Ref. Ares(2018)5582927 - 31/10/2018

PRECISE4Q

PREDICTIVE MODELLING IN STROKE

DELIVERABLE

Project Acronym: **Precise4Q**

Grant Agreement number: **777107**

Project Title: **Personalised Medicine by Predictive Modelling in Stroke for better Quality of Life**

D1.3 – Use cases and their inputs/outputs specifications

Revision: 1.0

Authors and Contributors	Alejandro García Rudolph (GUT); Eloy Opisso Salleras (GUT); Sara Laxe García (GUT); Joan Saurí Ruiz (GUT); Vince Istvan Madai (CUB); Dietmar Frey (CUB)			
Responsible Author	Alejandro García Rudolph		**Email**	agarciar@guttmann.com
	Beneficiary	GUT	**Phone**	+34 93 497 77 00-2265

Project co-funded by the European Commission within **H2020-SC1-2016-2017/SC1-PM-17-2017**		
Dissemination Level		
PU	Public, fully open	x
CO	Confidential, restricted under conditions set out in Model Grant Agreement	
CI	Classified, information as referred to in Commission Decision 2001/844/EC	

Revision History, Status, Abstract, Keywords, Statement of Originality

Revision History

Revision	Date	Author	Organisation	Description
0.1	15.10.18	Alejandro García Rudolph (GUT); Eloy Opisso Salleras (GUT); Sara Laxe García (GUT); Joan Saurí Ruiz (GUT);	GUT	First draft whole document and sections 1,2 5-8
0.2	26.10.18	Alejandro García Rudolph (GUT)	GUT	finalization of sections 5 and 6
0.3	27.10.18	Vince Madai (CUB), Dietmar Frey (CUB)	CUB	first draft sections 2 and 3, review of sections 1 and 4-8
0.4	28.10.18	Vince Madai (CUB)	CUB	finalization of sections 3 and 4
0.5	29.10.18	Alejandro García Rudolph (GUT)	GUT	review of sections 3 and 4, finalization of whole document
1.0	31.10.18	Vince Madai (CUB),	CUB	final layout, final check for grammar and typos, check of formal prerequisites

Date of delivery	Contractual:	31.10.2018	Actual:	31.10.2018
Status	final ☒ /draft ☐			

Abstract (for dissemination)	The objective of this report is to identify the most relevant scenarios and use cases for each of the patient journey phases, concentrating on the most common and complex questions. Swim lane processing mapping techniques are applied, in which processes and involved participants are grouped visually by placing them in lanes, with one lane for each person, group or relevant sub-process. Scenarios and use cases will be validated and adjusted on a

	yearly basis in cooperation with relevant users along the patient journey, thus such iterative process will be represented in the different versions of this document throughout the project
Keywords	Patient journey scenarios, use cases, involved participants

Statement of originality

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

Table of Content

List of Figures

Executive Summary

The objective of this report is to identify the most relevant scenarios and use cases for each of the patient journey phases, concentrating on the most common and complex questions. Swim lane processing mapping techniques are applied, in which processes and involved participants are grouped visually by placing them in lanes, with one lane for each person, group or relevant sub-process.

Scenarios and use cases will be validated and adjusted on a yearly basis in cooperation with relevant users along the patient journey, thus such iterative process will be represented in the different versions of this document throughout the project.

To this aim, in this work we address each phase individually. The Prevention phase focuses on use cases in the out-patient prevention setting and distinguishes between primary and secondary prevention. Naturally, the occurrence of stroke changes the input data as well as the tests which will be performed.

In the acute phase we outline the scenario of acute stroke treatment. Here, the focus is on the acute setting within the hospital.

Use cases in rehabilitation treatment are presented in this work focusing on cognitive impairments. Post-stroke cognitive impairment occurs frequently in ischemic stroke patients. Its prevalence ranges from 20% to 80% which varies for the differences between countries, races, and the diagnostic criteria. Two main scenarios are presented: non aphasic and aphasic treatments. Approximately one third of patients who survive the acute phase after stroke are aphasic. Aphasia due to stroke is associated with increased mortality, worse functional recovery, and lower chances of returning to work activities therefore it is worth considering both scenarios separately. Computerized tasks are increasingly being applied over traditional paper and pencil activities. Therefore this work focuses in computerized cognitive rehabilitation treatments. While task repetition is not the only important feature, it is becoming clear that neuroplastic changes and functional improvement occur after specific tasks are performed, but do not occur with others. Thus, one important focus for rehabilitation professionals is the treatment configuration, described for example in terms of number of rehabilitation sessions, number of tasks executions, different tasks performed at different difficulty levels during treatment. Specific use cases are presented in this work, targeting such treatment configurations.

While the majority of stroke survivors return to live in the community, re-integration may be an enormous challenge. The ability to return to an acceptable lifestyle, participating in both social and domestic activities is important for perceived quality of life. Therefore in this phase we addresses use cases arising following discharge from hospital care or rehabilitation into the community. These include social support, impact of caregiving on informal carers, family functioning, provision of information and education, leisure activities and return to work.

1 Scope and Purpose of this deliverable

The objective of this report is to identify the most relevant scenarios and use cases for each of the patient journey phases, concentrating on the most common and complex questions and relationships with quality of life. Swim lane processing mapping techniques are applied, in which processes and involved participants are grouped visually by placing them in lanes, with one lane for each person, group or relevant sub-process. Scenarios and use cases will be validated and adjusted on a yearly basis in cooperation with relevant users along the patient journey, thus such iterative process will be represented in the different versions of this document throughout the project

To this aim, in the following subsection and in the next section we briefly refresh each of the patient journey phases and the concept of quality of life. In the next sections we identify the most relevant use cases separately for each of the journey phases focusing on most relevant scenarios and involved actors.

1.1 Patient journey phases

The main medical concept of PRECISE4Q is to target four different stages of stroke in the life trajectory in a novel precision medicine approach. Precision medicine is defined as a concept to tailor prevention, diagnostics and therapeutics individually to any given patient. Thus, we will develop a set of models for each of the four clinical stages of stroke - prevention, stroke therapy, stroke rehabilitation and stroke reintegration - and combine these in a digital stroke patient platform.

Prevention. One of the most promising approaches to reduce the effects of stroke on individual health and healthcare systems is to prevent stroke. More than 77% of stroke events are first time events. Former epidemiologic studies have identified major overarching causes of stroke such as hypertension, cigarette smoking, diabetes, dyslipidemia, atrial fibrillation and carotid stenosis. While general recommendations can be given to patients to treat these conditions, it is currently unknown how a given patient is individually affected by these risk factors. Importantly, most of the risk factors are currently undertreated in the population.

Acute Treatment. There have been advances in the therapy of ischemic stroke in the past decades. Overall therapy success, however, is still poor. For thromboembolic stroke, the most favourable current treatment paradigm is the time-based dissolution of the obstructing blood clot by a drug or its mechanical retrieval. Unfortunately, up to 20% of patients arrive with an unknown time from stroke onset, and most patients present too late in the hospital to receive treatment. However, the optimal treatment strategy for an individual patient remains unknown. Additionally, what challenges the treatment of stroke patients is that the causes are highly heterogeneous. Thus, each patient suffering a stroke is an individual representation of the disease entity stroke. Current treatment paradigms, however, do not consider individual differences.

Rehabilitation. Multitude of different stroke rehabilitation concepts and methods has been developed to date. However, from an evidence-based perspective only very few general proven recommendations exist: a) Specialized rehabilitation is useful, b) early rehabilitation and mobilization is useful and c) higher intensities of therapy are useful. Beyond this, it is unclear which therapy options lead to better rehabilitation outcome, i.e. which therapies are best suited for the individual patient. Since the rehabilitation success can make the difference between the need for 24/7 care or independency, there is dire need to identify individual factors and therapy options to allow specifically tailored rehabilitation for optimal outcome after stroke.

Reintegration. Reintegration is the long-term outcome after stroke. After acute treatment and rehabilitation, reintegration success is measured by the patients' reintegration into their family, communities and workplaces. Self-esteem, depressive symptoms, social support satisfaction and other parameters are important. Such psycho-social parameters – together with functional rehab outcome – comprise long-term stroke outcome picture complete, e.g. by determining social integration, return to the work force (RTW) and work performance. However, this field is affected – up until now – by a lack of data, and it is no wonder that no guidelines for interventions exist that predict return to work force.

2 Quality of Life

The concept of quality of life first appeared in medical science in the 70s of the previous century (Sheridan C. L., Radmacher S. A., 1998). New methods of treatment, advances in medicine and the huge costs of treatment did not seem to directly translate into effects noticeable to the patient. This called for a change of approach – giving priority to non-material values.

Accordingly, medicine's interest in quality of life has been observed to relate in particular to the examination of medical and non-medical consequences of illness, as well as the assessment of medical and non-medical effects of health-care and treatment on the patient's well-being in such branches of medicine as oncology, cardiology, rheumatology, psychiatry or gerontology.

Attempts at delimiting the concept of quality of life led by Schipper (Schipper, 1999) to the formulation of the concept of ''health-related quality of life'' (HRQOL), which defines quality of life as a functional effect of illness and its treatment as perceived by the patient. HRQOL is a multidimensional concept embracing physical, emotional and social components relating to illness and its treatment.

