curriculums for PD (step 1 in Kern's six-step approach for curriculum development for medical education). These needs are further informed by a narrative literature review (step 2). Accordingly, the learning objectives and the content addressing learner's attitude, knowledge and skills are defined and finalized after revisions and consensus meetings with leading experts on the field, as well as a targeted online survey aiming at curriculum evaluation (step 3).

In their majority the topics and their objectives and content were considered as highly relevant and useful. The major modification resulting from the toolkit evaluation was the integration of the previously dedicated topic on "Nutrition in advanced PD" in the "Managing common symptoms in Late-Stage PD" topic. This discrepancy can be attributed to the fact that in some countries tube feeding is not a common practice especially for patients with PD, even in the advanced stages. The objectives and content were not modified though as the available literature indicates that decisions regarding artificial nutrition and hydration are among the most common and complex decisions facing clinicians when patients with neurologic diseases have swallowing difficulties. Such decisions often involve incomplete clinical information, strong and often conflicting patient, caregiver, and healthcare professional knowledge and attitudes as well as diverse cultural and religious views that affect the final decision. Another adjustment that is made in the final toolkit according to the analysis of the experts' feedback is that the topic "Spiritual Care" was assigned its own dedicated module while previously it was part of the broader "Grief management and Bereavement" topic.

The toolkit can be used in various ways. It can be the basis for traditional teaching through a series of workshops and seminars. It can also complement traditional teaching in order to enable participants delve into additional information for some of the topics. For instance, neurologists may only be interested in those topics related with palliative care. Educators can also choose which topics they want to include in their lessons and adjust accordingly. Within PD_Pal project the toolkit will be implemented as a Massive Open Online Course (MOOC) (97) which is a modern approach in medical education (98) increasingly gaining interest (99). This is step 4 in Kern's six-step approach for curriculum development for medical education. Specifically, the learner centric and focused on usability and scalability Open edX was adopted. It encourages active learning which is a modular approach to learning through interaction. And unlike traditional teaching, it supports self-paced learning. In fact, a weekly workload of 4 hours, which is adopted also in the curriculum toolkit, at each learner's pace, seems to facilitate course participation even for busy clinicians who tend to consider these open courses as relevant and potentially valuable means of post-graduate education (100). Importantly, to address the variance in experience and expertise among healthcare professionals in palliative care and Parkinson's disease topics, all learners can choose which topics are of their interest and be educated only on them: topics are designed to also be used as standalones.

The content for each topic which includes slides with transcripts, introductory and explanatory videos, additional resources, literature, and self-assessment exercises is being developed by a team of designated researchers working for PD_Pal project and is carefully revised by several experts. Then the course coordinating center which is the Paracelsus Medical University in Salzburg aligns all topics

to ensure their consistency and smooth integration. This process involves several parties and is time-consuming due to various levels of revisions and quality checks.

Consistent with findings from (101), we expect as positive outcomes of the course the efficient set-up and content of the course, the pedagogical approach and the consistent international focus. The major benefits of the MOOC presenting the toolkit will include mutual learning and exchange of palliative care experiences and know-how from around the world that would have been impossible to achieve in traditional learning contexts. We also anticipate the lack of more practical case studies. Advanced, in person, follow-up courses on certain topics are needed for fully achieving the acquisition of skills. In fact, our toolkit and its implementation as different topics allow palliative care educators to use either some parts of it or as a whole.

4.6 Future work

The curriculum will be piloted in order to be revised according to learners' experience and feedback, prior to full implementation (step 5 in Kern's approach). Evaluation will be an ongoing process and after each course deployment revisions will be applied as needed. In fact, an outcome-based program evaluation (102) is planned after each pilot phase. The MOOC approach calls for additional assessment of usability, sustainability and satisfaction with the technology (step 6).

4.7 Conclusions

The "Best Care for People with Late-Stage Parkinson's disease" curriculum toolkit was developed based on evidence and with a carefully designed methodology in order to provide high-quality and equitable education which will be delivered by an interdisciplinary team of educators. Implemented as a MOOC, it has the potential to educate patients and their families, informal and formal caregivers, medical and social profession students, healthcare providers, and eventually anyone interested in palliative care in PD. It can also be adapted to other neurological conditions. Overall, the toolkit has the potential to improve communication about palliative care at international level and at the same time improve health literacy for patients and their caregivers and offer continuing medical education for healthcare providers.

Executive Summary

Abstract – Technology solutions in the care of Parkinson's disease

Background: Mobile health, predominantly wearable technology and mobile apps, have been considered in Parkinson disease to provide valuable ecological data between face-to-face visits and improve monitoring of motor symptoms remotely.

Methods: We first explored the feasibility of using the technology-based mHealth platform PD_manager comprising a smartphone in combination with a smartwatch and a pair of smart insoles to collect clinically meaningful data. Compliance was assessed with statistical analysis and the factors affecting it using appropriate regression analysis. Finally, we further validated a tremor evaluation method with data collected while patients performed their daily activities.

Results: PD_manager was proved to be feasible. Motor Aspects of Experiences of Daily Living and patients' self-rated health status are major factors affecting the system's use. Our algorithm for tremor evaluation provided clinically meaningful data for the detection and evaluation of tremor. Then we have used all findings, our hands on experience and the lessons learnt to design the PRIME clinical decision support system (CDSS) which is powered by mhealth and clinical Guidelines and is implemented on top of Electronic Health Records.

Conclusions: Our work until now further supports that mHealth can be an effective tool for the ecologically valid, passive, unobtrusive monitoring and evaluation of symptoms. Future studies will demonstrate that a powered by mhealth CDSS can improve disease management and care.

Abstract - Online training in the care Late-Stage Parkinson's disease and related movement disorders

Background: Palliative care education among all stakeholders involved in the care of patients with late-stage Parkinson's disease is not adequate. In fact, there are many unmet educational and training needs as confirmed with our targeted, narrative literature review.

Methods: To address these needs the multidisciplinary PD_Pal team has developed the "Best Care for People with Late-Stage Parkinson's Disease" curriculum toolkit. The toolkit is based on recommendations and guidelines for training clinicians and other healthcare professionals involved in palliative care, feedback from Greek neurologists, educational material developed in recent research efforts for patients and caregivers with PD and consensus meetings of leading experts in the

field. The final version of the proposed toolkit was drafted after an evaluation by external experts with an online survey.

Results: The toolkit is compliant with Kern's foundational framework for curriculum development, recently adapted to online learning. The statistical analysis of the online survey, aiming at toolkit evaluation from external experts (27 in total), confirms that all but one (nutrition in advanced Parkinson's disease) topics included, as well as their objectives and content, are highly relevant and useful.

Conclusions: In this thesis, the methods for the development of the toolkit, its stepwise evolution, as well as the toolkit implementation as a Massive Open Online Course (MOOC), are presented. The "Best Care for People with Late-Stage Parkinson's disease" curriculum toolkit can provide high-quality and equitable education, delivered by an interdisciplinary team of educators. The toolkit can improve communication about palliative care in neurological conditions at international and multidisciplinary level. It can also offer continuing medical education for healthcare providers.

Περίληψη στην Ελληνική

Τεχνολογικές λύσεις στην φροντίδα της νόσου του Πάρκινσον

Οι φορέσιμες συσκευές και οι εφαρμογές για κινητά που εντάσσονται στις τεχνολογίες mhealth, θεωρείται ότι μπορούν να προσφέρουν πολύτιμες και αξιόπιστες πληροφορίες για την διαχείριση της νόσου του Πάρκινσον καλύπτοντας τις περιόδους μεταξύ ιατρικών επισκέψεων και βελτιώνοντας την εξ' αποστάσεως παρακολούθηση των συμπτωμάτων.

Στα πλαίσια της διατριβής αρχικά μελετήσαμε την εφικτότητα της χρήσης της πλατφόρμας mhealth PD_manager, που αποτελείται από ένα κινητό σε συνδυασμό με ένα έξυπνο ρολόι και ένα ζευγάρι έξυπνες σόλες, για την συλλογή κλινικά χρήσιμων δεδομένων. Η συμμόρφωση στην χρήση του συστήματος αξιολογήθηκε με στατιστική ανάλυση και οι παράγοντες που επηρεάζουν την συμμόρφωση με regression μεθόδους. Επίσης, επιβεβαιώσαμε περαιτέρω μια μέθοδο αξιολόγησης του τρόμου με εφαρμογή στην καθημερινότητα των ασθενών.

Η προσέγγιση PD_manager αποδείχτηκε εφικτή. Τα κινητικά συμπτώματα στις καθημερινές δραστηριότητες και η υποκειμενική αξιολόγηση της κατάστασης της υγείας τους όπως την αντιλαμβάνονται οι ασθενείς, ήταν οι παράγοντες που επηρεάζουν την συμμόρφωση με την χρήση του συστήματος. Στη συνέχεια χρησιμοποιήσαμε όλα τα ευρήματα και την πρακτική μας εμπειρία για να σχεδιάσουμε το σύστημα υποστήριξης κλινικής απόφασης PRIME, το οποίο τροφοδοτείται από mhealth δεδομένα και κλινικές κατευθυντήριες οδηγίες και υλοποιείται σαν επιπλέον λειτουργικότητα των ψηφιακών ιατρικών φακέλων.

Η μέχρι τώρα εργασία μας υποστηρίζει περαιτέρω ότι οι προσεγγίσεις mHealth μπορεί να είναι ένα αποτελεσματικό εργαλείο για την οικολογικά έγκυρη, παθητική, διακριτική παρακολούθηση και αξιολόγηση των συμπτωμάτων. Μελλοντικές μελέτες θα δείξουν ότι ένα mhealth σύστημα υποστήριξης κλινικής απόφασης μπορεί να βελτιώσει τη διαχείριση και τη φροντίδα της νόσου.

Διαδικτυακή εκπαίδευση για την φροντίδα στη νόσο του Πάρκινσον Τελικού Σταδίου

Η εκπαίδευση όσων εμπλέκονται στην ανακουφιστική φροντίδα ασθενών με νόσο του Πάρκινσον σε προχωρημένο στάδιο δεν είναι επαρκής. Στην πραγματικότητα, υπάρχουν πολλές ανεκπλήρωτες ανάγκες εκπαίδευσης και κατάρτισης, όπως επιβεβαιώνεται με μια στοχευμένη ανασκόπηση της βιβλιογραφίας.

Για την αντιμετώπιση αυτών των αναγκών, η διεπιστημονική ομάδα PD_Pal ανέπτυξε το πρόγραμμα σπουδών «Βέλτιστη φροντίδα για άτομα με τη νόσο του Πάρκινσον στο προχωρημένο

στάδιο». Η εργαλειοθήκη βασίζεται σε συστάσεις και οδηγίες για την επιμόρφωση και εκπαίδευση των κλινικών και άλλων επαγγελματιών της υγείας που ασχολούνται με την ανακουφιστική φροντίδα, ανατροφοδότηση από Έλληνες νευρολόγους, εκπαιδευτικό υλικό που αναπτύχθηκε σε πρόσφατες ερευνητικές προσπάθειες για ασθενείς και φροντιστές με Πάρκινσον και συναντήσεις κορυφαίων ειδικών στον τομέα. Η τελική έκδοση της προτεινόμενης εργαλειοθήκης συντάχθηκε μετά από αξιολόγηση εξωτερικών εμπειρογνομόνων με διαδικτυακή έρευνα.

Η εργαλειοθήκη είναι συμβατή με το θεμελιώδες πλαίσιο του Kern για την ανάπτυξη προγραμμάτων σπουδών, που προσαρμόστηκε πρόσφατα στη διαδικτυακή μάθηση. Η στατιστική ανάλυση της διαδικτυακής έρευνας, με στόχο την αξιολόγηση της εργαλειοθήκης από εξωτερικούς εμπειρογνώμονες (27 συνολικά), επιβεβαιώνει ότι όλα τα θέματα εκτός από ένα (διατροφή στην προχωρημένη νόσο του Πάρκινσον), καθώς και οι στόχοι και το περιεχόμενό τους, είναι εξαιρετικά σχετικά και χρήσιμα.

Στην παρούσα διατριβή παρουσιάζονται οι μέθοδοι ανάπτυξης της εργαλειοθήκης, η σταδιακή εξέλιξή της, καθώς και η εφαρμογή της εργαλειοθήκης ως Μαζικό Ανοιχτό Διαδικτυακό Μάθημα (MOOC). Η εργαλειοθήκη προγράμματος σπουδών «Βέλτιστη φροντίδα για άτομα με τη νόσο του Πάρκινσον στο προχωρημένο στάδιο» μπορεί να προσφέρει υψηλής ποιότητας εκπαίδευση, η οποία παρέχεται από μια διεπιστημονική ομάδα εκπαιδευτικών. Η εργαλειοθήκη μπορεί να βελτιώσει την επικοινωνία σχετικά με την ανακουφιστική φροντίδα σε νευρολογικές παθήσεις σε διεθνές και διεπιστημονικό επίπεδο. Μπορεί επίσης να προσφέρει συνεχή ιατρική εκπαίδευση για τους παρόχους υγειονομικής περίθαλψης.

References

1. Espay AJ, Bonato P, Nahab FB, Maetzler W, Dean JM, Klucken J, et al. Technology in Parkinson's disease: Challenges and opportunities. *Mov Disord.* 2016;31(9):1272-82.
2. Papa SM, Brundin P, Fung VS, Kang UJ, Burn DJ, Colosimo C, et al. Impact of the COVID-19 pandemic on Parkinson's disease and movement disorders. 2020;7(4):357.
3. Cubo E, Hassan A, Bloem BR, Mari ZJJoPsd. Implementation of telemedicine for urgent and ongoing healthcare for patients with Parkinson's disease during the COVID-19 pandemic: new expectations for the future. 2020;10(3).
4. Miele G, Straccia G, Moccia M, Leocani L, Tedeschi G, Bonavita S, et al. Telemedicine in Parkinson's disease: how to ensure patient needs and continuity of care at the time of COVID-19 pandemic. 2020;26(12):1533-6.
5. Dorsey E, Okun MS, Bloem BRJJoPsd. Care, convenience, comfort, confidentiality, and contagion: the 5 C's that will shape the future of telemedicine. 2020;10(3):893-7.
6. Rovini E, Maremmani C, Cavallo F. How wearable sensors can support Parkinson's disease diagnosis and treatment: a systematic review. *Frontiers in neuroscience.* 2017;11:555.
7. Del Din S, Kirk C, Yarnall AJ, Rochester L, Hausdorff JMJoPsd. Body-Worn Sensors for Remote Monitoring of Parkinson's Disease Motor Symptoms: Vision, State of the Art, and Challenges Ahead. 2021(Preprint):1-13.
8. Godinho C, Domingos J, Cunha G, Santos AT, Fernandes RM, Abreu D, et al. A systematic review of the characteristics and validity of monitoring technologies to assess Parkinson's disease. 2016;13(1):1-10.
9. Morgan C, Rolinski M, McNaney R, Jones B, Rochester L, Maetzler W, et al. Systematic review looking at the use of technology to measure free-living symptom and activity outcomes in Parkinson's disease in the home or a home-like environment. 2020;10(2):429-54.
10. Erb MK, Karlin DR, Ho BK, Thomas KC, Parisi F, Vergara-Diaz GP, et al. mHealth and wearable technology should replace motor diaries to track motor fluctuations in Parkinson's disease. 2020;3(1):1-10.
11. Bayés À, Samá A, Prats A, Pérez-López C, Crespo-Maraver M, Moreno JM, et al. A "HOLTER" for Parkinson's disease: Validation of the ability to detect on-off states using the REMPARK system. *Gait & posture.* 2018;59:1-6.
12. Bot BM, Suver C, Neto EC, Kellen M, Klein A, Bare C, et al. The mPower study, Parkinson disease mobile data collected using ResearchKit. *Scientific data.* 2016;3:160011.
13. Cohen S, Waks Z, Elm JJ, Gordon MF, Grachev ID, Navon-Perry L, et al. Characterizing patient compliance over six months in remote digital trials of Parkinson's and Huntington disease. 2018;18(1):1-10.
14. Elm JJ, Daeschler M, Bataille L, Schneider R, Amara A, Espay AJ, et al. Feasibility and utility of a clinician dashboard from wearable and mobile application Parkinson's disease data. *NPJ digital medicine.* 2019;2(1):1-6.