According to the experts of WHO, the concept of quality of life ought to comprise an individual's mode of perception of their material and subjective resources, information about their functioning, its assessment and the level of satisfaction with it (WHOQOL, 1998). Quality of life has been defined as the perception by an individual of their position in life in the context of value and culture systems they live in, and in relation to the culture's expectations, standards and interests. It includes the following elements:

- physical condition,
- mental condition,
- self-reliance,
- social relationships,
- environment,
- religion, beliefs, convictions and views.

The above definition views quality of life from the perspective of the individual. Previously, research on quality of life focused on the objective aspect, tending to ignore the subjective one. The former includes, among other things, the state of health and socio-economic status of an individual (occupation, family income, spare time); the latter stresses the level of contentment with life, satisfaction of one's needs and participation in social structures.
The assessment of health-related quality of life commonly takes into consideration the following three elements:

1) The functional capability of an individual, i.e. the ability to satisfy their everyday needs, to take up or continue in social roles; intellectual and emotional efficiency.
2) The way an individual perceives his/her situation in life; the level of satisfaction and contentment with life.
3) Symptoms of an illness, and the general level of fitness following on the illness and age.

The evaluation of quality of life must address both particular aspects of the individual's life as well as their life as a whole. It is significant that the concept of quality itself carries positive connotations, as does the notion of health. Health has an absolute value, but it also has an instrumental value, i.e. it enables the individual to achieve his/her goals, most importantly, a better quality of life.

Health, on the one hand, is treated as a general predisposition to and capability for all-round development, the ability to perform social roles and to adapt to the ever-changing environment. On the other hand, it is a process of seeking and maintaining an equilibrium continually disturbed by the pressures of the internal and external environment. Health thus conceived is the most valuable resource of the individual; therefore, its role in the shaping of quality of life cannot be overestimated

The holistic approach to health is based on five dimensions:

1) physical,
2) psychological (mental and emotional),
3) social,
4) public,
5) spiritual.

In comparison with the most frequently cited definition of health included in the WHO charter defining health as a physical, mental and social well-being, and not merely a lack of disease or ailment, the newer definition supplements the concept of health with public and spiritual dimensions (WHOQOL, 1998).

3 Prevention phase

One of the most promising approaches to reduce the effects of stroke on individual health and healthcare systems is to prevent stroke. More than 77% of stroke events are first time events. Former epidemiologic studies have identified major overarching causes of stroke such as hypertension, cigarette smoking, diabetes, dyslipidemia, atrial fibrillation and carotid stenosis. While general recommendations can be given to patients to treat these conditions, it is currently unknown how a given patient is individually affected by these risk factors. Importantly, most of the risk factors are currently undertreated in the population. Lifestyle modification is of particular interest for stroke prevention, as the incidence of stroke has decreased by up to 42% in developed countries within the last 30 years, whereas an increase by more than 100% has been reported in developing countries (Feigin et al, 2017). This observation indicates the important role of lifestyle and diet; the prevalence of risk factors such as smoking, hyperlipidemia, or high blood pressure has decreased considerably, thereby increasing awareness among the populations of high-income countries. However, in low-income countries, industrialization has led to unfavourable food and lifestyle changes.

The other important prevention scenario is secondary prevention. Minor stroke and TIA can be considered warning events (Amarenco et al, 2016). Here, it is very important to prevent the second – potentially deadly or devastating – second stroke event. In contrast to the primary prevention scenario the scenario is different, as other – often more expensive and less frequent – diagnostics are available as inputs.

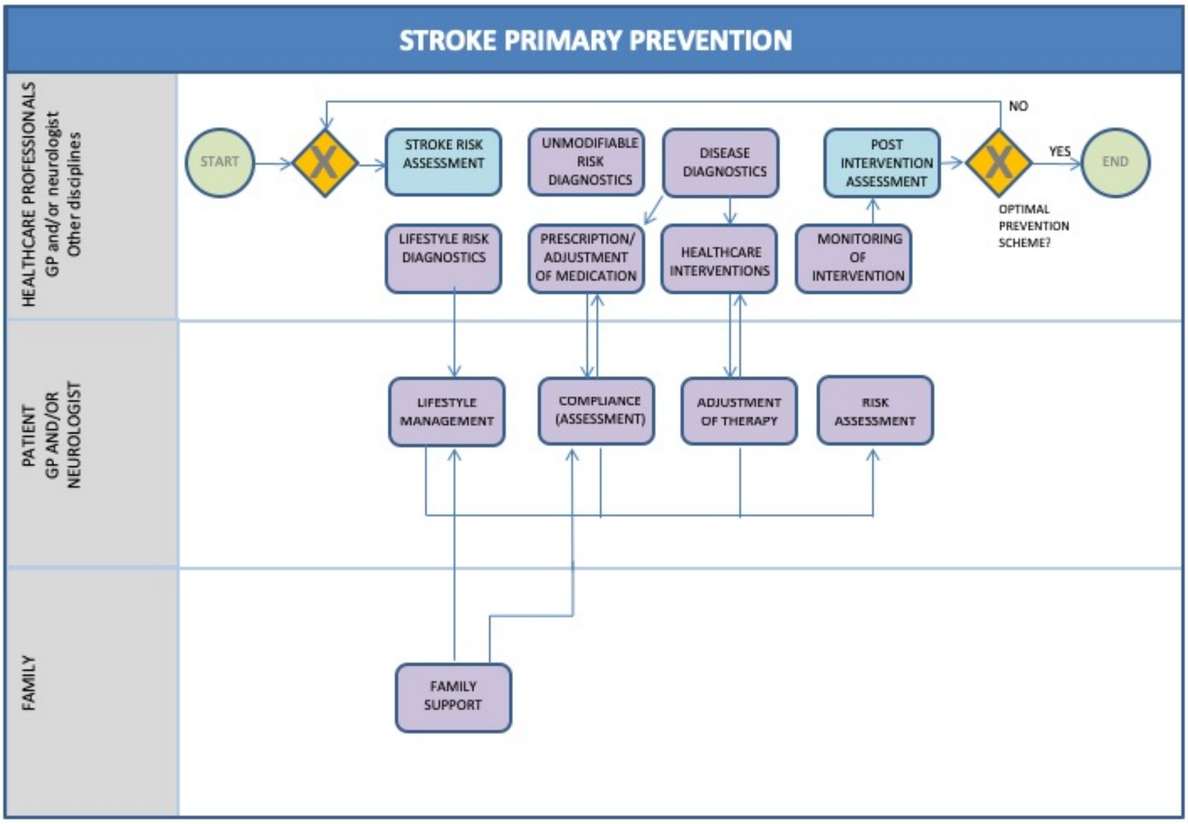
Generally, it is important to mention that primary and secondary prevention of stroke is strongly tied to tertiary prevention of diseases and chronic conditions that are stroke risks at the same time. For example, the optimal tertiary prevention of hypertension and diabetes mellitus is also primary prevention of the disease stroke.

3.1 Stroke primary prevention

In the primary prevention scenario, it is important to distinguish between modifiable and unmodifiable risk factors (See also D1.1 of the PRECISE4Q project). While unmodifiable risk factors will certainly play a role in determining the stroke risk – especially in predictive models – they are not available for interventions. In contrast, modifiable risk factors are the primary target of primary stroke prevention.

Modifiable risk factors involve 3 identified groups. Group one comprises the healthcare professionals, both the GP and/or neurologist in the outpatient setting diagnosing, monitoring and treating the patients as well as other healthcare professionals performing interventions to reduce stroke risk, e.g. endarterectomy of the carotid arteries. Group two comprises the patients, which are at the centre of the interventions, modifying their lifestyle, complying with medications, adjusting their stroke risk by undergoing risk modifying interventions and constantly re-evaluating their stroke risk together with their GP and/or neurologist. Lastly, family members are and important group, providing support for lifestyle changes and compliance, especially in elderly patients.

Figure 1 Stroke Primary Prevention scenario



3.1.1 Input data: Modifiable and Non-Modifiable Risk Factors

All major modifiable and non-modifiable risk factors comprise the input in this scenario.

Risk Factor	Modifiable (yes/no)/Intervention
Age	no
Sex	no
Ethnicity	no
Genetic factors	no
Hypertension	yes/medication, lifestyle change
Atrial fibrillation	yes/medication
Diabetes mellitus	yes/medication, lifestyle change
Carotid stenosis	yes/surgery, medication, lifestyle change
Dyslipidemia	yes/medication, lifestyle change
smoking	yes/lifestyle change

3.1.2 Main Outputs expected from predictive models:

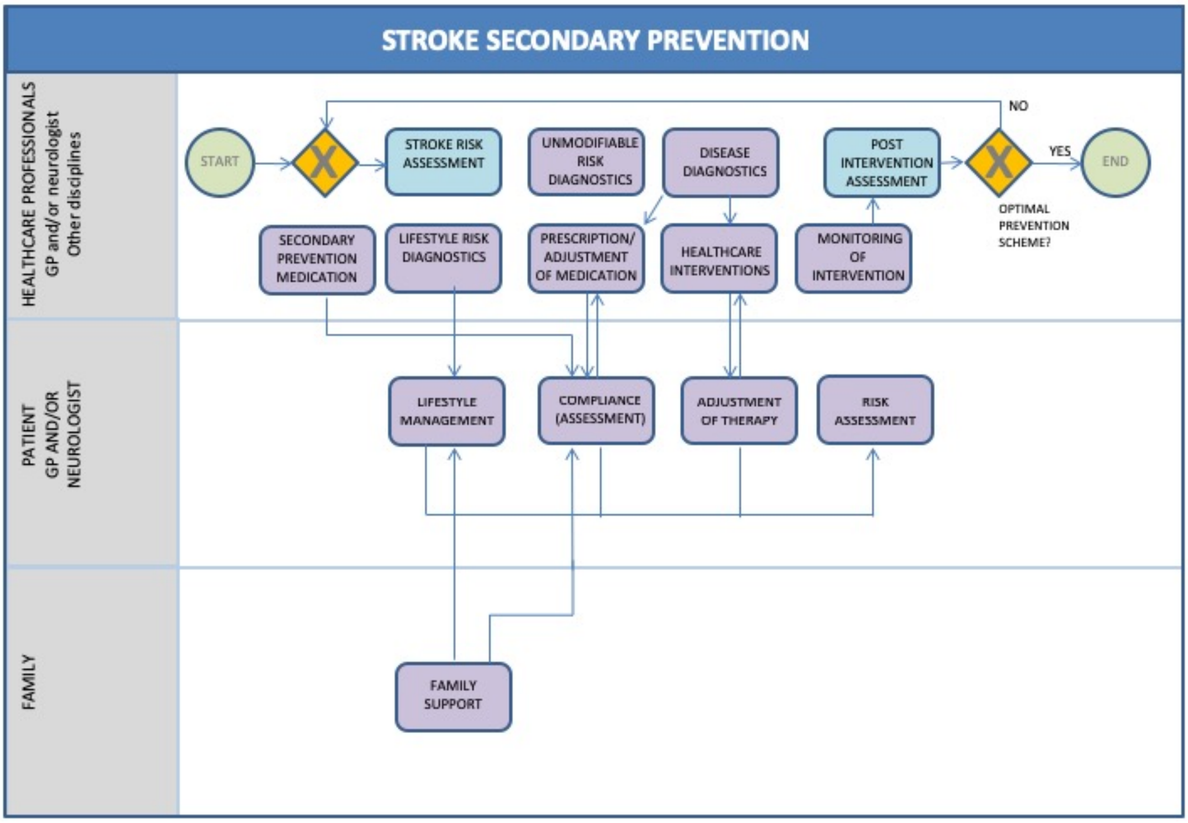
The main output in this scenario is the prediction of stroke risk. The input data determines the time frame in years for which a prediction is possible

# Use case	Description	End users involved
1	Predict stroke risk within time frame of n years	Patient, MD

3.2 Stroke secondary prevention

In the stroke secondary prevention scenario both potential intervention options as well as input parameters change. On one hand it is shown that pharmacological treatment is necessary to prevent another cerebrovascular event (Kernan et al, 2014). On the other hand the first cerebrovascular episode, TIA or stroke, will normally lead to performance of tests, the results of which will generally be available for predictive models. Amongst them the most important is neuroimaging diagnostics as well as specialized tests to determine stroke etiology. Also the number of prior events will be predictive of future events. This will modify the input parameters for predictive models. The swim lane scenario, however, will be very similar to the primary prevention setting, adding only specific medication to prevent a following new cerebrovascular event. Naturally, the nature of interventions and diagnostic tests will change, but it will not fundamentally change the stakeholders and processes.

Figure 2 Stroke Secondary Prevention scenario



3.2.1 Input data: Modifiable and Non-Modifiable Risk Factors

All major modifiable and non-modifiable risk factors comprise the input in this scenario.

Risk Factor	Modifiable (yes/no)/Intervention
Age	no
Sex	no
Ethnicity	no
Genetic factors	no
Hypertension	yes/medication, lifestyle change
Atrial fibrillation	yes/medication
Diabetes mellitus	yes/medication, lifestyle change
Carotid stenosis	yes/surgery, medication, lifestyle change
Dyslipidemia	yes/medication, lifestyle change
Smoking	yes/lifestyle change
Stroke Medication	yes/change of medication and dose
Neuroimaging	no
Specialized tests/Stroke etiology	no

Stroke Severity	no
number of prior events	no

3.2.2 Main Outputs expected from predictive models:

The main output in this scenario is the prediction of stroke risk. The input data determines the time frame in years for which a prediction is possible

# Use case	Description	End users involved
1	Predict re-stroke risk within time frame of n years	Patient, MD

4 Acute phase

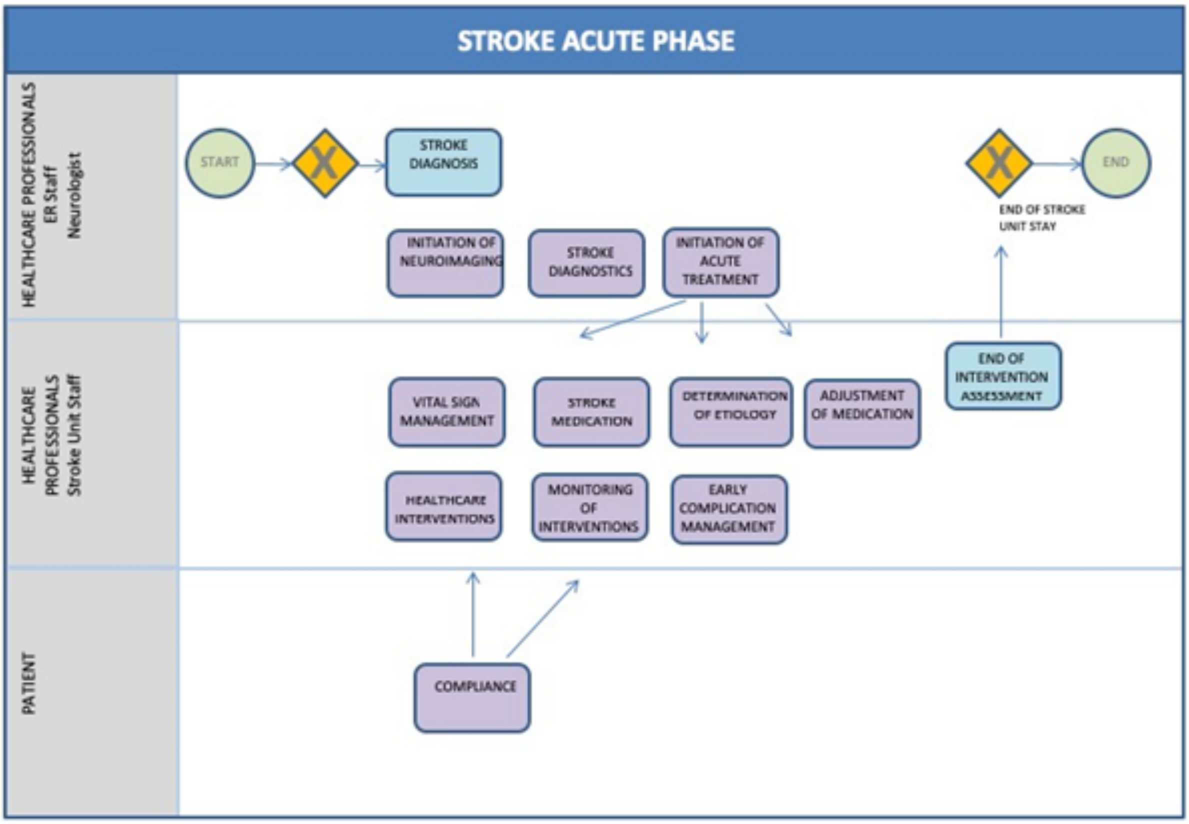
There have been advances in the therapy of ischemic stroke in the past decades. Overall therapy success, however, is still poor. For thromboembolic stroke, the most favourable current treatment paradigm is the time-based dissolution of the obstructing blood clot by a drug or its mechanical removal. Unfortunately, up to 20% of patients arrive with an unknown time from stroke onset, and most patients present too late in the hospital to receive treatment. Also, only very few patients are eligible for mechanical thrombectomy (Drocton et al., 2018), whereas the number needed to treat for intravenous thrombolysis drastically increases with time and reaches around 10 in the time window where most patients are treated (Wahlgren et al, 2008). Latest results have shown that the so called DWI-FLAIR-mismatch, a mismatch of stroke related signals in two different MRI-sequences, can identify patients eligible for treatment independent of their onset time (Lees et al, 2010). Approaches like these are called "tissue-based" approaches which have a much higher potential for patient selection than the purely time-based approaches of the past. However, they are not widespread and the DWI-FLAIR mismatch – as the only validated one – relies on MR-imaging which is far less often used than CT-imaging in the acute setting.

4.1 Acute stroke scenario

Acute stroke treatment naturally begins with neuroimaging – CT or MRI based – to exclude hemorrhage. Once an ischemic stroke is suspected with high enough likelihood based on neuroimaging and the clinical presentation, potential therapy is initiated if the patient is either in the appropriate time window or a tissue-based treatment paradigm identifies the patient as eligible for treatment. In either case, the patient is then transferred to a specialised acute care area, the so called Stroke Unit, where they receive specialised stroke care up to approximately one week after infarction by stroke specialists. Treatment within this Stroke Unit and potential early complications after stroke in this early phase may also have a strong impact on outcome (Heuschmann et al, 2004).