15. de Lima ALS, Hahn T, Evers LJ, de Vries NM, Cohen E, Afek M, et al. Feasibility of large-scale deployment of multiple wearable sensors in Parkinson's disease. *PLoS One*. 2017;12(12):e0189161.
16. Fisher JM, Hammerla NY, Rochester L, Andras P, Walker RW. Body-worn sensors in Parkinson's disease: Evaluating their acceptability to patients. *Telemedicine and e-Health*. 2016;22(1):63-9.
17. Ellis TD, Cavanaugh JT, DeAngelis T, Hendron K, Thomas CA, Saint-Hilaire M, et al. Comparative Effectiveness of mHealth-Supported Exercise Compared With Exercise Alone for People With Parkinson Disease: Randomized Controlled Pilot Study. *Phys Ther*. 2019;99(2):203-16.
18. Horin AP, McNeely ME, Harrison EC, Myers PS, Sutter EN, Rawson KS, et al. Usability of a daily mHealth application designed to address mobility, speech and dexterity in Parkinson's disease. *Neurodegenerative disease management*. 2019;9(2):97-105.
19. Heijmans M, Habets JG, Herff C, Aarts J, Stevens A, Kuijf ML, et al. Monitoring Parkinson's disease symptoms during daily life: a feasibility study. *npj Parkinson's Disease*. 2019;5(1):1-6.
20. Heldman DA, Harris DA, Felong T, Andrzejewski KL, Dorsey ER, Giuffrida JP, et al. Telehealth management of Parkinson's disease using wearable sensors: an exploratory study. *Digital biomarkers*. 2017;1(1):43-51.
21. Arora S, Venkataraman V, Zhan A, Donohue S, Biglan KM, Dorsey ER, et al. Detecting and monitoring the symptoms of Parkinson's disease using smartphones: a pilot study. *Parkinsonism & related disorders*. 2015;21(6):650-3.
22. Lakshminarayana R, Wang D, Burn D, Chaudhuri KR, Galtrey C, Guzman NV, et al. Using a smartphone-based self-management platform to support medication adherence and clinical consultation in Parkinson's disease. *npj Parkinson's Disease*. 2017;3(1):2.
23. Bouça-Machado R, Pona-Ferreira F, Leitão M, Clemente A, Vila-Viçosa D, Kauppila LA, et al. Feasibility of a Mobile-Based System for Unsupervised Monitoring in Parkinson's Disease. 2021;21(15):4972.
24. Pahwa R, Isaacson SH, Torres-Russotto D, Nahab FB, Lynch PM, Kotschet KE. Role of the Personal KinetiGraph in the routine clinical assessment of Parkinson's disease: recommendations from an expert panel. *Expert review of neurotherapeutics*. 2018;18(8):669-80.
25. Antonini A, Gentile G, Giglio M, Marcante A, Gage H, Touray MM, et al. Acceptability to patients, carers and clinicians of an mHealth platform for the management of Parkinson's disease (PD_Manager): study protocol for a pilot randomised controlled trial. *Trials*. 2018;19(1):492.
26. Tsiouris KM, Gatsios D, Rigas G, Miljkovic D, Korousic Seljak B, Bohanec M, et al. PD_Manager: an mHealth platform for Parkinson's disease patient management. *Healthc Technol Lett*. 2017;4(3):102-8.
27. Cancela J, Mascato SV, Gatsios D, Rigas G, Marcante A, Gentile G, et al. Monitoring of motor and non-motor symptoms of Parkinson's disease through a mHealth platform. 2016 38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC). 2016:663-6.
28. Cikajlo I, Hukić A, Dolinšek I, Zajc D, Vesel M, Krizmanič T, et al. Can telerehabilitation games lead to functional improvement of upper extremities in individuals with Parkinson's disease?

International journal of rehabilitation research Internationale Zeitschrift für Rehabilitationsforschung
Revue internationale de recherches de readaptation. 2018;41(3):230.

29. Bohanec M, Miljković D, Valmarska A, Mileva Boshkoska B, Gasparoli E, Gentile G, et al. A decision support system for Parkinson disease management: expert models for suggesting medication change. *Journal of Decision Systems*. 2018;27(sup1):164-72.
30. Rigas G, Gatsios D, Fotiadis DI, Chondrogiorgi M, Tsironis C, Konitsiotis S, et al., editors. Tremor UPDRS estimation in home environment. 2016 38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC); 2016: IEEE.
31. Espay AJ, Hausdorff JM, Sánchez-Ferro Á, Klucken J, Merola A, Bonato P, et al. A roadmap for implementation of patient-centered digital outcome measures in Parkinson's disease obtained using mobile health technologies. *Movement Disorders*. 2019.
32. Spear KL, Auinger P, Simone R, Dorsey ER, Francis J. Patient Views on Telemedicine for Parkinson Disease. *J Parkinsons Dis*. 2019;9(2):401-4.
33. Ferraris C, Nerino R, Chimienti A, Pettiti G, Cau N, Cimolin V, et al. Feasibility of Home-Based Automated Assessment of Postural Instability and Lower Limb Impairments in Parkinson's Disease. *Sensors*. 2019;19(5):1129.
34. Varghese J, Niewohner S, Soto-Rey I, Schipmann-Miletic S, Warneke N, Warnecke T, et al. A Smart Device System to Identify New Phenotypical Characteristics in Movement Disorders. *Front Neurol*. 2019;10:48.
35. de Lima ALS, Smits T, Darweesh SK, Valenti G, Milosevic M, Pijl M, et al. Home-based monitoring of falls using wearable sensors in Parkinson's disease. *Movement disorders*. 2019.
36. Farzanehfar P, Woodrow H, Braybrook M, McGregor S, Evans A, Nicklason F, et al. Objective measurement in routine care of people with Parkinson's disease improves outcomes. *npj Parkinson's Disease*. 2018;4(1):10.
37. Dorsey ER, Vlaanderen FP, Engelen LJ, Kiebertz K, Zhu W, Biglan KM, et al. Moving Parkinson care to the home. *Mov Disord*. 2016;31(9):1258-62.
38. Ben-Pazi H, Browne P, Chan P, Cubo E, Guttman M, Hassan A, et al. The Promise of Telemedicine for Movement Disorders: an Interdisciplinary Approach. *Curr Neurol Neurosci Rep*. 2018;18(5):26.
39. Evans L, Mohamed B, Thomas ECJBoq. Using telemedicine and wearable technology to establish a virtual clinic for people with Parkinson's disease. 2020;9(3):e001000.
40. Bloem B, Marks W, de Lima AS, Kuijf M, van Laar T, Jacobs B, et al. The Personalized Parkinson Project: examining disease progression through broad biomarkers in early Parkinson's disease. *BMC neurology*. 2019;19(1):160.
41. Lieber B, Taylor BE, Appelboom G, McKhann G, Connolly ES, Jr. Motion Sensors to Assess and Monitor Medical and Surgical Management of Parkinson Disease. *World Neurosurg*. 2015;84(2):561-6.

42. Kruse CS, Argueta DA, Lopez L, Nair A. Patient and provider attitudes toward the use of patient portals for the management of chronic disease: a systematic review. *Journal of medical Internet research*. 2015;17(2):e40.
43. Reed ME, Huang J, Millman A, Graetz I, Hsu J, Brand R, et al. Portal Use Among Patients With Chronic Conditions: Patient-reported Care Experiences. *Medical care*. 2019;57(10):809-14.
44. Kao CK, Liebovitz DM. Consumer Mobile Health Apps: Current State, Barriers, and Future Directions. *PM & R : the journal of injury, function, and rehabilitation*. 2017;9(55):S106-S15.
45. Christiansen EK, Skipenes E, Hausken MF, Skeie S, Østbye T, Iversen MM. Shared Electronic Health Record Systems: Key Legal and Security Challenges. *Journal of diabetes science and technology*. 2017;11(6):1234-9.
46. Hansen C, Sanchez-Ferro A, Maetzler WJJoPsd. How mobile health technology and electronic health records will change care of patients with Parkinson's disease. *J Parkinsons Dis*. 2018;8(s1):S41-S5.
47. Ryu B, Kim N, Heo E, Yoo S, Lee K, Hwang H, et al. Impact of an Electronic Health Record-Integrated Personal Health Record on Patient Participation in Health Care: Development and Randomized Controlled Trial of MyHealthKeeper. *Journal of medical Internet research*. 2017;19(12):e401.
48. Kong T, Scott MM, Li Y, Wichelman C. Physician attitudes towards-and adoption of-mobile health. *Digital health*. 2020;6:2055207620907187.
49. Tully J, Dameff C, Longhurst CA. Wave of Wearables: Clinical Management of Patients and the Future of Connected Medicine. *Clinics in laboratory medicine*. 2020;40(1):69-82.
50. Sutton RT, Pincock D, Baumgart DC, Sadowski DC, Fedorak RN, Kroeker KIJNdm. An overview of clinical decision support systems: benefits, risks, and strategies for success. *npj Digital Medicine*. 2020;3(1):1-10.
51. Sim I, Gorman P, Greenes RA, Haynes RB, Kaplan B, Lehmann H, et al. Clinical decision support systems for the practice of evidence-based medicine. 2001;8(6):527-34.
52. Dias D, Paulo Silva Cunha JJS. Wearable health devices—vital sign monitoring, systems and technologies. 2018;18(8):2414.
53. Gatsios D, Antonini A, Gentile G, Marcante A, Pellicano C, Macchiusi L, et al. Feasibility and Utility of mHealth for the Remote Monitoring of Parkinson Disease: Ancillary Study of the PD_manager Randomized Controlled Trial. *JMIR mHealth and uHealth*. 2020;8(6):e16414.
54. Timotijevic L, Hodgkins C, Banks A, Rusconi P, Egan B, Peacock M, et al. Designing a mHealth clinical decision support system for Parkinson's disease: a theoretically grounded user needs approach. *BMC Medical Informatics and Decision Making*. 2020;20(1):1-21.
55. Younesi E, Malhotra A, Gündel M, Scordis P, Kodamullil AT, Page M, et al. PDON: Parkinson's disease ontology for representation and modeling of the Parkinson's disease knowledge domain. *Theoretical biology & medical modelling*. 2015;12:20.

56. Fox SH, Katzenschlager R, Lim SY, Barton B, de Bie RM, Seppi K, et al. International Parkinson and movement disorder society evidence-based medicine review: update on treatments for the motor symptoms of Parkinson's disease. *Mov Disord.* 2018;33(8):1248-66.
57. Seppi K, Ray Chaudhuri K, Coelho M, Fox SH, Katzenschlager R, Perez Lloret S, et al. Update on treatments for nonmotor symptoms of Parkinson's disease—an evidence-based medicine review. *Mov Disord.* 2019;34(2):180-98.
58. Knaul FM, Bhadelia A, Rodriguez NM, Arreola-Ornelas H, Zimmermann CJTLGH. The Lancet Commission on Palliative Care and Pain Relief—findings, recommendations, and future directions. 2018;6:S5-S6.
59. Jordan SR, Kluger B, Ayele R, Brungardt A, Hall A, Jones J, et al. Optimizing future planning in Parkinson disease: suggestions for a comprehensive roadmap from patients and care partners. 2020;9(Suppl 1):S63.
60. Fox S, Cashell A, Kernohan WG, Lynch M, McGlade C, O'Brien T, et al. Palliative care for Parkinson's disease: Patient and carer's perspectives explored through qualitative interview. *J Palliative medicine.* 2017;31(7):634-41.
61. van der Eijk M, Faber MJ, Ummels I, Aarts JW, Munneke M, Bloem BRJP, et al. Patient-centeredness in PD care: development and validation of a patient experience questionnaire. 2012;18(9):1011-6.
62. McLaughlin D, Hasson F, Kernohan WG, Waldron M, McLaughlin M, Cochrane B, et al. Living and coping with Parkinson's disease: perceptions of informal carers. *J Palliative Medicine.* 2011;25(2):177-82.
63. Robinson MT, Holloway RG, editors. *Palliative care in neurology.* Mayo Clinic Proceedings; 2017: Elsevier.
64. Lum HD, Kluger BM. Palliative Care for Parkinson Disease. *J Clinics in geriatric medicine.* 2020;36(1):149.
65. Robinson MT, Barrett KM. Emerging subspecialties in neurology: neuropalliative care. *J Neurology.* 2014;82(21):e180-e2.
66. Paal P, Brandstötter C, Lorenzl S, Larkin P, Elsner F. Postgraduate palliative care education for all healthcare providers in Europe: results from an EAPC survey. *J Palliative supportive care.* 2019;17(5):495-506.
67. Paal P, Brandstötter C, Bükki J, Elsner F, Ersteniuk A, Jentschke E, et al. One-week multidisciplinary post-graduate palliative care training: an outcome-based program evaluation. *BMC Medical Education.* 2020;20(1):1-9.
68. Best M, Leget C, Goodhead A, Paal P. An EAPC white paper on multi-disciplinary education for spiritual care in palliative care. *J BMC Palliative Care.* 2020;19(1):9.
69. Brighton LJ, Koffman J, Hawkins A, McDonald C, O'Brien S, Robinson V, et al. A systematic review of end-of-life care communication skills training for generalist palliative care providers: research quality and reporting guidance. *Journal of pain symptom management.* 2017;54(3):417-25.

70. Gamondi C, Larkin P-J, Payne S. Core competencies in palliative care. *European Journal of palliative care*. 2013;20(2):86-91.
71. Mason SR, Ling J, Stanciulescu L, Payne C, Paal P, Albu S, et al. From European Association for Palliative Care Recommendations to a Blended, Standardized, Free-to-Access Undergraduate Curriculum in Palliative Medicine: The EDUPALL Project. *Journal of Palliative Medicine*. 2020.
72. A'campo L, Spliethoff-Kamminga N, Macht M, Roos R, Consortium E. Caregiver education in Parkinson's disease: formative evaluation of a standardized program in seven European countries. *J Quality of Life Research*. 2010;19(1):55-64.
73. Simons G, Thompson SB, Pasqualini MCS. An innovative education programme for people with Parkinson's disease and their carers. *Parkinsonism related disorders*. 2006;12(8):478-85.
74. Ministry of Health FSfPCiG, National Committee on the Development and Implementation of the Strategy for Relief Care in Greece," Funding from the Foundation Stavros Niarchos, New York - Athens, Greece.
75. Organization WH. Strengthening of palliative care as a component of integrated treatment throughout the life course. *Journal of Pain Palliative Care Pharmacotherapy*. 2014;28(2):130-4.
76. Miyasaki JM, Kluger B. Palliative care for Parkinson's disease: has the time come? *J Current Neurology Neuroscience Reports*. 2015;15(5):26.
77. Van Vliet LM, Gao W, DiFrancesco D, Crosby V, Wilcock A, Byrne A, et al. How integrated are neurology and palliative care services? Results of a multicentre mapping exercise. *BMC neurology*. 2016;16(1):63.
78. Jordan SR, Kluger B, Ayele R, Brungardt A, Hall A, Jones J, et al. Optimizing future planning in Parkinson disease: suggestions for a comprehensive roadmap from patients and care partners. *J Annals of palliative medicine*. 2020;9(Suppl 1):S63.
79. Sandsdalen T, Grøndahl VA, Hov R, Høye S, Rystedt I, Wilde-Larsson B. Patients' perceptions of palliative care quality in hospice inpatient care, hospice day care, palliative units in nursing homes, and home care: a cross-sectional study. *BMC palliative care*. 2016;15(1):79.
80. Moens K, Houttekier D, Van den Block L, Harding R, Morin L, Marchetti S, et al. Place of death of people living with Parkinson's disease: a population-level study in 11 countries. *BMC palliative care*. 2015;14(1):28.
81. Connor K, Cheng E, Siebens HC, Lee ML, Mittman BS, Ganz DA, et al. Study protocol of "CHAPS": a randomized controlled trial protocol of Care Coordination for Health Promotion and Activities in Parkinson's Disease to improve the quality of care for individuals with Parkinson's disease. *BMC neurology*. 2015;15(1):258.
82. van der Eijk M, Faber MJ, Ummels I, Aarts JW, Munneke M, Bloem BR. Patient-centeredness in PD care: development and validation of a patient experience questionnaire. *Parkinsonism related disorders*. 2012;18(9):1011-6.
83. Olsson Y, Clarén L, Alvariza A, Årestedt K, Hagell P. Health and social service access among family caregivers of people with Parkinson's disease. *Journal of Parkinson's disease*. 2016;6(3):581-7.