In the acute stroke treatment scenario, the main stakeholders are thus the acute ER-team that diagnoses the patient and initiates acute treatment as well as the Stroke Unit team that continues acute stroke treatment on the Stroke Unit. The patient itself is of course also a stake holder, but will naturally be due to the severe nature of stroke limited in active participation. Notwithstanding, also here patient compliance plays a role.

Figure 3 Stroke Acute Phase scenario



4.1.1 Input data: Acute Stroke Scenario

Input data for the acute stroke scenario comprises all available information about a patient as well information from neuroimaging.

Risk Factor
Age
Functional scales (e.g. NIHSS)
Sex
Ethnicity
Neuroimaging
Hypertension
Atrial fibrillation
Diabetes mellitus
Carotid stenosis

Dyslipidemia
Smoking
Stroke Medication
prior stroke events
other prior diseases

4.1.2 Main Outputs expected from predictive models:

The main output in this scenario is the prediction of functional outcome after a certain period of time. The most common used parameter is functional outcome after 3 months, measured by the modified Rankin Scale (mRS), which is usually – for predictive modelling – binarized into 0-2 (good outcome) and 3-6 (bad outcome). Another use case could be the prediction of early outcome, thus NIHSS or mRS scales at the end of the Stroke Unit treatment period.

# Use case	Description	End users involved
1	Predict functional stroke outcome by binarized mRS after 3 months	Patient, MD
2	Predict early outcome at time of transfer from Stroke Unit	Patient, MD

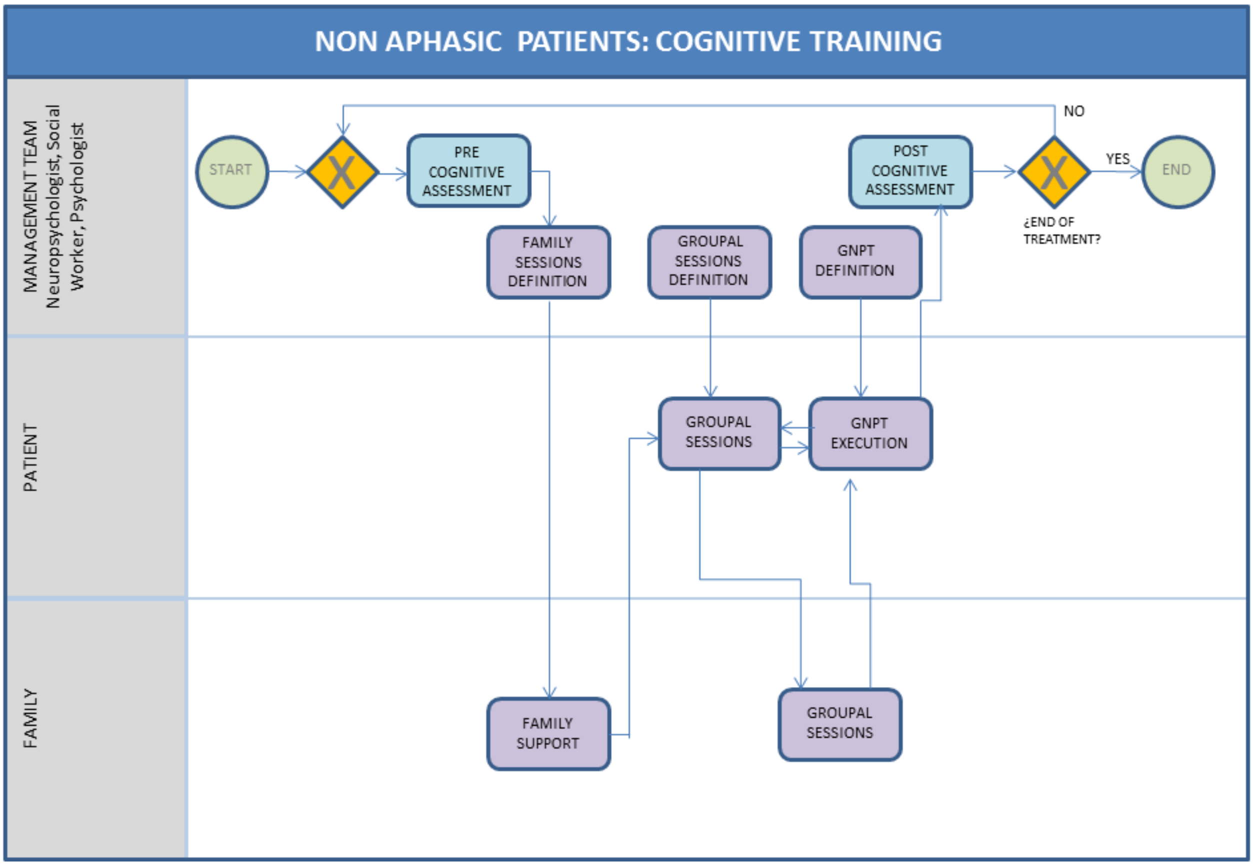
5 Rehabilitation phase: Cognitive treatment

Post-stroke cognitive impairment occurs frequently, it ranges from 20% to 80%, varying due to the difference between countries, races, and the diagnostic criteria (Sun et al, 2015). Computerized tasks are increasingly being applied over traditional paper and pencil activities. Therefore in this work the Guttmann, NeuroPersonalTrainer ® platform (https://www.gnpt.es/en) *GNPT*, is the cognitive rehabilitation framework applied for treatment systematization (Garcia-Rudolph and Gibert, 2014). While task repetition is not the only important feature, it is becoming clear that neuroplastic change and functional improvement occur after specific tasks are performed, but do not occur with others (Carey et al, 2007). Thus, one important focus for rehabilitation professionals is the treatment configuration, described for example in terms of number of rehabilitation sessions, number of tasks executions and different tasks performed during treatment.

5.1 Non aphasic scenario

Given a set of *n* patients that execute computerized cognitive rehabilitation tasks selected by clinicians along a treatment, each task targets a specific cognitive function e.g. Attention, Memory or Executive Function. Each cognitive function has been traditionally subdivided into sub-functions (e.g. Sustained, Selective and Divided Attention). Typically a cognitive rehabilitation task targets a particular sub-function of a function. Patients' cognitive level is assessed before and after treatment by means of standardized tests. This assessment can be conducted to explore each function, sub-function or a global cognitive outcome. Therefore a cognitive training outcome might be given for each patient e.g. a boolean label describing the global improvement (GLOBAL_IMP = (TRUE,FALSE)).

Figure 4 Cognitive training scenario for non-aphasic patients



5.1.1 Input data: assessment of main functions involved in ADLs

The non-aphasic neuropsychological scenario is defined as an active process that helps the affected person to optimize the recovery of superior functions, to better understand the nature of the alterations it presents and to develop strategies to compensate for disorders. The evaluation will be the first step for neuropsychological rehabilitation scenario as presented in Figure 4 swim lane. This allows to:

- Identify, describe and quantify cognitive, behavioural and emotional alterations as well as the preserved functions.
- Guiding the process in order to rehabilitate the affected functions and modify the maladaptive behaviours.
- Determine the patient's progress more objectively and evaluate the effectiveness of the different interventions
- Provide information and guidance to the family and the members of the rehabilitation team that help to set realistic and functional goals
- Estimate the severity of sequels within the forensic professionals in order to support legal decision-making.
- Contribute, along with other professionals, to the psychosocial orientation that allows the reintegration of the patient to his habitual environment

Main cognitive functions addressed in pre-post evaluations (with their corresponding evaluation tests) are presented in Table 1

Cognitive function	Test
Orientation	TB Orientation test (Katzman et al., 1983)
Attention	Direct Digits WAIS-III (Wechsler, 1999)
	TMT part A (Reitan and Wolfson, 1993)
	Stroop Test (Golden, 1994)
	Continuous Performance Task Test (Conners, 2002)
Information processing speed	Keys WAIS-III (Wechsler, 1999)
Language	Repetition – Boston test (Kaplan, 2001)
	Denomination – Boston test (Kaplan, 2001)
Visual-perception	Overlapping Images (Wechsler, 1999)
Visual-construction	Cubes WAIS-III (Wechsler, 1999)
Memory	Inverse digits WAIS-III (Wechsler, 1999)
	Numbers and Letters WAIS-III (Wechsler, 1999)
	The Rey Auditory Verbal Learning Test (Rey,1964)
Executive Functions	TMT part B (Reitan and Wolfson, 1993)
	Wisconsin Card Sorting Test (Heaton et al., 1997)
	Stroop Test (Golden, 1994)
	Letter Fluency Test (Artiola i Fortuny et al., 1999) (

Table 1. Main cognitive functions involved in non-aphasic scenario and their assessment tests

5.1.2 Input data: execution of cognitive rehabilitation tasks targeting main functions involved in ADLs

A standard cognitive rehabilitation treatment takes 2-5 months distributed in 3-5 sessions a week, each session is composed of 5-10 cognitive rehabilitation tasks. Typically each patient executes a different number of tasks along treatment and in a different order. For each execution, the patient gets a result (ranging from 0 to 100).

Table 2 presents for each cognitive function and sub-function the number of cognitive rehabilitation tasks available in GNPT platform. Regardless of the specific cognitive platform chosen for actual treatments, therapists traditionally select for each patient the order of execution of tasks and the targeted function based on patients' previous results and their own experience/intuition (Garcia Rudolph and Gibert, 2014).

There is very little research related on the amount and type of practice that occurs during cognitive rehabilitation treatment and its relationship to rehabilitation outcomes (Cicerone et al, 2011).

There is not enough on-field experience yet regarding which specific intervention (tasks and performance on them) is more appropriate to help cognitive rehabilitation therapists to design their clinical therapeutic plans. Therefore in the next section we propose several use cases addressing representative situations.

.

Function	Sub-function	Number of tasks
Orientation	Temporal & Spatial	2
Attention	Sustained	4
	Selective	5
	Divided	4
Memory	Visual	5
	Verbal	5
	Working	5
Executive Functions	Planning	5
	Inhibition	4
	Flexibility	3
	Sequencing	4
	Categorization	4
Gnosia	Visual	3
Calculus	Mental	7
Praxis	Constructive	1

Table 2. Number of rehabilitation tasks by cognitive functions and sub-functions in non-aphasic scenario

5.1.3 Main Outputs expected from predictive models:

Predict level of compliance. Clinicians prescribe activities that should be executed, nevertheless there's a percentage of activities that for several reasons are not actually executed by patients. Clinicians are interested in level of compliance at a global level (e.g. considering every function) or level of compliance at the function level (e.g. compliance when considering only attention or memory functions).

# Use case	Description	End users involved
1	Predict level of compliance considering number of tasks (in percentage) at a global cognitive level	NPS, MD
2	Predict level of compliance considering number of sessions at a global cognitive level	NPS, MD
3	Predict level of compliance considering number of tasks (in percentage) by cognitive function	NPs
4	Predict level of compliance considering number of sessions by cognitive function	NPS
5	Predict level of compliance considering number of tasks at a global level for different time-frames (for example if total treatment = 4 months consider 3 time frames 40 days each)	NPS, MD

Table 3. Use cases for level of compliance predictions (NPS = Neuropsychologist, MD = Medical Doctor)

Predict neuro-rehabilitation range (NRR). A typical cognitive rehabilitation program mainly provides tasks which require repetitive use of the impaired cognitive system in a progressively more demanding (Sohlberg, 2001) sequence of tasks. The rehabilitating impact of a task depends on the ratio between the skills of the treated patient and the challenges involved in the execution of the task itself. Thus, determining the correct training schedule requires a quite precise trade-off between sufficient stimulation and sufficiently achievable tasks, which is far from intuition, and is still an open issue, both empirically and theoretically (Green & Bavelier, 2005). It is difficult to identify this maximum effective level of stimulation and therapists use their expertise in daily practice,without precise guidelines on these issues.

In Clinical Pharmacokinetics, therapeutic range is defined as a range of drug concentrations within which the probability of the desired clinical response is relatively high and the probability of unacceptable toxicity is relatively low. Within this therapeutic range the desired effects of the drug are observed. Below it there is a greater probability that the therapeutic benefits are not realized (non-response or treatment-resistance); above it, toxic effects may occur (DiPiro & Spruill, 2010).

Using this analogy, we consider that a cognitive rehabilitation treatment task behaves in NRR if the desired clinical response is obtained i.e. if an observable improvement in the targeted cognitive function is registered for the patient.

In GNPT, following the execution of a given task T the subject gets a result RT ranging from 0 to 100. A 0 result denotes the lowest level of task completion and a 100 the highest. Being the NRR of task T defined as NRR(T) = [r-, r+], and being r-, r+ in [0, 100], using a simple test it is easy to determine whether or not the patient performed the task in NRR (García-Rudolph and Gibert, 2014) :NRR (RT) iff $RT \in NRR(T) \equiv r- \leq RT \leq r+$ Currently, some hypotheses are being tested for the values of r- and r+. For example nowadays we consider that *r- = 65* and *r+= 85 i.e. NRR(T) =[65,85].* Table 4 presents use cases for NRRs.

# Use case	Description	End users involved
6	Predict an unique NRR considering global improvement	NPS
7	Predict different NRRs for different cognitive functions (e.g. identify a specific NRR for attention tasks, another NRR for memory tasks, etc) considering global improvement	NPS
8	Predict an unique NRR considering the improvement of each cognitive function (e.g. identify NRR for attention tasks that lead to improvement in attention cognitive function)	NPS
9	Predict different NRRs for different cognitive functions (e.g. identify a specific NRR for attention tasks, another NRR for memory tasks, etc) considering improvement in attention and memory	NPS
10	Predict an unique NRR considering different time frames, it is possible that NRR vary in time, e.g. there is an NRR for the initial phase of treatment, for example for the first 40 days and another NRR for other time frames.	NPS
11	Predict different NRR for different cognitive functions, considering different time frames, it is possible that NRR vary in time, e.g. there is an NRR for attention tasks, the initial phase of treatment, for example for the first 40 days and another NRR for other time frames.	NPS

Table 4. Use cases for NRRs predictions for non aphasic scenario (NPS = Neuropsychologist)

Predict deficit reductions. Clinicians evaluate functionality pre- post treatment to assess individual global response (predict pre-post). Clinicians also evaluate functionality pre- post treatment to assess individual per function response (predict pre-post for each targeted function). Table 5 presents use cases for deficit reductions.

# Use case	Description	End users involved
12	Predict deficit reduction at a global level considering number of tasks or number of sessions	NPS, MD
13	Predict deficit reduction at a function level considering number of tasks, number of sessions (for example consider deficit reduction for an individual function such as attention or memory	NPS, MD
14	Predict deficit reduction at a global level considering number of tasks in NRR	NPS, MD
15	Predict deficit reduction at a function level considering number of tasks in NRR for such function(for example consider deficit reduction for an individual function such as attention or memory	NPS, MD

Table 5. Use cases for deficit reduction predictions in non aphasic scenario

5.2 Aphasic scenario

Approximately one third of patients who survive the acute phase after stroke are aphasic. Aphasia due to stroke is associated with increased mortality, worse functional recovery, and lower chances of returning to work activities (Laska et al, 2001).

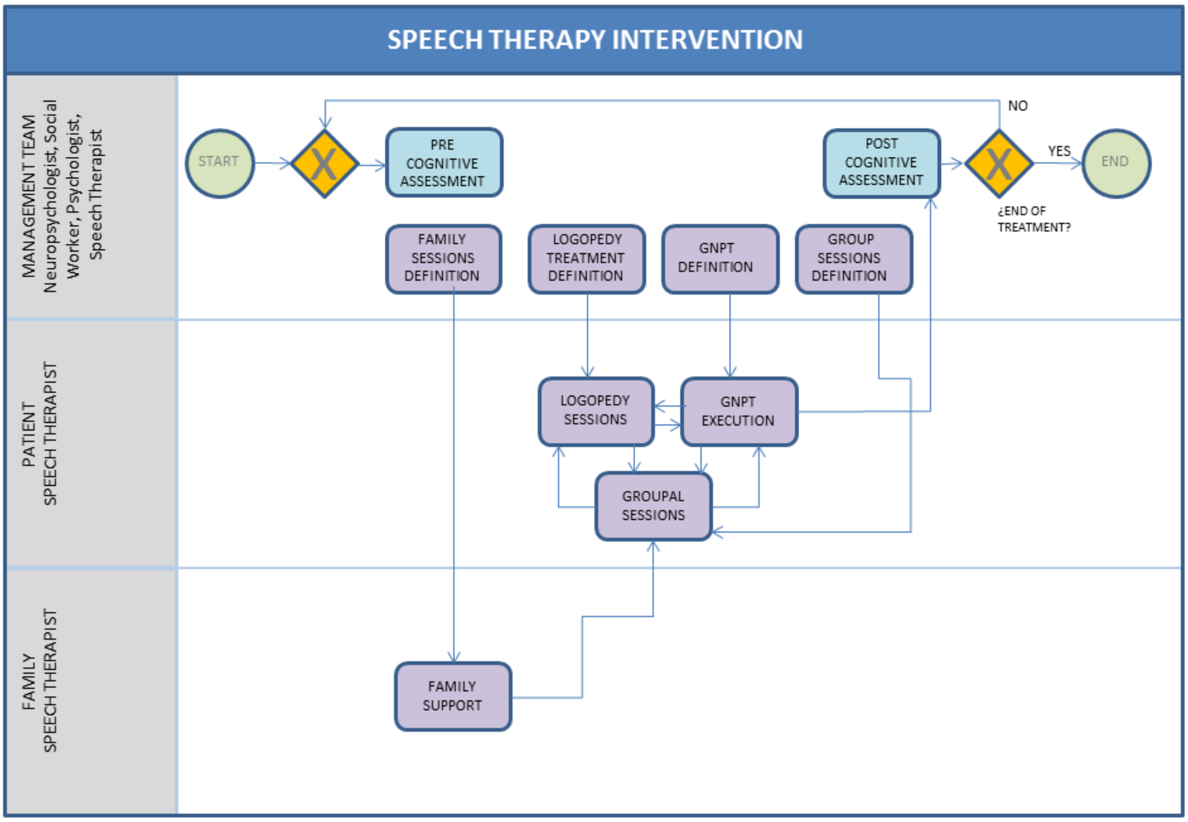
5.2.1 Input data: assessment of main functions

The aphasic neuropsychological scenario addresses different cognitive functions, as presented in Table 6 and involves a different set of cognitive tasks therefore should be analysed separately from the non aphasic scenario.