84. Schrag A, Hovris A, Morley D, Quinn N, Jahanshahi M. Caregiver-burden in Parkinson's disease is closely associated with psychiatric symptoms, falls, and disability. *Parkinsonism related disorders*. 2006;12(1):35-41.
85. Hasson F, Kernohan WG, McLaughlin M, Waldron M, McLaughlin D, Chambers H, et al. An exploration into the palliative and end-of-life experiences of carers of people with Parkinson's disease. *J Palliative medicine*. 2010;24(7):731-6.
86. Goy ER, Carter JH, Ganzini L. Needs and experiences of caregivers for family members dying with Parkinson disease. *Journal of Palliative Care*. 2008;24(2):69-75.
87. Sokol LL, Young MJ, Paparian J, Kluger BM, Lum HD, Besbris J, et al. Advance care planning in Parkinson's disease: ethical challenges and future directions. *NPJ Parkinsons Dis* 2019;5(1):1-7.
88. Aoun S, McConigley R, Abernethy A, Currow DC. Caregivers of people with neurodegenerative diseases: profile and unmet needs from a population-based survey in South Australia. *Journal of palliative medicine*. 2010;13(6):653-61.
89. Carter J, Lyons K, Lindauer A, Malcom J. Pre-death grief in Parkinson's caregivers: a pilot survey-based study. *J Parkinsonism related disorders*. 2012;18:S15-S8.
90. Tuck KK, Brod L, Nutt J, Fromme EK. Preferences of patients with Parkinson's disease for communication about advanced care planning. *American Journal of Hospice Palliative Medicine*. 2015;32(1):68-77.
91. Walter HA, Seeber AA, Willems DL, De Visser M. The role of palliative care in chronic progressive neurological diseases—A survey amongst neurologists in the Netherlands. *Frontiers in Neurology*. 2019;9:1157.
92. Miyasaki JM. Treatment of advanced Parkinson disease and related disorders. *CONTINUUM: Lifelong Learning in Neurology*. 2016;22(4):1104-16.
93. Katz M, Goto Y, Kluger BM, Galifianakis NB, Miyasaki JM, Kutner JS, et al. Top Ten Tips Palliative Care Clinicians Should Know About Parkinson's Disease and Related Disorders. *Journal of Palliative Medicine*. 2018;21(10):1507-17.
94. Tarolli CG, Holloway RG. Palliative care and Parkinson's disease: outpatient needs and models of care over the disease trajectory. *Annals of Palliative Medicine*. 2019;9(Suppl 1):S44-S51.
95. Thomas PA, Kern DE, Hughes MT, Chen BY. *Curriculum development for medical education: a six-step approach*: JHU Press; 2016.
96. Chen BY, Kern DE, Kearns RM, Thomas PA, Hughes MT, Tackett S. From modules to MOOCs: application of the six-step approach to online curriculum development for medical education. *J Academic Medicine*. 2019;94(5):678-85.
97. Hoy MB. MOOCs 101: an introduction to massive open online courses. *J Medical reference services quarterly*. 2014;33(1):85-91.
98. Goldberg LR, Crocombe LA. Advances in medical education and practice: role of massive open online courses. *J Advances in medical education practice*. 2017;8:603.

99. Mehta NB, Hull AL, Young JB, Stoller JK. Just imagine: new paradigms for medical education. *J Academic Medicine*. 2013;88(10):1418-23.
100. Subhi Y, Andresen K, Bojsen SR, Nilsson PM, Konge L. Massive open online courses are relevant for postgraduate medical training. *Dan Med J*. 2014;61(10):A4923.
101. Koch S, Hägglund M. Mutual Learning and Exchange of Health Informatics Experiences from Around the World-Evaluation of a Massive Open Online Course in eHealth. *Studies in Health Technology Informatics*. 2017;245:753-7.
102. Paal P, Brandstötter C, Bükki J, Elsner F, Ersteniuk A, Jentschke E, et al. One-week multidisciplinary post-graduate palliative care training: an outcome-based program evaluation. *BMC medical education*. 2020;20(1):276.

Appendix I: Author's publications

[Feasibility and Utility of mHealth for the Remote Monitoring of Parkinson Disease: Ancillary Study of the PD_manager Randomized Controlled Trial.](#)

Gatsios D, Antonini A, Gentile G, Marcante A, Pellicano C, Macchiusi L, Assogna F, Spalletta G, Gage H, Touray M, Timotijevic L, Hodgkins C, Chondrogiorgi M, Rigas G, Fotiadis DI, Konitsiotis S.

JMIR Mhealth Uhealth. 2020 Jun 29;8(6):e16414. doi: 10.2196/16414.

PMID: 32442154 **Free PMC article.**

[Education on palliative care for Parkinson patients: development of the "Best care for people with late-stage Parkinson's disease" curriculum toolkit.](#)

Gatsios D, Antonini A, Gentile G, Konitsiotis S, Fotiadis D, Nixina I, Taba P, Weck C, Lorenzl S, Lex KM, Paal P.

BMC Med Educ. 2021 Oct 25;21(1):538. doi: 10.1186/s12909-021-02964-6.

PMID: 34696752 **Free PMC article.** Review.

[Exploring the knowledge and views of Greek Neurologists regarding Palliative Care Topics.](#)

Nixina I, Gatsios D, Paal P, Konitsiotis S, Fotiadis DI.

Annu Int Conf IEEE Eng Med Biol Soc. 2021 Nov;2021:7617-7620. doi: 10.1109/EMBC46164.2021.9629508.

PMID: 34892853

[Design of a clinical decision support system powered by mhealth for the management of Parkinson's disease](#)

Gatsios D, Rigas G, Konitsiotis S.

6th South-East Europe Design Automation, Computer Engineering, Computer Networks and Social Media Conference (SEEDA-CECNSM). 2021 Oct 18. doi: 10.1109/SEEDA-CECNSM53056.2021.9566260

[Designing interoperable telehealth platforms: bridging IoT devices with cloud infrastructures](#)

Tsiouris K, Gatsios D, Tsakanikas V, ...Koutsouris D, Fotiadis D.I.

Enterprise Information Systems. 2020 Apr 19, 14(8): 1194–1218. doi: 10.1080/17517575.2020.1759146

[Decision Support for Medication Change of Parkinson's Disease Patients.](#)

Boshkoska BM, Miljković D, Valmarska A, Gatsios D, Rigas G, Konitsiotis S, Tsiouris KM, Fotiadis D, Bohanec M.

Comput Methods Programs Biomed. 2020 Nov;196:105552. doi: 10.1016/j.cmpb.2020.105552. Epub 2020 May 29.

PMID: 32531652

[Designing a mHealth clinical decision support system for Parkinson's disease: a theoretically grounded user needs approach.](#)

Timotijevic L, Hodgkins CE, Banks A, Rusconi P, Egan B, Peacock M, Seiss E, Touray MML, Gage H, Pellicano C, Spalletta G, Assogna F, Giglio M, Marcante A, Gentile G, Cikajlo I, Gatsios D, Konitsiotis S, Fotiadis D.

BMC Med Inform Decis Mak. 2020 Feb 19;20(1):34. doi: 10.1186/s12911-020-1027-1.

PMID: 32075633 **Free PMC article.**

[Acceptability to patients, carers and clinicians of an mHealth platform for the management of Parkinson's disease \(PD Manager\): study protocol for a pilot randomised controlled trial.](#)

Antonini A, Gentile G, Giglio M, Marcante A, Gage H, Touray MML, Fotiadis DI, Gatsios D, Konitsiotis S, Timotijevic L, Egan B, Hodgkins C, Biundo R, Pellicano C; PD_Manager consortium.

Trials. 2018 Sep 14;19(1):492. doi: 10.1186/s13063-018-2767-4.

PMID: 30217235 **Free PMC article.**

[Tremor UPDRS estimation in home environment.](#)

Rigas G, Gatsios D, Fotiadis DI, Chondrogiorgi M, Tsironis C, Konitsiotis S, Gentile G, Marcante A, Antonini A.

Annu Int Conf IEEE Eng Med Biol Soc. 2016 Aug;2016:3642-3645. doi: 10.1109/EMBC.2016.7591517.

PMID: 28269083

[Foot Pressure Wearable Sensors for Freezing of Gait Detection in Parkinson's Disease.](#)

Marcante A, Di Marco R, Gentile G, Pellicano C, Assogna F, Pontieri FE, Spalletta G, Macchiusi L, Gatsios D, Giannakis A, Chondrogiorgi M, Konitsiotis S, Fotiadis DI, Antonini A.

Sensors (Basel). 2020 Dec 28;21(1):128. doi: 10.3390/s21010128.

PMID: 33379174 **Free PMC article.**

[Symptoms and medications change patterns for Parkinson's disease patients stratification.](#)

Valmarska A, Miljkovic D, Konitsiotis S, Gatsios D, Lavrač N, Robnik-Šikonja M.

Artif Intell Med. 2018 Sep;91:82-95. doi: 10.1016/j.artmed.2018.04.010. Epub 2018 May 24.

PMID: 29803610

[Automatic Absence Seizures Detection in EEG signals: An Unsupervised Module.](#)

Tsiouris KM, Konitsiotis S, Gatsios D, Koutsouris DD, Fotiadis DI.

Annu Int Conf IEEE Eng Med Biol Soc. 2020 Jul;2020:532-535. doi: 10.1109/EMBC44109.2020.9176082.

PMID: 33018044

[A Review of Virtual Coaching Systems in Healthcare: Closing the Loop With Real-Time Feedback.](#)

Tsiouris KM, Tsakanikas VD, Gatsios D, Fotiadis DI.

Front Digit Health. 2020 Sep 30;2:567502. doi: 10.3389/fdgth.2020.567502. eCollection 2020.

PMID: 34713040 **Free PMC article.** Review.

[A Dynamic Bayesian Network Approach to Behavioral Modelling of Elderly People during a Home-based Augmented Reality Balance Physiotherapy Programme.](#)

Georga EI, Gatsios D, Tsakanikas V, Kourou KD, Liston M, Pavlou M, Kikidis D, Bibas A, Nikitas C, Bamiou DE, Fotiadis DI.

Annu Int Conf IEEE Eng Med Biol Soc. 2020 Jul;2020:5544-5547. doi: 10.1109/EMBC44109.2020.9175435.

PMID: 33019234

[Identification of genetic markers for treatment success in heart failure patients: insight from cardiac resynchronization therapy.](#)

Schmitz B, De Maria R, Gatsios D, Chrysanthakopoulou T, Landolina M, Gasparini M, Campolo J, Parolini M, Sanzo A, Galimberti P, Bianchi M, Lenders M, Brand E, Parodi O, Lunati M, Brand SM.

Circ Cardiovasc Genet. 2014 Dec;7(6):760-70. doi: 10.1161/CIRCGENETICS.113.000384. Epub 2014 Sep 10.

PMID: 25210049

[Evaluating the Performance of Balance Physiotherapy Exercises Using a Sensory Platform: The Basis for a Persuasive Balance Rehabilitation Virtual Coaching System.](#)

Tsakanikas VD, Gatsios D, Dimopoulos D, Pardalis A, Pavlou M, Liston MB, Fotiadis DI.

Front Digit Health. 2020 Nov 27;2:545885. doi: 10.3389/fdgth.2020.545885. eCollection 2020.

PMID: 34713032 **Free PMC article.**

[Monitoring of motor and non-motor symptoms of Parkinson's disease through a mHealth platform.](#)

Cancela J, Villanueva Mascato S, Gatsios D, Rigas G, Marcante A, Gentile G, Biundo R, Giglio M, Chondrogiorgi M, Vilzmann R, Konitsiotis S, Antonini A, Arredondo MT, Fotiadis DI.

Annu Int Conf IEEE Eng Med Biol Soc. 2016 Aug;2016:663-666. doi: 10.1109/EMBC.2016.7590789.

PMID: 28268415

[Investigating the feasibility and acceptability of the HOLOBalance system compared with standard care in older adults at risk for falls: study protocol for an assessor blinded pilot randomised controlled study.](#)

Liston M, Genna G, Maurer C, Kikidis D, Gatsios D, Fotiadis D, Bamiou DE, Pavlou M.

BMJ Open. 2021 Feb 12;11(2):e039254. doi: 10.1136/bmjopen-2020-039254.

PMID: 33579762 **Free PMC article.**

[Exploring the Acceptability and Feasibility of Providing a Balance Tele-Rehabilitation Programme to Older Adults at Risk for Falls: An Initial Assessment.](#)

Pardalis AA, Gatsios D, Tsakanikas VD, Walz I, Maurer C, Kikidis D, Nikitas C, Papadopoulou S, Bibas A, Fotiadis DI.

Annu Int Conf IEEE Eng Med Biol Soc. 2021 Nov;2021:6915-6919. doi: 10.1109/EMBC46164.2021.9629478.

PMID: 34892694

[Modeling of blood flow through sutured micro-vascular anastomoses.](#)

Karanasiou GS, Gatsios DA, Lykissas MG, Stefanou KA, Rigas GA, Lagaris IE, Kostas-Agnantis IP, Gkiatas I, Beris AE, Fotiadis DI.

Annu Int Conf IEEE Eng Med Biol Soc. 2015;2015:1877-80. doi: 10.1109/EMBC.2015.7318748.

PMID: 26736648

[Predicting rapid progression of Parkinson's Disease at baseline patients evaluation.](#)

Tsiouris KM, Rigas G, Gatsios D, Antonini A, Konitsiotis S, Koutsouris DD, Fotiadis DI.

Annu Int Conf IEEE Eng Med Biol Soc. 2017 Jul;2017:3898-3901. doi: 10.1109/EMBC.2017.8037708.

PMID: 29060749

[PD Manager: an mHealth platform for Parkinson's disease patient management.](#)

Tsiouris KM, Gatsios D, Rigas G, Miljkovic D, Koroušić Seljak B, Bohanec M, Arredondo MT, Antonini A, Konitsiotis S, Koutsouris DD, Fotiadis DI.

Healthc Technol Lett. 2017 May 23;4(3):102-108. doi: 10.1049/htl.2017.0007. eCollection 2017 Jun.

PMID: 28706727 **Free PMC article.**

[Microsurgery training: A combined educational program.](#)

Beris A, Kostas-Agnantis I, Gkiatas I, Gatsios D, Fotiadis D, Korompilias A.

Injury. 2020 Dec;51 Suppl 4:S131-S134. doi: 10.1016/j.injury.2020.03.016. Epub 2020 Mar 9.

PMID: 32173081

Appendix II: MOOC Quick Guide

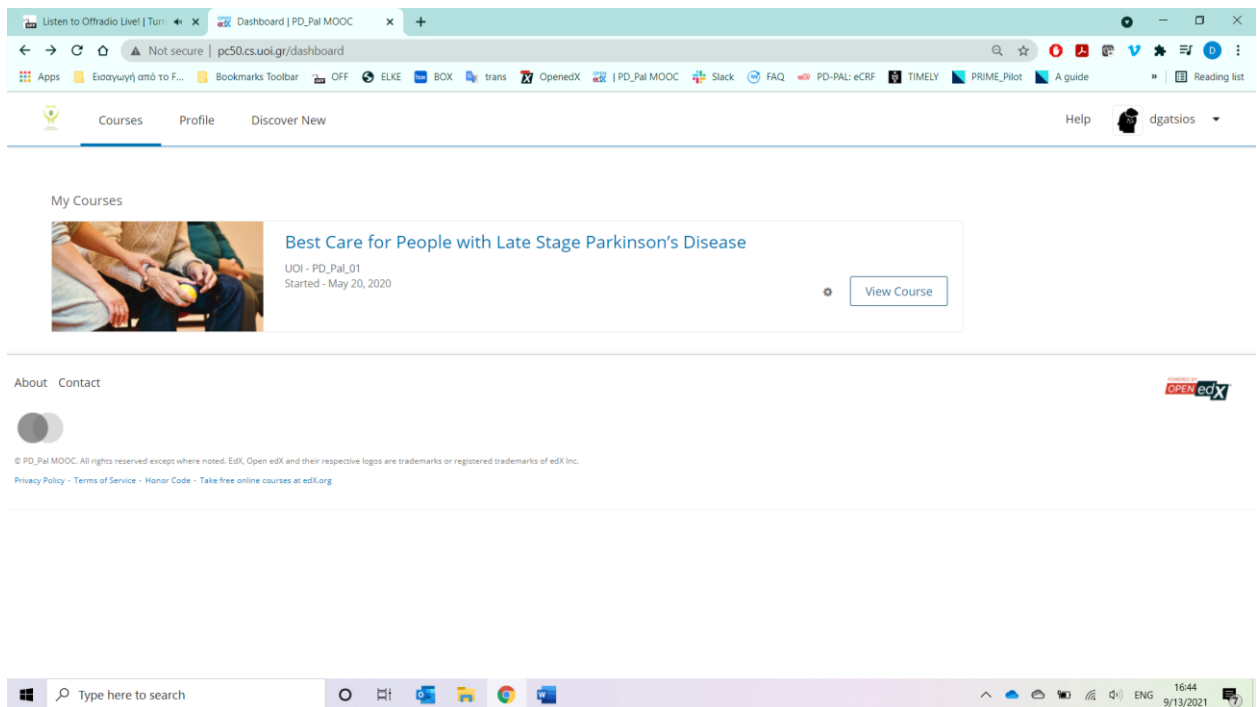


Figure 18: Overview of available courses.

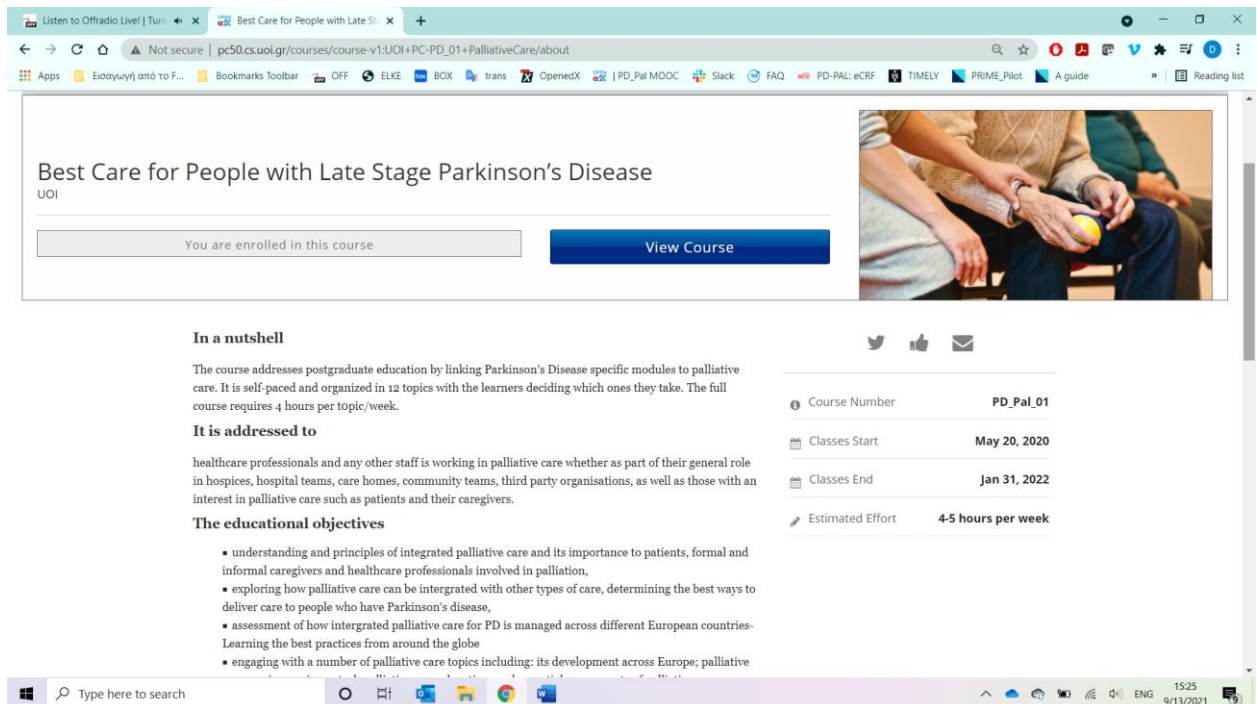


Figure 19: The welcome-introduction page after login.

The screenshot shows a web browser window displaying a course page. The browser's address bar shows the URL: `pc50.cs.uoi.gr/courses/course-v1:UOI+PC-PD_01+PalliativeCare/course/`. The page title is "Best Care for People with Late Stage Parkinson's Disease". The navigation menu includes "Course", "Curriculum", "Course Handouts", "Progress", and "Discussion". The main content area lists 10 weeks of the curriculum:

- Week 1: Parkinson's Disease and Related Disorders
- Week 2 Palliative Care Philosophy, Policy and Definitions, Symptom Control and Shared Decision Making
- Week 3 Parkinson's Disease and its Management
- Week 4 How To Design Care Plans Accordingly To Patients' and Families' Wishes Intergrating Multi-Professional and Interdisciplinary Approaches
- Week 5 Getting On With Life
- Week 6 Providing Care For Caregivers
- Week 7 Importance Of Advance Directive
- Week 8 Advance PD, Death And Dying
- Week 9 Common Symptoms in Late-Stage Parkinson's disease
- Week 10 Loss, Grief and Bereavement

On the right side, there are sections for "Course Tools" (Bookmarks, Updates), "Important Course Dates" (Today is Sep 13, 2021 15:25 EEST, Course End in 5 months - Jan 31, 2022), and "Course Handouts" (Example handout). A "Start Course" button is visible in the top right corner.

Figure 20: The overview of the topics-week of the curriculum.

This screenshot shows the same course page as Figure 20, but with the "Week 1: Parkinson's Disease and Related Disorders" section expanded. The expanded content for Week 1 includes:

- About Week 1
- Educational Material
- Assessment Exam
- One Question to Stefan

The rest of the curriculum list remains the same as in Figure 20. The right-hand sidebar and navigation elements are also consistent with the previous figure.

Figure 21: The main contents of each week.

The screenshot shows a web browser window displaying a course page. The browser's address bar shows the URL: `pc50.cs.uoi.gr/courses/course-v1:UOI+PC-PD_01+PalliativeCare/course/`. The page title is "Best Care for People with Late Stage Parkinson's Disease". The course is by "UOI: PD_Pal_01". The page has a navigation menu with "Course", "Curriculum", "Course Handouts", "Progress", and "Discussion". The main content area is titled "Best Care for People with Late Stage Parkinson's Disease" and includes a "Start Course" button. A sidebar on the right contains "Course Tools" (Bookmarks, Updates), "Important Course Dates" (Today is Sep 13, 2021 15:25 EEST, Course End in 5 months - Jan 31, 2022), and "Course Handouts" (Example handout). The main content area is expanded to show "Week 1: Parkinson's Disease and Related Disorders". Under "Educational Material", there are links for "Presentation", "Interview with an expert", "Reading Materials", and "Additional Resources". There are also links for "Assessment Exam" and "One Question to Stefan". A "Week 2" link is visible at the bottom of the list.

Figure 22: The educational material components.

The screenshot shows a web browser window displaying an "about" page for the week. The browser's address bar shows the URL: `pc50.cs.uoi.gr/courses/course-v1:UOI+PC-PD_01+PalliativeCare/courseware/6f97b6d97c214dacb32081fb916d715e/dae36922bbad4f9abc292083b8cd...`. The page title is "This week is about: | About Week 1". The page has a navigation menu with "Previous" and "Next" buttons. The main content area is titled "This week is about:" and includes a "Bookmark this page" link. A large blue box on the left contains the text "THIS WEEK IS ABOUT:". To the right, there are two summary boxes: an orange box with a heart icon and text "Palliative care philosophy, policy and definitions. Basic understanding of complex symptoms assessment and management and shared decision making." and a grey box with a star icon and text "The importance of Self-Care and multidisciplinary team." The page also has "Previous" and "Next" buttons at the bottom.

Figure 23: An example "about" page for the week/topic.

Facilitators

Bookmark this page

FACILITATORS

Piret Paal
PhD, Philosophy
PMU

Giovanni Gentile
MSc, PsyD, Research Fellow
UNIPD

Previous Next

Type here to search

15:27
9/13/2021

Figure 24: The facilitators of a week/topic.

Learning Objectives

Bookmark this page

LEARNING OBJECTIVES

1. Comprehending the palliative care principles.
2. Get introduced to the multi-dimensionality of human-being and the complexity of accepting death and non-ideal outcomes.
3. Understanding the dynamic involvement of palliative care throughout the illness.
4. Get familiar with patient-family oriented care management competencies.
5. Taking care of oneself and multidisciplinary team.

Previous Next

Type here to search

15:27
9/13/2021

Figure 25: The learning objectives of a week/topic.

Learning Content

Attitudes: Participants will see palliative care in terms of comfort it offers to patients and caregivers. Understand the importance of the unit of care approach.

Knowledge: Participants know the basics of palliative care, specifically:

- What palliative care is
- The dynamic involvement of palliative care throughout the illness
- The palliative care principles
- The multi-dimensionality of human-being
- The importance of self-care

Skills: Participants will be able to better handle issues related to the complexity of accepting death and non-ideal outcomes.

Figure 26: The learning content and the expected outcomes in attitude, knowledge and skills.

Presentation

Content

- Global facts about Parkinson's Disease
- The Cause of Parkinson's Disease
- How to diagnose Parkinson's Disease?
- The Symptoms of Parkinson's Disease
- Expected influence on patient's and caregiver's life
- Telling the Diagnosis

Figure 27: The presentation component, using google slides.

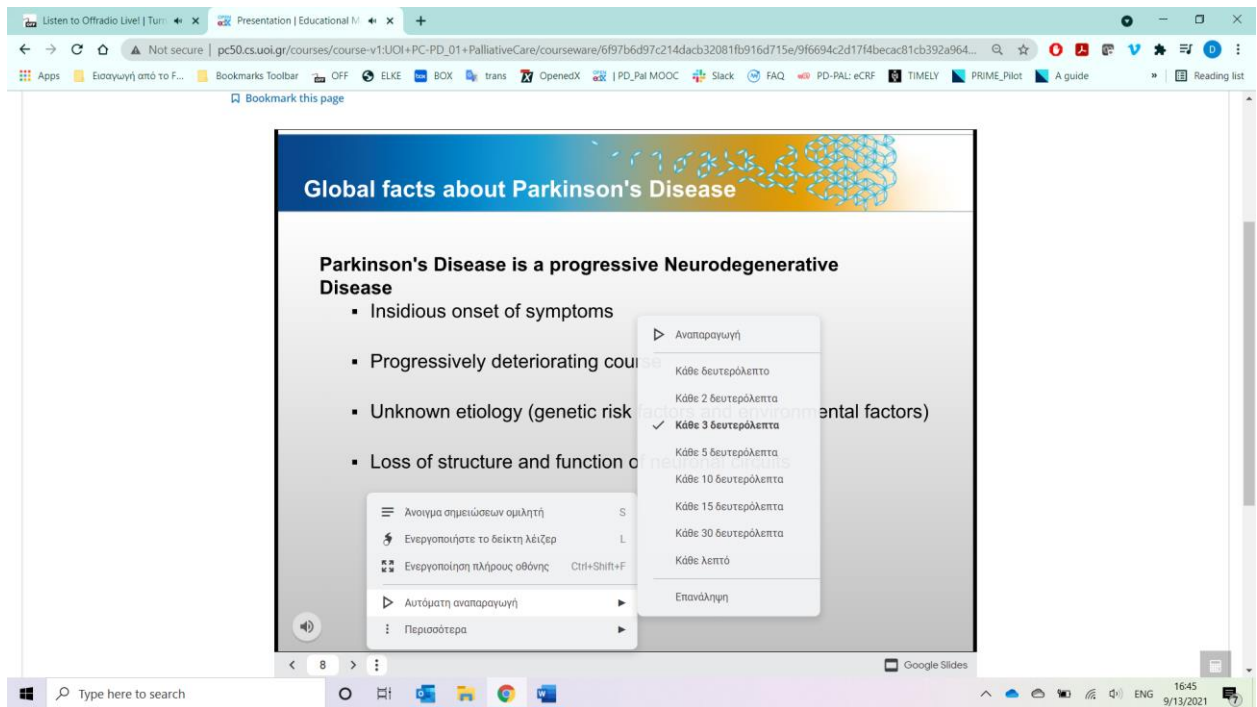


Figure 28: Overview of options provided for the customization of the presentation.