Cognitive function	Test
Spontaneous Language	Thematic narrative
	Description
	Fluency and Grammar
	Informative content
Repetition	Syllables
	Words
	Phrases
Denomination	Visuo-verbal
	Verbo-verbal
	Complement
Comprehension	Words
	Orders
	Material verbal complex
Reading	Letters
	Numbers
	Words
	Texts
Reading comprehension	Word-image
	Written orders
	Phrases-texts
Writing	Mechanics - writing
	Letters
	Numbers
	Words
	Phrases

Table 6. Main cognitive functions reduction predictions in aphasic scenario

Figure 5 Speech therapy for aphasic patients scenario



5.2.2 Input data: execution of cognitive rehabilitation tasks targeting main speech functions

A standard cognitive rehabilitation treatment takes 2-5 months distributed in 3-5 sessions a week, each session is composed of 5-10 cognitive rehabilitation.

Function	Subfunction	Number of parameters
	Direct copy	4
	Deferred copy	4
Writing	Joining fragments	6
	Denomination responding	3
	Images denomination	5
	Grapheme identification	2
	Identical words	3
	Upper and lowercase words	3
	Automatic series order	2
	Written and head word	8
Reading	Classifying	2

Comprehension	Antonyms	2
	Delete the different	2
	Related words	9
Hearing Comprehension	Basic skills – Identical images	3
	Basic skills – Sorting by size	4
	Basic skills – Copy series	3
	Basic skills – Continue series	3
	Memory – temporal order	5
	Environmental sounds	2
Semantics	Associate by category	5
	Associate by relation	3
	Images classification	4
	Delete the different	2

Table 7. Number of parameters of main training tasks by functions and sub-functions in aphasic scenario

5.2.3 Main Outputs expected from predictive models:

Predict level of compliance. Clinicians prescribe language activities that should be executed, nevertheless there's a percentage of activities that for several reasons are not actually executed by patients therefore specific use cases are generated and shown in Table 8.

# Use case	Description	End users involved
1	Predict level of compliance considering number of tasks (in percentage) at a global level	NPS, MD, ST
2	Predict level of compliance considering number of sessions at a global level	NPS, MD, ST
3	Predict level of compliance considering number of tasks (in percentage) by cognitive function for example Writing or Reading Comprehension tasks	NPS, MD, ST
4	Predict level of compliance considering number of sessions by cognitive function (for example Writing or Reading)	NPS, MD, ST
5	Predict level of compliance considering number of tasks at a global level for different time-frames (for example if total treatment = 4 months consider 3 time frames 40 days each)	NPS, MD, ST

Table 8. Use cases for level of compliance in aphasic scenario (ST = Speech Therapyst)

Predict neuro-rehabilitation range (NRR). Identify different NRR values, considering global improvement or per-function responses as presented in Table 9.

# Use case	Description	End users involved
6	Predict an unique NRR considering global improvement	NPS, MD, ST
7	Predict different NRRs for different cognitive functions (e.g. identify a specific NRR for reading tasks, another NRR for comprehension tasks, etc) considering global improvement	NPS, MD, ST
8	Predict an unique NRR considering the improvement of each cognitive function (e.g. identify NRR for writing tasks that lead to improvement in writing cognitive function)	NPS, MD, ST
9	Predict different NRRs for different cognitive language functions (e.g. identify a specific NRR for writing tasks, another NRR for comprehension tasks, etc)	NPS, MD, ST
10	Predict an unique NRR considering different time frames, it is possible that NRR vary in time, e.g. there is an NRR for the initial phase of treatment, for example for the first 40 days and another NRR for other time frames.	NPS, MD, ST
11	Predict different NRR for different cognitive functions, considering different time frames, it is possible that NRR vary in time, e.g. there is an NRR for reading tasks, the initial phase of treatment, for example for the first 40 days and another NRR for other time frames.	NPS, MD, ST

Table 9. Use cases for NRRs in aphasic scenario

Predict deficit reductions. Clinicians evaluate functionality pre- post treatment to assess individual global response (predict pre-post). Clinicians also evaluate functionality pre- post treatment to assess individual per function response (predict pre-post for each targeted function) as shown in Table 10.

# Use case	Description	End users involved
12	Predict deficit reduction at a global level considering number of tasks or number of sessions	NPS, MD, ST
13	Predict deficit reduction at a function level considering number of tasks, number of sessions (for example consider deficit reduction for an individual function such as reading or writing	NPS, MD, ST
14	Predict deficit reduction at a global level considering number of tasks in NRR	NPS, MD, ST
15	Predict deficit reduction at a function level considering number of tasks in NRR for such function(for example consider deficit reduction for an individual function such as reading or writing	NPS, MD, ST

Table 10. Use cases for deficit reduction predictions in aphasic scenario

6 Reintegration phase

While the majority of stroke survivors return to live in the community, re-integration may be an enormous challenge. The ability to return to an acceptable lifestyle, participating in both social and domestic activities is important for perceived quality of life. The present section addresses use cases arising following discharge from hospital care or rehabilitation into the community. These include social support, impact of caregiving on informal carers, family functioning, provision of information and education, leisure activities and return to work.

6.1 Input Specifications: Periodic Integral Evaluation

Every stroke patient, after discharge from Institut Guttmann, periodically undergoes follow up evaluations which may also lead to detect early pathology that, due to the characteristics of the specific lesion, could be asymptomatic and/or remain unnoticed until advanced stages.

Therefore such evaluations are preventive actions, which aim to reduce the incidence of complications in the population with acquired brain damage while allowing the monitoring of the results of long-term treatment, in terms of restriction of participation, as well as the assessment of the family, community and employment insertion.

It has a periodicity of 12-24 months, patients can request it by telephone, or in person to the Admissions Service, which, approximately one month before the evaluation, sends a reminder letter of the visit to the patient by mail. The periodic review will be done within the least amount of time as possible, with the objective of interfering as little as possible in the usual activities of the person (it usually takes from 9:00 to 12:30 during one morning). There is also the possibility, for patients from other Autonomous Communities of Spain or abroad, to perform this procedure within a short admission to the hospital of less than 5 days.

Subsequently, within approximately three weeks, the patient receives at home the report with the conclusions of the medical examinations. If problems have been detected that require urgent intervention, patients will be personally contacted or the responsible relative, to give the pertinent information as well as to request additional tests or refer to the adequate service for the follow-up and / or treatment of the eventual complications detected.

6.1.1 Involved clinical professionals

Periodic integral evaluations are performed within the framework of an interdisciplinary team which will comprehensively assess the patient, the team is integrated by:

a. Medical Doctor (Coordinator of the whole process)
b. Nurse
c. Urologist
d. Physiotherapist and / or Diploma in Occupational Therapy
e. Psychologist
f. Neuropsychologist
g. Social worker.

Each involved professional undertakes the assessment of the patient that corresponds to their field of knowledge, but it is always shared and complemented with the assessment of the rest of the professionals and a fluid collaboration and communication is maintained between the different professionals.