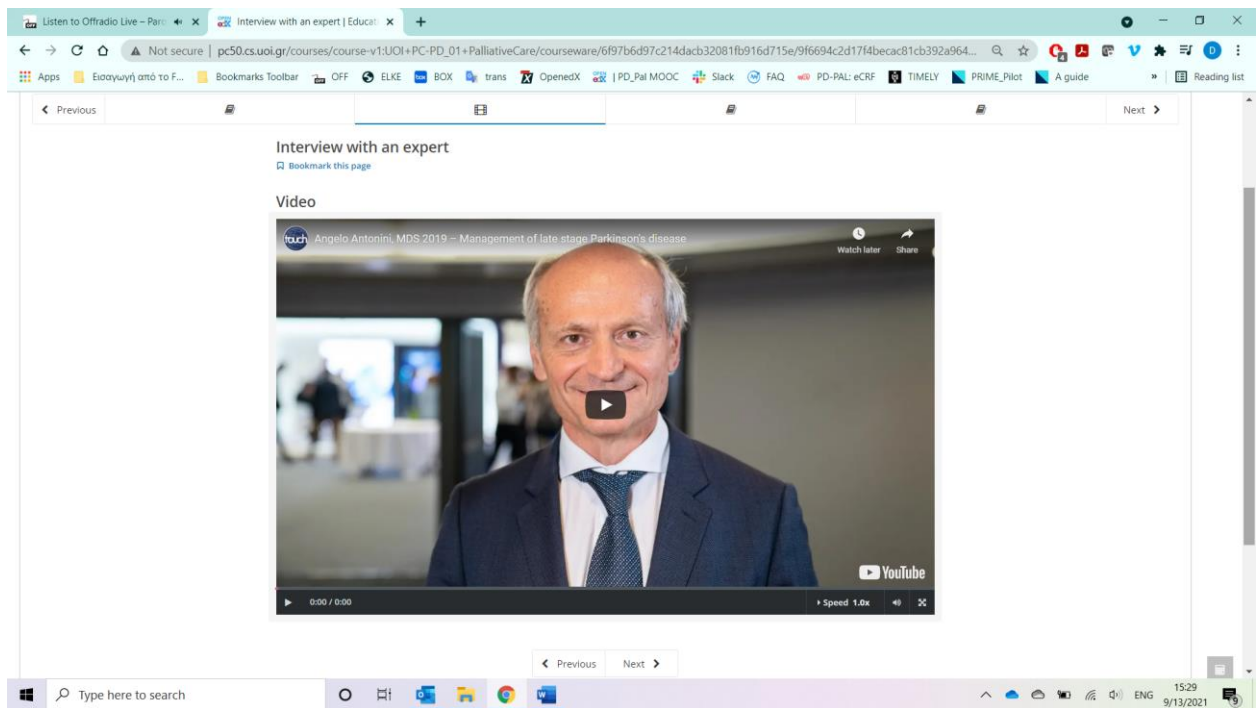


Figure 29: Video with interview from an expert in the topic. Can be viewed also in YouTube.

The screenshot shows a web browser window with the address bar displaying a URL from pc50.cs.uoi.gr. The page title is 'Reading Materials' and it includes a 'Bookmark this page' link. Below the title is a list of 13 research articles, each with a bullet point and a full citation including authors, year, journal name, volume, and page numbers. At the bottom of the article list are 'Previous' and 'Next' navigation buttons.

- Ball, N. et al. (2019). Parkinson's Disease and the Environment. *Front Neurol*, 10, 218.
- Billingsley, K. J. et al. (2018). Genetic risk factors in Parkinson's Disease. *Cell Tissue Res*, 373(1), 9-20.
- Cherubini, M. & Wade-Martins, R. (2018). Convergent pathways in Parkinson's Disease. *Cell Tissue Res*, 373(1), 79-90.
- Hernandez, D.G., Reed, X. & Singleton, A. B. (2016). Genetics in Parkinson disease: Mendelian versus non-Mendelian inheritance. *J Neurochem*, 139 Suppl 1, 59-74.
- Marsili, L., Rizzo, G. & Colosimo C. (2018). Diagnostic Criteria for Parkinson's Disease: From James Parkinson to the Concept of Prodromal Disease. *Front Neurol*, 9, 156.
- Miller, I. N. & Cronin-Golomb, A. (2010). Gender differences in Parkinson's Disease: clinical characteristics and cognition. *Mov Disord*, 25(16), 2695-2703.
- Polymeropoulos, M. H. et al. (1997). Mutation in the alpha-synuclein gene identified in families with Parkinson's Disease. *Science*, 276(5321), 2045-7.
- Sarafis, P. et al. (2013). Disclosing the truth: a dilemma between instilling hope and respecting patient autonomy in everyday clinical practice. *Glob J Health Sci*, 6(2), 128-137.
- Surmeier, D. J. (2018). Determinants of dopaminergic neuron loss in Parkinson's Disease. *FEBS J*, 285(19), 3657-3668.
- Tysnes, O. B. & Storstein, A. (2017). Epidemiology of Parkinson's Disease. *J Neural Transm (Vienna)*, 124(8), 901-905.
- van der Steen, J. T. et al. (2019). Dementia and Parkinson's Disease: Similar and Divergent Challenges in Providing Palliative Care. *Front Neurol*, 10, 54.
- Vu, T. C., Nutt, J. G. & Holford, N. H. (2012). Progression of motor and nonmotor features of Parkinson's Disease and their response to treatment. *Br J Clin Pharmacol*, 74(2), 267-283.

Figure 30: Additional reading materials with hyperlinks in the suggested publications.

The screenshot shows a web browser window with the address bar displaying a URL from pc50.cs.uoi.gr. The page title is 'Additional Resources' and it includes a 'Bookmark this page' link. Below the title is a section titled 'Links to websites' which contains two logos and their corresponding URLs: the World Health Organization logo with the URL <https://www.who.int/> and the AHA Center for Health Innovation logo with the URL <https://www.aha.org/center/palliative-care/leading-experts>. At the bottom of the resource list are 'Previous' and 'Next' navigation buttons.

Figure 31: Other resources such as websites, libraries etc.

The screenshot shows a web browser window with the URL `pc50.cs.uoi.gr/courses/course-v1:UOI+PC-PD_01+PalliativeCare/courseware/6f97b6d97c214dadb32081fb916d715e/4d3890314f614bec9c803b71464b...`. The page title is "Best Care for People with Late Stage Parkinson's Disease". The navigation menu includes "Course", "Curriculum", "Course Handouts", "Progress", and "Discussion". The current page is "Multiple Choice Questions".

Below the navigation, there are "Previous" and "Next" buttons. The main heading is "Multiple Choice Questions" with a "Bookmark this page" link. A blue italicized instruction reads: "After completing the first section, it's time to test your knowledge. Be aware that you can give only one answer, so be careful!!!!".

The question is titled "Question 1" and is worth "1 point possible (graded)". The text of the question is "Parkinson's Disease is a Neurodegenerative Disease with:". Below this are four radio button options:

- Mild onset of symptoms and progressive exacerbating course
- Acute onset of symptoms and progressive exacerbating course
- Mild onset of symptoms and relapsing-remitting course
- Acute onset of symptoms and relapsing-remitting course

The browser's taskbar at the bottom shows the time as 15:30 on 9/13/2021.

Figure 32: Multiple choice questions for the assessment at the end of each week.

The screenshot shows a web browser window with the URL `pc50.cs.uoi.gr/courses/course-v1:UOI+PC-PD_01+PalliativeCare/bookmarks/`. The page title is "Best Care for People with Late Stage Parkinson's Disease". The navigation menu includes "Course", "Curriculum", "Course Handouts", "Progress", and "Discussion". The current page is "Bookmarks".

Below the navigation, there is a "Showing 1 out of 1 total" indicator. The bookmarked item is "LESSON 1 ▶ PARKINSON'S DISEASE AND RELATED DISORDERS ▶ Presentation", which was "Bookmarked on June 19, 2020". There is a "View" link with a right-pointing arrow.

At the bottom of the page, there is a footer with "About Contact" and the "OPEN edX" logo. Below that, it says "© PD_Pal MOOC. All rights reserved except where noted. EdX, Open edX and their respective logos are trademarks or registered trademarks of edX Inc." and "Privacy Policy - Terms of Service [Help Code](#) Take free online courses at edX.org".

The browser's taskbar at the bottom shows the time as 15:31 on 9/13/2021.

Figure 33: Bookmarked page.

The screenshot shows a web browser window with the following details:

- Browser Tabs:** "Listen to Offradio Live - Lj...", "Course | PD_Pal_01 | PD_Pal MOOC".
- Address Bar:** "Not secure | pc50.cs.uoi.gr/courses/course-v1:UOI+PC-PD_01+PalliativeCare/course/updates".
- Page Header:** "UOI: PD_Pal_01", "Best Care for People with Late Stage Parkinson's Disease", "Discover New", "Help", "dgatsios".
- Navigation Menu:** "Course", "Curriculum", "Course Handouts", "Progress", "Discussion".
- Content Area:**
 - Section: "Course > Updates"
 - Update 1: "December 7, 2020", "hello"
 - Update 2: "May 22, 2020", "for more information there will be given extra guidance"
 - Update 3: "May 21, 2020", "we would like to let you know that for week 1, lesson 1 you will be provided with additional material."
- Page Footer:** "About Contact", "Powered by Open edX", "© PD_Pal MOOC. All rights reserved except where noted. EdX, Open edX and their respective logos are trademarks or registered trademarks of edX Inc.", "Privacy Policy - Terms of Service - Honor Code - Take free online courses at edX.org".
- Taskbar:** Windows search bar, task icons (Edge, File Explorer, Chrome, Word), system tray (15:32, 9/13/2021).

Figure 34: Updates in the content.

Appendix III: The PD_Pal Curriculum Toolkit (available online at <https://www.pdpal.eu/courses>)

Lesson Plan	
Teaching Unit	Parkinson's Disease
Title	Week 1: Parkinson's Disease
Learning Objectives	<p>Getting familiar with Parkinson's disease in terms of epidemiology and prevalence, known causes including genetics, environmental and their interactions, how diagnosis is made and communicated and which are the main symptoms.</p> <p>Understanding the impact of PD to patients and their caregivers and how the early and timely integration of palliative care can help deal with it.</p>
Summary & scheduling	<p>Part 1: Facts, cause, diagnosis and symptoms</p> <p>Part 2: Expected impact of diagnosis, prognosis and importance of timely integration of Palliative Care</p>
Learning Content A - Attitude K - Knowledge S - Skills	<p><u>Attitude:</u> The clinicians are encouraged to be respectful towards patients and caregivers need for information. To encourage patients and caregivers ask the questions.</p> <p><u>Knowledge:</u> Participants know the basics of PD, specifically:</p> <ul style="list-style-type: none"> • What PD is • The factors that modify the risk of developing PD • The pathogenetic mechanisms that lead to the degeneration of PD • The clinical features of the disorder • The presentation and diagnosis of PD • What is the prognosis of the disease and the timing of introducing Palliative Care <p><u>Skills:</u> Clinicians are able to recognise PD and its complex symptoms and discuss disease management with their patients and caregivers.</p>
Teaching Methods	<ul style="list-style-type: none"> • Presentation (slides) • Video component • Reading materials
Literature	<ul style="list-style-type: none"> • Tysnes OB, Storstein A. Epidemiology of Parkinson's disease. J Neural Transm (Vienna). 2017;124(8):901–905. • Miller IN, Cronin-Golomb A. Gender differences in Parkinson's disease: clinical characteristics and cognition. Mov Disord. 2010;25(16):2695–2703. • Billingsley KJ, Bandres-Ciga S, Saez-Atienzar S, Singleton AB. Genetic risk factors in Parkinson's disease. Cell Tissue Res. 2018;373(1):9–20.

Lesson Plan	
	<ul style="list-style-type: none"> • Hernandez DG, Reed X, Singleton AB. Genetics in Parkinson disease: Mendelian versus non-Mendelian inheritance. <i>J Neurochem.</i> 2016;139 Suppl 1(Suppl 1):59–74. • Ball N, Teo WP, Chandra S, Chapman J. Parkinson's Disease and the Environment. <i>Front Neurol.</i> 2019;10:218. Published 2019 Mar 19. • Surmeier DJ. Determinants of dopaminergic neuron loss in Parkinson's disease. <i>FEBS J.</i> 2018;285(19):3657–3668. • Cherubini M, Wade-Martins R. Convergent pathways in Parkinson's disease. <i>Cell Tissue Res.</i> 2018;373(1):79–90. • Marsili L, Rizzo G, Colosimo C. Diagnostic Criteria for Parkinson's Disease: From James Parkinson to the Concept of Prodromal Disease. <i>Front Neurol.</i> 2018;9:156. Published 2018 Mar 23. • Vu TC, Nutt JG, Holford NH. Progression of motor and nonmotor features of Parkinson's disease and their response to treatment. <i>Br J Clin Pharmacol.</i> 2012;74(2):267–283. • Sarafis P, Tsounis A, Malliarou M, Lahana E. Disclosing the truth: a dilemma between instilling hope and respecting patient autonomy in everyday clinical practice. <i>Glob J Health Sci.</i> 2013;6(2):128–137. Published 2013 Dec 20. • van der Steen JT, Lennaerts H, Hommel D, et al. Dementia and Parkinson's Disease: Similar and Divergent Challenges in Providing Palliative Care. <i>Front Neurol.</i> 2019;10:54. Published 2019 Mar 11
Assessment	<ul style="list-style-type: none"> • Topic related Discussion/Exercise • Self-Assessment (20 multiple choice questions)

Lesson Plan	
Teaching Unit	Palliative care principles and concepts
Title	Week 2: Palliative care principles and concepts
Learning Objectives	<p>Comprehending the palliative care principles.</p> <p>Get introduced to the multi-dimensionality of human-being and the complexity of accepting death and non-ideal outcomes.</p> <p>Understanding the dynamic involvement of palliative care throughout the illness.</p> <p>Get familiar with patient-family oriented care management competencies.</p> <p>Taking care of oneself and multidisciplinary team.</p>
Summary & scheduling	<p>Part 1- Palliative care philosophy, policy and definitions. Basic understanding of complex symptoms assessment and management and shared decision making.</p> <p>Part 2- Importance of Self-Care and multidisciplinary team.</p>
Learning Content A - Attitude K - Knowledge S - Skills	<p><u>Attitude:</u> Participants will see palliative care in terms of the comfort it offers to patients and caregivers. Understand the importance of the unit of care approach.</p> <p><u>Knowledge:</u> Participants know the basics of palliative care, specifically:</p> <ul style="list-style-type: none"> • What palliative care is • The dynamic involvement of palliative care throughout the illness • The Palliative care principles • The multi-dimensionality of human-being • The importance of self-care <p><u>Skills:</u> Participants will be able to better handle issues related to the complexity of accepting death and non-ideal outcomes.</p>
Teaching Methods	<ul style="list-style-type: none"> • Presentation (slides) • Video component • Self-Assessment • Reading materials
Literature	<ul style="list-style-type: none"> • Porter, R. (1999). The Greatest Benefit to the Mankind: A Medical History of Humanity from Antiquity to the Present. Los Angeles: Fontana Press. • Vanderpool, H. Y. (2015). Palliative Care: The 400-year Quest for a Good Death. North Carolina: McFahrland & Company, Inc, Publishers. • World Health Organization. (2002). Palliative care. http://www.who.int/cancer/palliative/definition/en/ • Oliver, D.J. et al. (2016). A consensus review on the development of palliative care for patients with chronic and progressive neurological disease. Eur J Neurol. 23(1), 30-38. • Clark, D. (2015). Public debate begins in Scotland on future of NHS. BMJ, 351, h4266.

Lesson Plan	
	<ul style="list-style-type: none"> • Etkind, S. N. et al. (2017). How many people will need palliative care in 2040? Past trends, future projections and implications for services. <i>BMC Med</i>, 15, 102. • WPCA (2014). Global Atlas of Palliative Care at the End of Life. In: WHO (ed.). • WHO (2014). Strengthening of Palliative Care as a Component of Integrated Treatment throughout the Life Course. <i>Journal of Pain & Palliative Care Pharmacotherapy</i>, 28, 130-134. • Powell, R. A. et al. (2015). Putting palliative care on the global health agenda. <i>The Lancet Oncology</i>, 16, 131-133. • UNICEF, W. (2018). Astana Declaration. Astana, Kazakhstan. • Line, D. (2015). Quality of Death Index. https://eiperspectives.economist.com/healthcare/2015-quality-death-index • IAHPCC (2019). Palliative Care Definition. https://hospicecare.com/what-we-do/projects/consensus-based-definition-of-palliative-care/definition/ • WHO (2017). Ten Facts on Palliative Care. https://www.who.int/features/factfiles/palliative-care/en/ • Becker, E. (1973). <i>The Denial of Death</i>. New York: Simon & Schuster. • Department of Health (2012). <i>End of Life Care Strategy: Fourth Annual Report</i>. https://webarchive.nationalarchives.gov.uk/20130104174405/http://www.dh.gov.uk/health/2012/10/end-of-life-care-fourth/ • Paal, P. et al. (2019). Postgraduate palliative care education for all healthcare providers in Europe: Results from an EAPC survey. <i>Palliative and Supportive Care</i>, 1-12. • Boyd, M. (2016). My Life, My Death: The Voices of Palliative Patients, Informal Caregivers and Health Care Providers. <i>Journal of Pain and Symptom Management</i>, 52, E95-E96. • BMJ (2017). Palliative Care from Diagnosis to death. https://youtu.be/vS7ueVoui5U
Assessment	<ul style="list-style-type: none"> • Topic related Discussion/Exercise • Self-Assessment (20 multiple choice questions)

Lesson Plan	
Teaching Unit	Parkinson's Disease and its management
Title	Week 3: Parkinson's Disease and its management
Learning Objectives	<p>Be informed about the available pharmacological treatments for PD.</p> <p>Be informed about the surgical options that exist for the advanced Parkinson's Disease.</p> <p>Comprehend the importance of multi-professional, interdisciplinary and continuous management of PD.</p>
Summary & scheduling	<p>Part 1: drug therapy and surgical options for PD.</p> <p>Part 2: information about complementary therapies and occupational therapy, introduction to multi-professional, interdisciplinary approaches for the management of PD.</p>
Learning Content A - Attitude K - Knowledge S - Skills	<p><u>Attitude:</u> To engage patients and caregivers into their care management. All participants will recognize the importance of multi-professional, interdisciplinary approaches for the management of PD.</p> <p><u>Knowledge:</u> Participants know the basics of PD management options, specifically:</p> <ul style="list-style-type: none"> • Which are the therapeutic options for Parkinson's Disease (PD) • The indications, effectiveness and adverse effects of drug and surgery treatments • The role of non-pharmacological therapies and of allied professionals <p><u>Skills:</u> Participants will be able to direct patients and caregivers to the best sources of information. They will also be able to provide practical aids and solutions to keep patients independent.</p>
Teaching Methods	<ul style="list-style-type: none"> • Presentation (slides) • Video component • Reading materials
Literature	<ul style="list-style-type: none"> • Aragon A. and Kings J. (2018). Occupational therapy for people with Parkinson's (Second edition). London: Copyright © Royal College of Occupational Therapists. • Cianci H. (2001). Activities of Daily Living: Practical Pointers for Parkinson's Disease (Third edition). Miami: National Parkinson Foundation. • Dietrichs E, Odin P. Algorithms for the treatment of motor problems in Parkinson's disease. Acta Neurol Scand. 2017;136(5):378–385. • Radder DLM, de Vries NM, Riksen NP, et al. Multidisciplinary care for people with Parkinson's disease: the new kids on the block!. Expert Rev Neurother. 2019;19(2):145–157.

Lesson Plan	
	<ul style="list-style-type: none"> • Rabin ML, Stevens-Haas C, Havrilla E, et al. Complementary Therapies for Parkinson's Disease: What's Promoted, Rationale, Potential Risks and Benefits. <i>Mov Disord Clin Pract.</i> 2015;2(3):205–212. • Hauser, RA. (2020). Parkinson Disease Treatment & Management. (Access on 14.04.2020). Medscape https://emedicine.medscape.com/article/1831191-treatment#d1
Assessment	<ul style="list-style-type: none"> • Topic related Discussion/Exercise • Self-Assessment (20 multiple choice questions)

Lesson Plan	
Teaching Unit	Interdisciplinary approaches for the management of PD
Title	Week 4: Interdisciplinary approaches for the management of PD
Learning Objectives	<p>Understand the concepts of multidisciplinary and interdisciplinary approaches and their difference.</p> <p>Identify the different healthcare professionals involved in the management of patients with Parkinson's disease and their roles.</p> <p>Learn how to design individual care plans by taking the needs and preferences of the patient and caregiver into account.</p>
Summary & scheduling	How to design care plans accordingly to patients' and families' wishes integrating multi-professional and interdisciplinary approaches (3 hours).
Learning Content A - Attitude K - Knowledge S - Skills	<p><u>Attitude:</u> Prioritize patients and caregivers needs and design and implement personalized, interdisciplinary management and care plans based on shared decision making. Acknowledge the role of allied professionals.</p> <p><u>Knowledge:</u> Participants know the basics of interdisciplinary care, specifically:</p> <ul style="list-style-type: none"> • multi-professional, coordinated care • the different healthcare professionals involved in patients with Parkinson's disease • when to involve which healthcare professional according to the care needs of the patient • how to design individual care plans by taking the wishes of the patient and caregiver into account <p><u>Skills:</u> Participants will be able to understand the competencies interplay and the professional limits, as well as who/what is the best source to give/get sufficient solutions and answers for the patients' needs. Adopt a methodology for providing interdisciplinary care based on patients' and caregivers' needs.</p>
Teaching Methods	<ul style="list-style-type: none"> • Presentation (slides) • Video component

Lesson Plan	
	<ul style="list-style-type: none"> • Reading materials
Literature	<ul style="list-style-type: none"> • Brinkman-Stoppelenburg, A., Rietjens, J. A., & Van der Heide, A. (2014). The effects of advance care planning on end-of-life care: a systematic review. <i>Palliative medicine</i>, 28(8), 1000-1025. • Bruera, E., Kuehn, N., Miller, M. J., Selmsler, P., & Macmillan, K. (1991). The Edmonton Symptom Assessment System (ESAS): A Simple Method for the Assessment of Palliative Care Patients. <i>Journal of Palliative Care</i>, 7(2), 6-9. doi:10.1177/082585979100700202 • Fox, S., Azman, A., & Timmons, S. (2020). Palliative care needs in Parkinson's disease: focus on anticipatory grief in family carers. <i>Annals of Palliative Medicine</i>, 9(Supplement 1), 34-43. • Fox, S., Cashell, A., Kernohan, W. G., Lynch, M., McGlade, C., O'Brien, T., . . . Timmons, S. (2017). Palliative care for Parkinson's disease: Patient and carer's perspectives explored through qualitative interview. <i>Palliative medicine</i>, 31(7), 634-641. • Giladi, N., Manor, Y., Hilel, A., & Gurevich, T. (2014). Interdisciplinary Teamwork for the Treatment of People with Parkinson's Disease and Their Families. <i>Current Neurology and Neuroscience Reports</i>, 14(11), 493. doi:10.1007/s11910-014-0493-1 • Giles, S., & Miyasaki, J. (2009). Palliative stage Parkinson's disease: patient and family experiences of health-care services. <i>Palliative medicine</i>, 23(2), 120-125. • Hudson, P. L., Toye, C., & Kristjanson, L. J. (2006). Would people with Parkinson's disease benefit from palliative care? <i>Palliative medicine</i>, 20(2), 87-94. • Irish Palliative Care in Parkinson's Disease Group. (2016). Palliative care in People with Parkinson's disease: Guidelines for professional healthcare workers on the assessment and management of palliative care needs in Parkinson's disease and related Parkinsonian syndromes. In: University College Cork Cork. • Kalf, J., de Swart, B., Bonnier, M., Hofman, M., Kanters, J., Kocken, J., . . . Munneke, M. (2011). Guidelines for speech-language therapy in Parkinson's disease. Nijmegen, The Netherlands/Miami, FL: ParkinsonNet/NPF. • Keus, S., Munneke, M., Graziano, M., Paltamaa, J., Pelosin, E., Domingos, J., . . . Struiksma, C. (2014). European physiotherapy guideline for Parkinson's disease. The Netherlands: KNGF/ParkinsonNet. • Lennaerts, H., Groot, M., Rood, B., Gilissen, K., Tulp, H., van Wensen, E., . . . Bloem, B. R. (2017). A Guideline for Parkinson's Disease Nurse

Lesson Plan

Specialists, with Recommendations for Clinical Practice. *Journal of Parkinson's Disease*, 7, 749-754. doi:10.3233/JPD-171195

- McLaughlin, D., Hasson, F., Kernohan, W. G., Waldron, M., McLaughlin, M., Cochrane, B., & Chambers, H. (2011). Living and coping with Parkinson's disease: perceptions of informal carers. *Palliative medicine*, 25(2), 177-182.
- Miyasaki, J. M., & Kluger, B. (2015). Palliative care for Parkinson's disease: has the time come? *Current Neurology and Neuroscience Reports*, 15(5), 26.
- Miyasaki, J. M., Long, J., Mancini, D., Moro, E., Fox, S., Lang, A., . . . Arshinoff, R. (2012). Palliative care for advanced Parkinson disease: an interdisciplinary clinic and new scale, the ESAS-PD. *Parkinsonism & related disorders*, 18, S6-S9.
- Radder, D. L. M., de Vries, N. M., Riksen, N. P., Diamond, S. J., Gross, D., Gold, D. R., . . . Bloem, B. R. (2019). Multidisciplinary care for people with Parkinson's disease: the new kids on the block! *Expert Review of Neurotherapeutics*, 19(2), 145-157. doi:10.1080/14737175.2019.1561285
- Sturkenboom, I., Thijssen, M., Gons-van Elsacker, J., Jansen, I., Maasdam, A., Schulten, M., . . . Munneke, M. (2011). Guidelines for occupational therapy in Parkinson's disease rehabilitation. Nijmegen, The Netherlands/Miami (FL), USA: ParkinsonNet/NPF. Heruntergeladen von http://www.parkinsonnet.info/media/14820461/ot_guidelines_final-npf__3_.pdf am, 3, 2016.
- van Asseldonk, M., Dicke, H., van den Beemt, B., van den Berg, D., ter Borg, S., Duin, G., . . . van Harten, B. (2012). Dietetic guideline for Parkinson's.
- van der Marck, M. A., & Bloem, B. R. (2014). How to organize multispecialty care for patients with Parkinson's disease. *Parkinsonism & related disorders*, 20, S167-S173.
- van der Marck, M. A., Kalf, J. G., Sturkenboom, I. H. W. M., Nijkrake, M. J., Munneke, M., & Bloem, B. R. (2009). Multidisciplinary care for patients with Parkinson's disease. *Parkinsonism & related disorders*, 15, S219-S223. doi:https://doi.org/10.1016/S1353-8020(09)70819-3
- WHO. WHO Definition of palliative care Retrieved from <https://www.who.int/cancer/palliative/definition/en/>

Assessment

- Topic related Discussion/Exercise
- Self-Assessment (20 multiple choice questions)

Lesson Plan	
Teaching Unit	Getting on with life (Living with Parkinson's)
Title	Week 5: Getting on with life (Living with Parkinson's)
Learning Objectives	Understand the impact of PD in common activities of daily life. Learning practical tips that will help patients and caregivers improve their quality of life.
Summary & scheduling	Parkinson's disease (PD) may impact day to day life and make some daily routines more burdensome. Having a positive attitude to life and maintaining an active daily routine adapting daily activities as much as possible is vital for the management of PD in the long term.
Learning Content A - Attitude K - Knowledge S - Skills	<p><u>Attitude:</u> Keeping a positive attitude to life. Remaining optimistic. Acknowledging the role and needs of informal caregivers.</p> <p><u>Knowledge:</u> Participants are informed about:</p> <ul style="list-style-type: none"> • Sleep disturbances • Emotional health • Cognitive decline • Economic and social burden <p><u>Skills:</u> Participants will be provided with practical advice on how to cope with aspects of daily living (getting a good night's sleep, cognitive training etc.)</p>
Teaching Methods	<ul style="list-style-type: none"> • Presentation (slides) • Video component • Reading materials
Literature	<ul style="list-style-type: none"> • InfoPark Infosheets: QLRT 2000-00303 (2001-2004, European Commission) - Information, health and social needs of older, disabled people (Parkinson's disease) and their carers / InfoPark. • Miyasaki, J. M., & Kluger, B. (2015). Palliative care for Parkinson's disease: has the time come?. <i>Current neurology and neuroscience reports</i>, 15(5), 26. • McLaughlin et al. (2010). Living and coping with Parkinson's disease: Perceptions of informal carers. <i>Palliative Medicine</i>, 25(2), 177-182. • Goy, E.R., Boling, A., Carter, J. (2015). Identifying Predictors of Hospice Eligibility in Patients With Parkinson Disease. <i>American Journal of Hospice & Palliative Medicine</i>, 32(1), 29-33. • Strupp, J., Kunde, A., Galushko, M., Voltz, R., Golla, H. (2017). Severely Affected by Parkinson Disease: The Patient's View and Implications for Palliative Care. <i>American Journal of Hospice & Palliative Medicine</i>, 1-7.

Lesson Plan	
	<ul style="list-style-type: none"> • Fereshtehnejad, S.-M. (2016). Strategies to maintain quality of life among people with Parkinson's disease: what works?. <i>Neurodegenerative Disease Management</i>, 6(5), 399–415. • Lim, S.-Y., Tan, A. H., Fox, S. H, Evans, A. H., Low, S. C. (2017). Integrating Patient Concerns into Parkinson's Disease Management. <i>Curr Neurol Neurosci Rep</i>, 17:3. • Titova, N., Chaudhuri, R. K. (2017). Palliative Care and Nonmotor Symptoms in Parkinson's Disease and Parkinsonism. <i>International Review of Neurobiology</i>, 134, 1239-55. • Katz, M., Goto, Y., Kluger, B. M. (2018). Top Ten Tips Palliative Care Clinicians Should Know About Parkinson's Disease and Related Disorders. <i>Journal of Palliative Medicine</i>, 21(10):1507-1517.
Assessment	<ul style="list-style-type: none"> • Topic related Discussion/Exercise • Self-Assessment (20 multiple choice questions)

Lesson Plan	
Teaching Unit	Providing care for caregivers
Title	Week 6: Providing care for caregivers
Learning Objectives	<p>Comprehend what caregiving entails.</p> <p>Understand the rights and needs of caregivers.</p> <p>Be educated in basic caring skills.</p> <p>Become aware of interventions aiming to reduce the burden and distress of the caregiver.</p> <p>Understand the role of support groups.</p>
Summary & scheduling	Parkinson's disease (PD) may impact caregivers' day to day life and make some daily routines more burdensome. Having a positive attitude to life and maintaining an active daily routine adapting daily activities as much as possible is vital for the management of PD in the long term (3 hours).
Learning Content A - Attitude K - Knowledge S - Skills	<p><u>Attitude</u>: Become aware of stress factors and the fact that caregivers' emotions need special attention. Grasping the importance of looking after oneself as a carer: avoiding burn out, accepting outside help and sharing the caring tasks.</p> <p><u>Knowledge</u>: Participants will know:</p> <ul style="list-style-type: none"> • Caregiver and caregiving concepts and definitions • The rights and needs of caregivers

Lesson Plan	
	<ul style="list-style-type: none"> • the role of support groups that may ease the caregiver burden <p><u>Skills:</u> Participants will be able to recognise and address caregivers' burden. Practical advice and tips on basic caring skills to prevent burn out and reduce the distress of the caregiver.</p>
Teaching Methods	<ul style="list-style-type: none"> • Presentation (slides) • Video component • Reading materials
Literature	<ul style="list-style-type: none"> • Boersma, I., Jones, J., Coughlan, C., Carter, J., Bekelman, D., Miyasaki, J., ... & Kluger, B. (2017). Palliative care and Parkinson's disease: caregiver perspectives. <i>Journal of Palliative Medicine</i>, 20(9), 930-938. • Lokk, J., & Delbari, A. (2012). Clinical aspects of palliative care in advanced Parkinson's disease. <i>BMC palliative care</i>, 11(1), 20. • Miyasaki, J. M., & Kluger, B. (2015). Palliative care for Parkinson's disease: has the time come? <i>Current neurology and neuroscience reports</i>, 15(5), 26. • Abernethy, A. P., Currow, D. C., Fazekas, B. S., Luszcz, M. A., Wheeler, J. L., & Kuchibhatla, M. (2008). Specialized palliative care services are associated with improved short-and long-term caregiver outcomes. <i>Supportive Care in Cancer</i>, 16(6), 585-597. • Bédard, M., Molloy, D. W., Squire, L., Dubois, S., Lever, J. A., & O'Donnell, M. (2001). The Zarit Burden Interview: a new short version and screening version. <i>The Gerontologist</i>, 41(5), 652-657. • Zarit, S. H., Reever, K. E., & Bach-Peterson, J. (1980). Relatives of the impaired elderly: correlates of feelings of burden. <i>The gerontologist</i>, 20(6), 649-655. • Martínez-Martín, P., Forjaz, M. J., Frades-Payo, B., Rusinol, A. B., Fernández-García, J. M., Benito-León, J., ... & Catalán, M. J. (2007). Caregiver burden in Parkinson's disease. <i>Movement disorders</i>, 22(7), 924-931. • Martinez-Martin, P., Rodriguez-Blazquez, C., Forjaz, M. J., Frades-Payo, B., Agüera-Ortiz, L., Weintraub, D., ... & Chaudhuri, K. R. (2015). Neuropsychiatric symptoms and caregiver's burden in Parkinson's disease. <i>Parkinsonism & Related Disorders</i>, 21(6), 629-634. • Macchi, Z. A., Koljack, C. E., Miyasaki, J. M., Katz, M., Galifianakis, N., Prizer, L. P., ... & Kluger, B. M. (2019). Patient and caregiver characteristics associated with caregiver burden in Parkinson's disease: a palliative care approach. <i>Annals of palliative medicine</i>.