6.1.2 Main inputs from different professionals

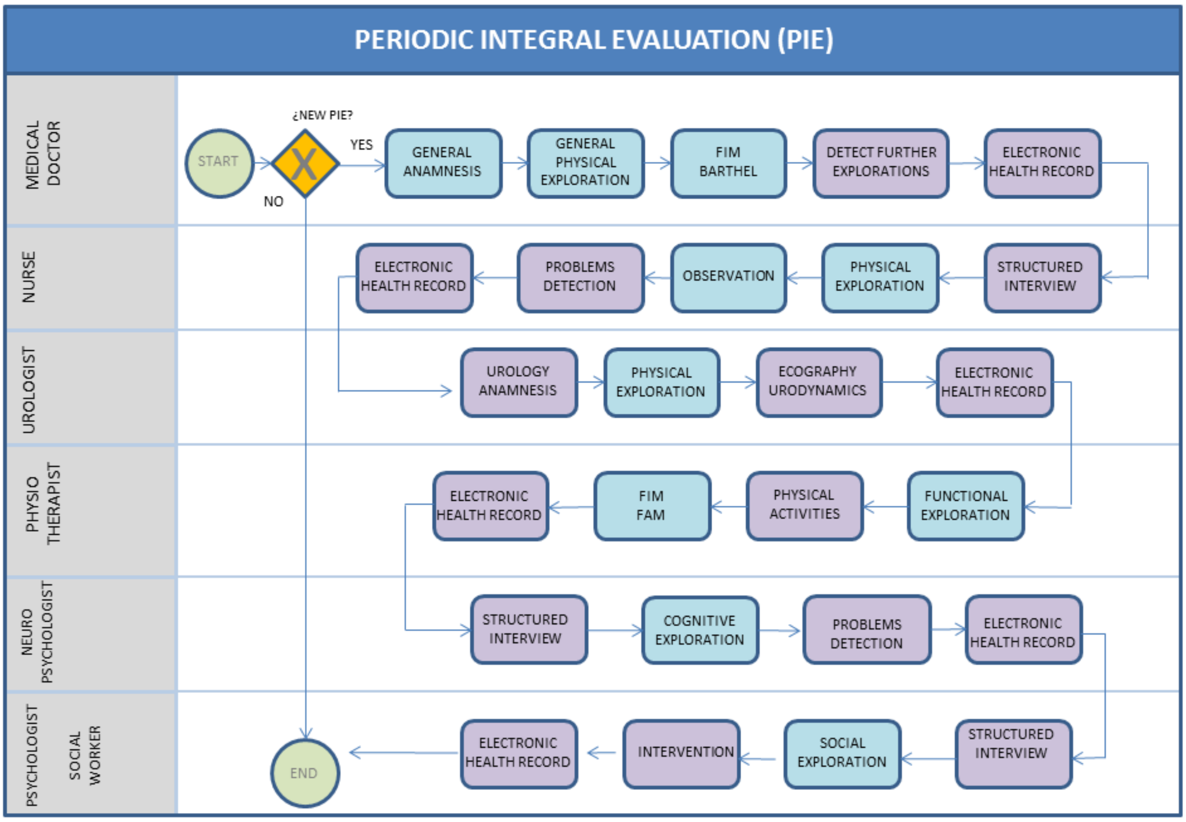
Medical Doctor. Initially performs the General Anamnesis emphasizing the most common problems in the specific pathology, considering medium and long term aspects such as: date of last revision, medical and surgical incidents since the last revision, allergies. Then the General Physical Exploration body weight, overall status, skin, cardiorespiratory system, abdomen, vascular, locomotor and genitourinary system, neurological exploration (state of consciousness, behaviour, cognition, communication, swallowing, sensitivity, muscular tone, reflexes, mobility, coordination.
As shown in Figure 6 Medical Doctor also detects faults and needs of other complementary explorations or inter-consultations to other specialists and registers all activities in the patient's Electronic Health Record.

Nurse. Performs the structured interview and observation, addresses several aspects such as: breathing, feeding, bladder and intestinal elimination, mobility, postural changes, transfers, locomotion, rest and sleep, communication, pain, usual medication, as well as the evaluation of the knowledge and skills of the patient and / or family for self-care. Regarding the physical exploration, general aspect, state of the skin, general constants (heart rate, blood pressure) and electrocardiograms in patients> 35 years.

Urologist. Carries out the anamnesis focusing on the genitourinary tract, considers the complications or urological interventions that have occurred since the last revision, recurrent urine infections, stones, continence, bladder emptying type and neuro-prosthesis. Performs the genitourinary physical exploration, renal echography and urodynamic.

Physiotherapist. Functional exploration, body weight, performs the assessment of the neurological process from the functional side (food, hygiene, mobility in bed, ability with a wheelchair or with other technical aids ...). Daily life activities: feeding, personal care, hygiene, use of the bathroom, dressing, transfers, locomotion, standing and walking, physical maintenance. Administration of FIM+FAM test. The FAM items were developed by clinicians representing each of the disciplines in an inpatient rehabilitation program. The FAM was developed as an adjunct to the FIM to specifically address the major functional areas that are relatively less emphasized in the FIM, including cognitive, behavioral, communication and community functioning measures. The FAM consists of 12 items. These items do not stand alone, but are intended to be added to the 18 items of the FIM. The total 30 item scale combination is referred to as the FIM+FAM. The time required to administer the FIM+FAM is approximately 35 minutes (Wright, 2000).

Figure 6 Periodic integral evaluation scheme



Social Worker/Psychologist. Performs the semi-structured interview allowing us to know the current situation of the patient and socio-familiar environment, and guide if any aspect is appropriate. Evaluate and interpret the results of the scales, integrate the data. Return of results. Delivery of information dossier. If the professional detects a new deficit or disorder, the patient is referred to the relevant professional expert (psychologist, neuropsychologist or social worker), depending on the problem., it can also be referred to an external specialist.

Neuropsychologist. Neuropsychological evaluation(presented in Table XXX). Attention to the family Rehabilitation process: Cognitive rehabilitation with G-NPT platform. Group of patients with non-traumatic brain damage with cognitive impairment. Group of patients with brain damage for the treatment of the conscience of deficit and emotional involvement. Basic cognitive stimulation group for patients with brain damage with overall impairment of higher functions (see annex 3) or Speech therapy (if applicable; see corresponding protocol of speech therapy).

In order to assess functional independence the **Functional Independence Measure (FIM)** is used. It is an 18-item of physical, psychological and social function (Linacre et al, 1994) The tool is used to assess a patient's level of disability as well as change in patient status in response to rehabilitation or medical intervention. The main tasks that are evaluated using the FIM include bowel and bladder control, transfers, locomotion, communication, social cognition as well as the following six self-care activities: feeding, grooming, bathing, upper body dressing, lower body dressing and toileting. The FIM measures what an individual can perform and not what that person could do under certain circumstances. Description of items is presented in Table 11.

Description	Domain
Eating	Motor Subscale
Grooming	
Bathing	
Dressing Upper Body	
Dressing Lower Body	
Toileting	
Bladder Management	
Bowel Management	
Transfer bed/chair/wheelchair	
Transfer toilet	
Transfer bath/shower	
Locomotion	
Stairs	
Motor Subtotal Score (max. score 91)	
Comprehension	Cognition Subscale
Expression	
Social interaction	
Problem solving	
Memory	
Cognition Subtotal Score (max. score 35)	

Table 11. Main items addressed in FIM scale.

The Barthel Index (BI) measures the extent to which somebody can function independently and has mobility in their activities of daily living (ADL) i.e. feeding, bathing, grooming, dressing, bowel control, bladder control, toileting, chair transfer, ambulation and stair climbing. The index also indicates the need for assistance in care (Collin et al 1988). The BI is a widely used measure of functional disability. The index was developed for use in rehabilitation patients with stroke and other neuromuscular or musculoskeletal disorders. Description of the main items are presented in Table 12.

Description
Feeding (if food needs to be cut up = help)
Moving from wheelchair to bed and return (includes sitting up in bed)
Personal toilet (wash face, comb hair, shave, clean teeth)
Getting on and off toilet (handling clothes, wipe, flush)
Bathing self
Walking on level surface (or if unable to walk, propel wheelchair)

Ascend and descend stairs
Dressing (includes tying shoes, fastening fasteners)
Controlling bowels
Controlling bladder

Table 12.Main items addressed in Barthel index .

A patient scoring 100 BI is continent, feeds himself, dresses himself, gets up out of bed and chairs, bathes himself, walks at least a block, and can ascend and descend stairs. This does not mean that he is able to live alone: he may not be able to cook, keep house, and meet the public, but he is able to get along without attendant care.

The Community Integration Questionnaire (CIQ). In response to the limitations of traditional outcome measures, Willer and colleagues developed the Community Integration Questionnaire (CIQ). The CIQ was developed to assess handicap, as defined by the World Health Organization (WH0).7 WHO defines handicap as a limitation, resulting from impairment or disability, that leads to an inability to perform normal age-, sex-, and culture-appropriate roles. The CIQ was designed to assess handicap in three domains: within the home, in social interactions, and in productive activities, including work, school, and volunteer activities (details in Table 13).

Description	DOMAIN
Do your personal hygiene, dress, eat alone, go to the toilet ...?	HOME
Do you prepare your lunch?	
Help with household tasks? Lay the table, tidy up, clean..	
Who is in charge of your finances? Pay the bills, do the shopping	
Who plans the social activities? Go out with friends, go to the movies..	
Leisure activities (going out for dinner, movies, sports…)	SOCIAL INTEGRATION
Visit friends or family	
When you participate in leisure activities do you usually do this alone or with others?	
Do you have a friend you can trust?	
How often do you go out from home?	
Employment situation during the last month (or academic situation in case of students)	PRODUCTIVE ACTIVITIES
Situation regarding educational activities carried out during the last month (courses, computer science, languages, complementary training ...)	
During the last month, how often did you participate in voluntary activities?	

Table 13.Main items addressed in CIQ questionnaire

The **Patient Competency Rating Scale (PCRS)** was developed in the 1980s by George Prigatano, Ph.D. and colleagues at Presbyterian Hospital's Neuropsychological Rehabilitation Program (Prigatano et al, 1986). The primary purpose of the PCRS is to evaluate self-awareness (the ability to appraise one's current strengths and weaknesses) following traumatic brain injury. The PCRS is a 30-item self-report instrument which asks the subject to use a 5-point Likert scale to rate his or her degree of difficulty in a variety of tasks and functions. The subject's responses are compared to those of a significant other (a relative or therapist) who rates the subject on the identical items. Impaired self-awareness may be inferred from discrepancies between the two ratings, such that the subject overestimates his/ her abilities compared to the other informant. Awareness of deficit may also be examined separately for the various domains sampled by PCRS items. These include activities of daily living, behavioral and emotional function, cognitive abilities, and physical function. Details are presented in Table 14.