Lesson Plan	
	<ul style="list-style-type: none"> • Prizer, L. P., Kluger, B. M., Sillau, S., Katz, M., Galifianakis, N., & Miyasaki, J. M. (2019). Correlates of spiritual wellbeing in persons living with Parkinson disease. <i>Annals of Palliative Medicine</i>, 9(Suppl 1), S16-S23. • Fox, S., Azman, A., & Timmons, S. (2020). Palliative care needs in Parkinson's disease: focus on anticipatory grief in family carers. <i>Annals of Palliative Medicine</i>, 9 (Supplement 1), 34-43. • InfoPark Infosheets: QLRT 2000-00303 (2001-2004, European Commission) - Information, health and social needs of older, disabled people (Parkinson's disease) and their carers. • EduPark Infosheets; QLRT 2001-02674 (2003-2005, European Commission, 258 587 Eur) - Patient education in Parkinson's disease).
Assessment	<ul style="list-style-type: none"> • Topic related Discussion/Exercise • Self-Assessment (20 multiple choice questions)

Lesson Plan	
Teaching Unit	Advance Care Planning and Advance Directives
Title	Week 7: Advance Care Planning and Advance Directives
Learning Objectives	<p>Be able to identify and describe the different "last decisions" in late stage PD.</p> <p>Have basic knowledge on how to make a will.</p> <p>Know basics on how to deal with power of attorneys.</p> <p>Being part of science: participating in clinical studies and the "brain bank" initiative.</p> <p>Have some basic knowledge on the most important research activities in late stage PD.</p>
Summary & scheduling	<p>Part 1: Getting to know Advance Care Directives and what Planning includes</p> <p>Part 2: Relevant Research activities</p>
Learning Content A - Attitude K - Knowledge S - Skills	<p><u>Attitude:</u> Participants will get familiar with the whole complex subject of Advanced Care Planning (ACP) and of the, most times, challenging, decisions that it entails. Patients are encouraged to participate in clinical studies and even donate cells and tissues.</p> <p><u>Knowledge:</u> Participants will:</p> <ul style="list-style-type: none"> • learn what ACP is and what it includes • get some basic knowledge on prognostics in PD • be informed about the Power of Attorneys and other procedures

Lesson Plan	
	<ul style="list-style-type: none"> • be informed about the importance of the research concerning late stage PD <p>Skills: Participants are able to explain ACP concepts and its benefits. They are also able to plan advance care according to patients' needs and preferences.</p>
Teaching Methods	<ul style="list-style-type: none"> • Presentation (slides) • Video component • Reading materials
Literature	<ul style="list-style-type: none"> • Balzer-Geldsetzer M, Ferreira J, Odin P, Bloem BR, Meissner WG, Lorenzl S, Wittenberg M, Dodel R, Schrag A. Study protocol: Care of Late-Stage Parkinsonism (CLaSP): a longitudinal cohort study. <i>BMC Neurology</i> 2018, 5; 18(1): 185. • Bower JH, Maraganore DM, McDonnell SK, Rocca WA. Incidence and distribution of Parkinsonism in Olmsted Coutry, Minnesota, 1976-1990. <i>Neurology</i> 1999 (52): 1214-1220. • DZNE Brain Bank (ed.) Biomaterial Bank of Postmortem Brain Tissue for the Resarch on Neurodegenerative Diseases, https://www.dzne.de/forschung/brain-bank/ (30.03.2020) • Ebke M, Koch A, Dillen K, Becker I, Voltz R, Golla H. (2018) The "Surprise Question" in Neurorehabilitation—Prognosis Estimation by Neurologist and Palliative Care Physician; a Longitudinal, Prospective, Observational Study. <i>Frontiers in Neurology</i>, 2018, 9:792. • NICE guideline (ed.) [NG 71]. Parkinson's Disease in adults, 2017. https://www.nice.org.uk/guidance/ng71/chapter/Recommendations#palliative-care (01.04.2020). • Oliver D, Borasio GD, Caraceni A, de Visser M, Grisold W, Lorenzl S, Veronese S, Voltz R. Palliative care in chronic and progressive neurological disease: summary of a consensus review. <i>European Journal of Palliative Care</i> 2016; 23(5): 232-235. • Parkinsons.org.uk (ed.): preparing for end of life. https://www.parkinsons.org.uk/information-and-support/preparing-end-life (05.04.2020). • https://mrc.ukri.org/research/facilities-and-resources-for-researchers/brain-banks/about-the-uk-brain-banks-network/ (24.03.2020). • WHO (ed.). <i>State of the world's nursing 2020: investing in education, jobs and leadership</i>. Geneva: World Health Organization; 2020. • Seppi K, Ray Chaudhuri K, Coelho M, Fox SH, Katzenschlager R, Perez Lloret S, Weintraub D, Sampaio C; and the collaborators of the Parkinson's Disease Update on Non-Motor Symptoms Study Group on behalf of the

Lesson Plan	
	Movement Disorders Society Evidence-Based Medicine Committee. Update on treatments for nonmotor symptoms of Parkinson's disease-an evidence-based medicine review. <i>Mov Disord.</i> 2019 Jan 17. doi: 10.1002/mds.27602.
Assessment	<ul style="list-style-type: none"> • Topic related Discussion/Exercise • Self-Assessment (20 multiple choice questions)

Lesson Plan	
Teaching Unit	Advanced Parkinson`s Disease, Death and Dying
Title	Week 8: Advanced Parkinson`s Disease, Death and Dying
Learning Objectives	<p>Be able to recognise the advanced stage PD and start or increase the intensity of palliative care.</p> <p>Understand the difficulties of the advanced stage.</p> <p>Understand and accept the end-of-life decision-making process.</p> <p>Be aware of alternative settings and different options for the advanced stage.</p>
Summary & scheduling	Helping to comprehend what advanced stage PD means and what additional difficulties and complexities it entails (3 hours).
Learning Content A - Attitude K - Knowledge S - Skills	<p><u>Attitude:</u> Participants will comprehend that the patients and caregivers might need extra support in the advanced stage coping with the disease.</p> <p><u>Knowledge:</u> Participants will get to know:</p> <ul style="list-style-type: none"> • Global facts about the advanced stage of PD • The meaning of falling out of care • The gender gap • Prognostication in PD • Symptoms and indications of advanced stage of PD • Triggers and indicators for referral to specialist palliative care <p><u>Skills:</u> Participants are able to coordinate and manage an informed and structured decision-making process, including referral to palliative care in different care settings.</p>
Teaching Methods	<ul style="list-style-type: none"> • Presentation (slides) • Video component • Reading materials
Literature	<ul style="list-style-type: none"> • Baldereschi M, DiCarlo A, RoccaWA, Vanni P, Maggi S, Perissinotto E, Grigoletto F, Amaducci L, Inzitari D. (2000): Parkinson`s disease and parkinsonism in a longitudinal study: Two-fold higher incidence in men.

Lesson Plan

ILSA Working Group. Italian Longitudinal Study on Aging. *Neurology* 9, 1358-1363.

- Bükki J, Nübling G, Lorenzl S. (2014): Managing Advanced Progressive Supranuclear Palsy and Corticobasal Degeneration in a Palliative Care Unit: Admission Triggers and Outcomes. *American Journal of Hospice and Palliative Medicine*. <https://doi.org/10.1177/1049909114565110>.
- Cerri S, Mus L, Blandine F. (2019): Parkinson's Disease in Women and Men: What's the Difference? *Journal of Parkinson's Disease* 9 (2019) 501–515. doi: 10.3233/JPD-191683.
- Dahodwala N, Shah K, He Y, Wu SS, Schmidt P, Cubillos F, Willis AW (2018): Sex disparities in access to caregiving in Parkinson disease. *Neurology* 90, 48-e54. doi: 10.1212/WNL.0000000000004764 .
- Dexter DT, Jenner P (2013): Parkinson disease: From pathology to molecular disease mechanisms. *Free Radic Biol Med* 62, 132-144, doi: 10.1016/j.freeradbiomed.2013.01.018.
- Enders D, Balzer-Geldsetzer M, Riedel O et al. (2017): "Prevalence, duration and severity of Parkinson's disease in Germany: a combined meta-analysis from literature data and outpatient samples," *Europ Neurol*, 78(3-4):128–136. doi: 10.1159/000477165.
- Goy E R, Bohlig A, Carter J, Ganzini L. (2013): Identifying Predictors of Hospice Eligibility in Patients with Parkinson Disease. *American Journal of Hospice and Palliative Medicine*. <https://doi.org/10.1177/1049909113502119>
- Gries CJ, Engelberg RA, Erin K. Kross, Doug Zatzick, Elizabeth L. Nielsen, Lois Downey J, Randall Curtis, Predictors of Symptoms of Posttraumatic Stress and Depression in Family Members After Patient Death in the ICU, *Chest*, Volume 137, Issue 2, 2010, 280-287, <https://doi.org/10.1378/chest.09-1291>.
- Lökk J, Delbari A. Clinical aspects of palliative care in advanced Parkinson's disease. *BMC Palliat Care* 2012 ,11:20. Published 2012 Oct 25. doi:10.1186/1472-684X-11-20.
- Lorenzl S, Nübling G, Perrar KM, Voltz R. (2013): Palliative treatment of Chronic neurological disorders. In: James L, Bernat H, Beresford R. (ed.) (2013): *Ethical and Legal Issues in Neurology* 118: 133-139.
- Nübling S, Schuberth M, Feldmer K, Giese A, Holdt L M, Teupser D, Lorenzl S. (2017): Cathepsin S increases tau oligomer formation through limited cleavage, but only IL-6, not cathepsin S serum levels correlate with disease severity in the neurodegenerative tauopathy progressive supranuclear palsy. *Experimental Brain Research* 235: 2407-2412.

Lesson Plan	
	<ul style="list-style-type: none"> • Oliver DJ, Borasio GD, Caraceni A, et al. A consensus review on the development of palliative care for patients with chronic and progressive neurological disease. <i>Eur J Neurol.</i> 2016;23(1):30-38. doi:10.1111/ene.12889. • Oliver DJ, Veronese S. Specialist palliative care for Parkinson's Disease. <i>Ann Palliat Med</i> 2020;9(Suppl 1):52-62. http://dx.doi.org/10.21037/apm.2019.12.01. • Papapetropoulos S, Mash D C (2005): Psychotic Symptoms in Parkinson's disease. <i>Journal of Neurol</i> 252:753-764. • Petrinec AB, Mazanec PM, Burant CJ, Hoffer A, Daly BJ. (2015): Coping Strategies and Posttraumatic Stress Symptoms in Post-ICU Family Decision Makers. <i>Crit Care Med.</i>;43(6):1205-1212. doi:10.1097/CCM.0000000000000934. • Snell K, Pennington S, Lee M, Walker R. (2009): The place of death in Parkinson's disease. <i>Age and Ageing</i> 38(5): 617-619. doi: 10.1093/ageing/afp123. • Lim SY, Tan AH, Ahmad-Annuar A, Klein C, Tan LCS, Rosales RL, Bhidayasiri R, Wu YR, Shang HF, Evans AH, Pal PK, Hattori N, Tan CT, Jeon B, Tan EK, Lang AE. Parkinson's disease in the Western Pacific Region. <i>Lancet Neurol.</i> 2019 Sep;18(9):865-879. doi: 10.1016/S1474-4422(19)30195-4. • Ben-Joseph A, Marshall CR, Lees AJ, Noyce AJ. Ethnic Variation in the Manifestation of Parkinson's Disease: A Narrative Review. <i>J Parkinsons Dis.</i> 2020;10(1):31-45. doi: 10.3233/JPD-191763.
Assessment	<ul style="list-style-type: none"> • Topic related Discussion/Exercise • Self-Assessment (20 multiple choice questions)

Lesson Plan	
Teaching Unit	Managing common symptoms in Late Stage PD
Title	Week 9: Managing common symptoms in Late Stage PD
Learning Objectives	<p>Understand the clinical aspects of specialist palliative care in Parkinson's disease.</p> <p>Be able to recognize, assess and manage common symptoms in late stage PD.</p> <p>Understand the social aspects of eating.</p> <p>Swallowing problems in the advanced stages of the disease.</p> <p>Comprehend when a feeding tube is indicated and what it entails.</p>

Lesson Plan	
	Be aware of speech therapeutics options towards eating.
Summary & scheduling	<p>Part 1: Best palliative care model to provide the patient with comfort and support. A summary of the palliative care management issues and palliative care management options of late stage PD patients.</p> <p>Part 2: Nutrition related issues and problems which may arise when caring for somebody suffering from late stage Parkinson's disease and the different management options including feeding tubes.</p>
Learning Content A - Attitude K - Knowledge S - Skills	<p><u>Attitude:</u> In advanced PD patients, the focus of treatment shifts to treating the predominant non-motor symptoms and having a more supportive and comforting nature. Participants will understand the social dimension of nutrition beyond medical decision making.</p> <p><u>Knowledge:</u> Participants will get to know how late stage symptoms are managed. Specifically:</p> <ul style="list-style-type: none"> • Motor symptoms and motoric complications including rigidity and mobility • Autonomic symptoms including pain • Psychiatric complications including depression, hallucinations, cognitive decline • Hypoactive delirium • Breathing dysregulation • Dopaminergic crisis • Obstipation and severe vomiting • The social importance of food • Nutrition and Hydration in the advanced stage of PD • Swallowing problems • Ethical and social implication of feeding tubes (e.g.) PEG-tubes • Hygiene and managing the side effects <p><u>Skills:</u> Being able to treat motor complications in late-stage PD needs to increase the time with a view to decreasing dyskinesias and decreasing the occurrence of motor and non-motor off times. Practical skills also include palliative sedation (timeframe, indications etc.) and availability of scheduled analgesics & analgesics on demand (PRN). Moreover, how to manage specific emergencies which might occur in the final phase, for example, the dopaminergic crisis and vomiting. Be able to recognise and deal with swallowing problems. Understand what the installation of a gastric tube means for a patient, how care should be provided, and which are the alternatives.</p>
Teaching Methods	<ul style="list-style-type: none"> • Presentation (slides) • Video component • Reading materials
Literature	<ul style="list-style-type: none"> • Schrag A, Hommel ALAJ, Lorenzl S, Meissner WG, Odin P, Coelho M, Bloem BR, Dodel R; CLaSP consortium. The late stage of Parkinson's -results of a large multinational study on motor and non-motor complications. <i>Parkinsonism Relat Disord.</i> 2020 Jun;75:91-96. doi: 10.1016/j.parkreldis.2020.05.016.

Lesson Plan	
	<ul style="list-style-type: none"> • Hommel ALAJ, Meinders MJ, Weerkamp NJ, Richinger C, Schmotz C, Lorenzl S, Dodel R, Coelho M, Ferreira JJ, Tison F, Boraud T, Meissner WG, Rosqvist K, Timpka J, Odin P, Wittenberg M, Bloem BR, Koopmans RT, Schragand A; CLaSP consortium. Optimizing Treatment in Undertreated Late-Stage Parkinsonism: A Pragmatic Randomized Trial. <i>J Parkinsons Dis.</i> 2020;10(3):1171-1184. doi: 10.3233/JPD-202033. • Hommel ALAJ, Meinders MJ, Lorenzl S, Dodel R, Coelho M, Ferreira JJ, Laurens B, Spampinato U, Meissner W, Rosqvist K, Timpka J, Odin P, Wittenberg M, Bloem PhD BR, Koopmans RT, Schrag A; Care of Late-Stage Parkinsonism Consortium. The Prevalence and Determinants of Neuropsychiatric Symptoms in Late-Stage Parkinsonism. <i>Mov Disord Clin Pract.</i> 2020 May 21;7(5):531-542. doi: 10.1002/mdc3.12968. • Titova N, Chaudhuri KR. Palliative Care and Nonmotor Symptoms in Parkinson's Disease and Parkinsonism. <i>Int Rev Neurobiol.</i> 2017;134:1239-1255. doi: 10.1016/bs.irn.2017.05.014. • Birnbacher, D. (2014). Sterbefasten – eine ethische Bewertung. Humanistischer Pressedienst. • Burgos, R., Bretón, I., Cereda, E., Desport, J., Dziewas, R., L., G., et al. (2018). ESPEN guideline clinical nutrition in neurology. <i>Clinical Nutrition.</i> • Elena Klinik Kassel, S. (kein Datum). Schluckstörung bei Parkinson; Invormationsblatt für Patienten und Angehörige. • Evans, S., Soar, N., Lang, A., P., S., Archer, S., & Birns, J. (28. November 2019). Risk feeding in the advanced stages of Parkinson's disease. <i>Progress in Neurology and Psychiatry.</i> • Goldman, J., & Postuma, R. (August 2014). Premotor and non-motor features of Parkinson's disease. <i>Current Opinion in Neurology, S.</i> 434-4441. • Höglinger G. U. (2018). Parkinson-Syndrome kompakt. Thieme. • Jox, R., Black, I., Borasio, G. D., & Anneser, J. (2017). Voluntary stopping of eating and drinking: is medical support ethically justified? <i>BMC Medicin.</i> • Manor, Y., Giladi, N., Cohen, A., Fliss, D., & Cohen, J. (15. October 2007). Validation of a swallowing disturbance questionnaire for detecting dysphagia in patients with Parkinson's disease. <i>Movement disorders, S.</i> 1917-21. • Myrte E. Hamburg, C. F. (31. Januar 2014). Food for love: the role of food offering in empathic emotion regulation. <i>Frontiers in Psychology.</i> • Parkinson's, U. (March 2018). Diet and Parkinson's. Brochure.
Assessment	<ul style="list-style-type: none"> • Topic related Discussion/Exercise • Self-Assessment (20 multiple choice questions)

Lesson Plan	
Teaching Unit	Loss, Grief management and Bereavement
Title	Week 10: Loss, Grief management and Bereavement
Learning Objectives	<p>Identify and describe the losses (and their impact) that patients and their families face across the illness trajectory and (for families) after death.</p> <p>Differentiate between loss, grief, bereavement and mourning, including triggers for abnormal or prolonged grief reactions.</p> <p>Identify common loss/grief models and describe their value for practice, including identification of complex grief.</p>
Summary & scheduling	Focuses on loss, grief and bereavement. It includes the definitions, explains the healthcare relevant management strategies, and inspects helpful and unhelpful coping strategies.
Learning Content A - Attitude K - Knowledge S - Skills	<p><u>Attitude:</u> Participants understand how people deal with the loss. They also appreciate that grief is a natural process which should not be medicalised.</p> <p><u>Knowledge:</u> Participants will get to know about:</p> <ul style="list-style-type: none"> • Definitions of loss, grief, mourning, bereavement. • Theories and types of loss, grief and bereavement. • The interplay of loss and grief. • The different aspects and stages of grief. • Coping strategies. • Clinical indications of poor coping. <p><u>Skills:</u> Healthcare professionals will be able to identify grief patterns. They will also be able to use the clinical indicators of poor coping and intervene as necessary.</p>
Teaching Methods	<ul style="list-style-type: none"> • Presentation (slides) • Video component • Reading materials
Literature	<ul style="list-style-type: none"> • Gofton TE, Chum M, Schulz V, et al. Challenges facing palliative neurology practice: A qualitative analysis. <i>Journal of the Neurological Sciences</i> 2018;385:225-31. • Fox S, Azman A, Timmons S. Palliative care needs in Parkinson's disease: focus on anticipatory grief in family carers. <i>Ann Palliat Med</i> 2020;9(Suppl 1):S34-S43. • Ryan K, Connolly M, Charnley K, Ainscough A, Crinion J, Hayden C, Keegan O, Larkin P, Lynch M, McEvoy D, McQuillan R, O'Donoghue L, O'Hanlon M, Reaper-Reynolds S, Regan J, Rowe D, Wynne M; Palliative Care Competence Framework Steering Group. (2014). <i>Palliative Care Competence Framework</i>. Dublin: Health Service Executive

Lesson Plan	
	<ul style="list-style-type: none"> • Ma HI, Saint-Hilaire M, Thomas CA, Tickle-Degnen L. Stigma as a key determinant of health-related quality of life in Parkinson's disease. <i>Qual Life Res.</i> 2016. 25(12):3037-3045. • Oehlberg K, Barg FK, Brown GK, Taraborelli D, Stern MB, Weintraub D. Attitudes regarding the etiology and treatment of depression in Parkinson's disease: a qualitative study. <i>J Geriatr Psychiatry Neurol.</i> 2008. 21(2):123-32. • Penner LA.& Roger K 2012. The person in the room: how relating holistically contributes to an effective patient-care provider alliance. <i>Communication & Medicine</i>, 9, 49-58. • Diane Wepa (Ed.), <i>Cultural Safety in Aotearoa New Zealand</i> (2nd ed). 2015. • Bowlby, J. (1980) <i>Attachment and Loss Vol. 3</i> London: Pelican Books • Doka KJ (1989) <i>Disenfranchised Grief: Recognizing Hidden Sorrow</i>. Lexington: Lexington Books • Silverman and Klass (1996) <i>Continuing bonds. New Understandings of grief</i>. Phil.PA, USA: Taylor and Francis. • Kübler-Ross E (1969) <i>On Death and Dying</i>, Macmillan, New York NY • Kübler-Ross, E. and Kessler, D. (2005) <i>On Grief and Grieving</i>. London: Bath Press/Simon & Schuster • Rando, T.A (1993) <i>Treatment of Complicated Mourning</i> IL: Research Press. • Stroebe, M.& Schut, H. (1999) The dual process model of coping with bereavement: rationale and description. <i>Death Studies</i>, Vol.23 pp 197-224 • Worden, J.W. (2003) <i>Grief Counselling and Grief Therapy</i>. 3rd ed. Hove: Brunner-Routledge
Assessment	<ul style="list-style-type: none"> • Topic related Discussion/Exercise • Self-Assessment (20 multiple choice questions)

Lesson Plan	
Teaching Unit	Spiritual Care
Title	Week 11: Spiritual Care
Learning Objectives	Understand the concepts of spirituality, spiritual needs and care. Be able to apply the spiritual care model throughout the illness course.
Summary & scheduling	It introduces basic concepts, such as spiritual dimension, spirituality and presents a comprehensive spiritual care model for managing PD.
Learning Content A - Attitude K - Knowledge S - Skills	<p><u>Attitude:</u> Participants will also tap into the spiritual dimension sensibly so as not to cause false hopes or increasing vulnerability in patients with PD and their caregivers.</p> <p><u>Knowledge:</u></p> <ul style="list-style-type: none"> • The terms spiritual dimension, spirituality, and spiritual care • The impact of spirituality and unmet spiritual needs to patients' and their caregivers lives • The meaning of patient-caregiver centred care model(s) • The importance of self-care strategies and support for professionals <p><u>Skills:</u> Healthcare professionals will be prompted to explore their own spirituality also as a defence to emotional cookout/burnout whist providing palliative and terminal care.</p>
Teaching Methods	<ul style="list-style-type: none"> • Presentation (slides) • Video component • Reading materials
Literature	<ul style="list-style-type: none"> • Best M. Dignity in Palliative Care. In: MacLeod RD, Van den Block L. editors. Textbook of Palliative Care. Springer Nature Switzerland AG, 2019:1-11. • Best M, Leget C, Goodhead A, et al. An EAPC white paper on multi-disciplinary education for spiritual care in palliative care. BMC Palliat Care 2020;19:9. • Centeno C, Arias-Casais N. Global palliative care: from need to action. Lancet Glob Health 2019;7:e815-6. • CHANG, GITLIN D., PATEL R., 2011, The depressed patient and suicidal patient in the emergency department: evidence-based management and treatment strategies, in Emergency medicine practice, vol. 13, n° 9 • Chirico F. Spiritual well-being in the 21st century: It is time to review the current WHO's health definition. J Health Soc Sci 2016;1:11-6. • Chochinov HM, Hack T, Hassard T, et al. Dignity therapy: a novel psychotherapeutic intervention for patients near the end of life. J Clin Oncol 2005;23:5520-5.

Lesson Plan	
	<ul style="list-style-type: none"> • Gamondi C, Larkin P, Payne S. Core competencies in palliative care: an EAPC white paper on palliative care education: part 2. <i>Eur J Palliat Care</i>. 2013. • Harris DA, Jack K, Wibberley C. The meaning of living with uncertainty for people with motor neurone disease. <i>J Clin Nurs</i> 2018;27:2062-71. • Kleinman A. <i>Patients and Healers in the Context of Culture. An Exploration of the Borderland between Anthropology, Medicine, and Psychiatry</i>. Berkeley, Los Angeles & London: University of California Press; 1980. • Kleinman A. <i>The Illness Narrative. Suffering, Healing & the Human Condition</i>. New York: Basic Books; 1988. • Lipscomb J, Gotay C, Snyder C. editors. <i>Outcomes Assessment in Cancer: Measures, Methods and Applications</i>. Cambridge: Cambridge University Press; 2004. • McSherry W, Smith J. Spiritual Care. In: McSherry W, McSherry R, Watson R, editors. <i>Care in Nursing: Principles, Values and Skills</i>. Oxford Oxford University Press; 2012. p. 118. • Paal P, Lex KM, Brandstötter C, Weck C, Lorenzl S. Spiritual care as an integrated approach to palliative care for patients with neurodegenerative diseases and their caregivers: a literature review. <i>Ann Palliat Med</i> 2020. • Penner LA, Roger K. The person in the room: how relating holistically contributes to an effective patient-care provider alliance. <i>Commun Med</i> 2012;9:49-58. • Piderman KM, Radecki Breitkopf C, Jenkins SM, et al. The impact of a spiritual legacy intervention in patients with brain cancers and other neurologic illnesses and their support persons. <i>Psychooncology</i> 2017;26:346-53. • Roger K, Wetzel M, Hutchinson S, et al. "How can I still be me?": Strategies to maintain a sense of self in the context of a neurological condition. <i>Int J Qual Stud Health Well-being</i> 2014;9:23534. • Sharpe M, Stone J, Hibberd C, et al. Neurology out- patients with symptoms unexplained by disease: illness beliefs and financial benefits predict 1-year outcome. <i>Psychological Medicine</i> 2010;40:689-98. • Snyder J, Adams K, Crooks VA, et al. "I knew what was going to happen if I did nothing and so I was going to do something": faith, hope, and trust in the decisions of Canadians with multiple sclerosis to seek unproven interventions abroad. <i>BMC Health Serv Res</i> 2014;14:445.
Assessment	<ul style="list-style-type: none"> • Topic related Discussion/Exercise • Self-Assessment (20 multiple choice questions)

Lesson Plan	
Teaching Unit	Testimonials and Discussion on Advanced Directives
Title	Week 12: Testimonials and Discussion on Advanced Directives
Learning Objectives	Comprehend patients' and caregivers' views on advance care planning. Understand different perspectives in complex, advance care decisions.
Summary & scheduling	Stories from patients and families describing how they reached their ACP decisions, how satisfied they are with these decisions, and why they feel that way (3 hours).
Learning Content A - Attitude K - Knowledge S - Skills	<p><u>Attitude:</u> Participants are encouraged to collaborate to identify values, goals, and preferences early, as well as throughout the disease trajectory, to facilitate care concordant with patients' preferences to maintain their quality of life.</p> <p><u>Knowledge:</u> Participants will have improved knowledge of how:</p> <ul style="list-style-type: none"> • PD-related life changes impact daily life activities and affect future planning, including advance care • Support and advice should be provided for life changes within a structured decision-making process • Important the personalization of the provided information and support (no 'one-size-fits-all' models) is for patients and their caregivers <p><u>Skills:</u> Enable patients and their caregivers to make informed decisions in collaboration with their formal healthcare providers.</p>
Teaching Methods	<ul style="list-style-type: none"> • Presentation (slides) • Video component • Reading materials
Literature	<ul style="list-style-type: none"> • Lum HD, Jordan SR, Brungardt A, Ayele R, Katz M, Miyasaki JM, Hall A, Jones J, Kluger B. Framing advance care planning in Parkinson disease: Patient and care partner perspectives. <i>Neurology</i>. 2019 May 28;92(22):e2571-e2579. doi: 10.1212/WNL.0000000000007552. Epub 2019 Apr 26. PMID: 31028124; PMCID: PMC6556088. • Armstrong MJ, Alliance S, Taylor A, Corsentino P, Galvin JE. End-of-life experiences in dementia with Lewy bodies: Qualitative interviews with former caregivers. <i>PLoS One</i>. 2019 May 30;14(5):e0217039. doi: 10.1371/journal.pone.0217039. PMID: 31145749; PMCID: PMC6542529. • Sokol LL, Young MJ, Papanian J, Kluger BM, Lum HD, Besbris J, Kramer NM, Lang AE, Espay AJ, Dubaz OM, Miyasaki JM, Matlock DD, Simuni T, Cerf M. Advance care planning in Parkinson's disease: ethical challenges and future directions. <i>NPJ Parkinsons Dis</i>. 2019 Nov

Lesson Plan	
	<p>22;5:24. doi: 10.1038/s41531-019-0098-0. PMID: 31799376; PMCID: PMC6874532.</p> <ul style="list-style-type: none">• Tuck KK, Brod L, Nutt J, Fromme EK. Preferences of patients with Parkinson's disease for communication about advanced care planning. <i>Am J Hosp Palliat Care</i>. 2015 Feb;32(1):68-77. doi: 10.1177/1049909113504241. Epub 2013 Sep 19. PMID: 24052430.
Assessment	<ul style="list-style-type: none">• Topic related Discussion/Exercise• Self-Assessment (20 multiple choice questions)