Description
How much of a problem do I have in preparing my own meals?
How much of a problem do I have in dressing myself?
How much of a problem do I have in taking care of my personal hygiene?
How much of a problem do I have in washing the dishes?
How much of a problem do I have in doing the laundry?
How much of a problem do I have in taking care of my finances?
How much of a problem do I have in keeping appointments on time?
How much of a problem do I have in starting conversation in a group?
How much of a problem do I have in staying involved in work activities even when bored or tired?
How much of a problem do I have in remembering what I had for dinner last night?
How much of a problem do I have in remembering names of people I see often?
How much of a problem do I have in remembering my daily schedule?
How much of a problem do I have in remembering important things I must do?
How much of a problem would I have driving a car if I had to?
How much of a problem do I have in getting help when I'm confused?
How much of a problem do I have in adjusting to unexpected changes?
How much of a problem do I have in handling arguments with people I know well?
How much of a problem do I have in accepting criticism from other people?
How much of a problem do I have in controlling crying?
How much of a problem do I have in acting appropriately when I'm around friends?
How much of a problem do I have in showing affection to people?
How much of a problem do I have in participating in group activities?

How much of a problem do I have in recognizing when something I say or do has upset someone else?
How much of a problem do I have in scheduling daily activities?
How much of a problem do I have in understanding new instructions?
How much of a problem do I have in consistently meeting my daily responsibilities?
How much of a problem do I have in controlling my temper when something upsets me?
How much of a problem do I have in keeping from being depressed?
How much of a problem do I have in keeping my emotions from affecting my ability to go about the dayÕs activities?
How much of a problem do I have in controlling my laughter?

Table 14.Main items addressed in PCRS scale

The modified Rankin Scale (mRS) is a commonly used scale for measuring the degree of disability or dependence in the daily activities of people who have suffered a stroke or other causes of neurological disability. It has become the most widely used clinical outcome measure for stroke clinical trials.
The scale was originally introduced in 1957 by Dr. John Rankin of Stobhill Hospital, Glasgow, Scotland (Rankin, 1957) and then modified to its currently accepted form by Prof. C. Warlow's group at Western General Hospital in Edinburgh for use in the UK-TIA study in the late 1980s.(Farrell et alt, 1991) The modified version differs from Rankin's original scale mainly in the addition of grade 0, indicating a lack of symptoms. The first publication of the current modified Rankin Scale was in 1988 by van Swieten, et al., who also published the first interobserver agreement analysis of the modified Rankin Scale.(van Swieten et al, 1988), different scores are described in Table 15.

Score	Description
0	No symptoms at all
1	No significant disability despite symptoms; able to carry out all usual duties and activities
2	Slight disability; unable to carry out all previous activities, but able to look after own affairs without assistance
3	Moderate disability; requiring some help, but able to walk without assistance
4	Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance
5	Severe disability; bedridden, incontinent and requiring constant nursing care and attention
6	Dead

Table 15.Main items addressed in mRS scale

The Functional Ambulation Categories (FAC) is a functional walking test that evaluates ambulation ability. This 6-point scale assesses ambulation status by determining how much human support the patient requires when walking, regardless of whether or not they use a personal assistive device (Teasell, Foley & Salter, 2011). The FAC can be used with, but is not limited to, patients with stroke (details are presented in Table 16).

Score	Short name	Description
0	Non-functional ambulation	Subject cannot ambulate, ambulates in parallel bars only, or requires supervision or physical assistance from more than one person to ambulate safely outside of parallel bars
1	Ambulator-Dependent for Physical Assistance Level II	Subject requires manual contacts of no more than one person during ambulation on level surfaces to prevent falling. Manual contacts are continuous and necessary to support body weight as well as maintain balance and/or assist coordination
2	Ambulator-Dependent for Physical Assistance Level I	Subject requires manual contact of no more than one person during ambulation on level surfaces to prevent falling. Manual contact consists of continuous or intermittent light touch to assist balance or coordination
3	Ambulator- Dependent for Supervision	Subject can physically ambulate on level surfaces without manual contact of another person but for safety requires standby guarding on no more than one person because of poor judgment, questionable cardiac status, or the need for verbal cuing to complete the task.
4	Ambulator-Independent Level Surfaces only	Subject can ambulate independently on level surfaces but requires supervision or physical assistance to negotiate any of the following: stairs, inclines, or non-level surfaces.
5	Ambulator-Independent	Subject can ambulate independently on nonlevel and level surfaces, stairs, and inclines.

Table 16.Main items addressed in FAC scale

Social Interview at Institut Guttmann (ESIG). Collects different social aspects that are significant at the time of considering quality of life and lifestyle of the people affected by disability. It is a survey of 9 items and the obtained results raise the social needs that the patient may face after discharge and during the reintegration phase. Main items are presented in Table 17 to Table 21.

Item	Values
Educational level	Illiterate Primary School

	Secondary University
Permanent residence	Regular address Disabled residence Geriatric residence Other centers of an institutional nature Pension, hotel, hostel, rented room No housing
Accessibility	Accessible inside and outside Accessible only inside Only accessible outside Inaccessible
Cohabitation	Live alone Live with your partner Live with your parents Live with other close relatives Live with colleagues Live with an assistant Live in an institution

Table 17.ESIG Items addressing residence, accessibility, educational level and cohabitation

Item	Values
Productive activities	Active Active + pensioner Unemployment Pensioner Housewife Student
Productive activities - Work	Yes, for someone else's account (private sector) Yes, for someone else's account (public sector) Yes, on your own (self-employed) Yes, special work center No, I'm over 65 years old No, I can not because of health problems No, I have a Social Security pension and I'm not thinking about it

	No, I have a Social Security pension I think is incompatible No, I'm not currently considering it No, I am a student No, I am a housewife No, I'm looking for a job
Pension from Social Security	Total permanent disability pension Absolute permanent disability pension Permanent disability great invalidity pension Retirement pension Non-contributory disability pension Others (orphanhood, widowhood, son ...) I have no pension

Table 18.ESIG Items addressing economic retributions

Item	Values
Do you use adapted transportation?	Yes Driver Passenger No
Do you use NON adapted transportation?	Yes Driver Passenger No
Do you use public transportation?	Yes Bus Subway Taxi No

Table 19.ESIG Items addressing mobility

Item	Values
Do you need support for autonomy?	You do not need help in ADLs Partner Peers Other relatives

	Professional (contracted for hours) Personal assistant Partner + professional Parent + professional Other family + professional Professional institute
Support for autonomy (Dedication)	Daily. 24 hours Daily: from 12 to 23 hours Daily: 6 to 11 hours Daily: from 3 to 5 hours Daily: less than 3 hours Sporadic

Table 20.ESIG Items addressing support in ADLs

6.2 Main Outputs expected from predictive models

Functional independence in motor activities of daily living (extracted from FIM), level of independence are grouped in the following main categories: No Helper required (Complete Independence, Modified Independence) Supervision required, Minimal Assistance, Moderate Assistance, Maximal Assistance and Total Assistance required (use cases presented in Table 21).

# Use case	Description	End users involved
1	Eating	P, PS, SW, MD
2	Grooming	P, PS, SW, MD
3	Bathing	P, PS, SW, MD
4	Dressing Upper Body	P, PS, SW, MD
5	Dressing Lower Body	P, PS, SW, MD
6	Toileting	P, PS, SW, MD
7	Bladder Management	P, PS, SW, MD
8	Bowel Management	P, PS, SW, MD
9	Transfer bed/chair/wheelchair	P, PS, SW, MD
10	Transfer toilet	P, PS, SW, MD
11	Transfer bath/shower	P, PS, SW, MD
12	Locomotion	P, PS, SW, MD
13	Stairs	P, PS, SW, MD

Table 21. Functional independence in motor activities use cases (P = Physiotherapyst, SW=Social Worker, P = Psychologist)

Functional independence in cognitive activities of daily living, level of independence are grouped in the following main categories: No Helper required (Complete Independence, Modified Independence) Supervision required, Minimal Assistance, Moderate Assistance, Maximal Assistance and Total Assistance required. (use cases presented in Table 22)

# Use case	Description	End users involved
14	Comprehension	NPS, P
15	Expression	NPS, P
16	Social interaction	NPS, P
17	Problem solving	NPS, P
18	Memory	NPS, P

Table 22.Functional independence in cognitive activities use cases

Community integration in social interactions, and in productive activities, including work, school, and volunteer activities. They are grouped in the following main categories: The activity is performed alone, The activity is performed with someone else, The activity is performed by someone else, The activity was performed 5 or more times in the past month, The activity was performed 1 - 4 times in the past month, The activity was not performed in the past month (use cases detailed in Table 23).

# Use case	Description	End users involved
19	Leisure activities (going out for dinner, movies, sports…)	P, PS, SW, MD
20	Visit friends or family	P, PS, SW, MD
21	When you participate in leisure activities do you usually do this alone or with others?	P, PS, SW, MD
22	Do you have a friend you can trust?	P, PS, SW, MD
23	How often do you go out from home?	P, PS, SW, MD
24	Employment situation during the last month (or academic situation in case of students)	P, PS, SW, MD
25	Situation regarding educational activities carried out during the last month (courses, computer science, languages, complementary training ...)	P, PS, SW, MD
26	During the last month, how often did you participate in voluntary activities?	P, PS, SW, MD

Table 23.Community integration in social interactions use cases

Types of economic retributions perceived, depending on Educational level (Primary School, Secondary, University) and on modified Rankin Scale (use cases presented in Table 24).

# Use case	mRS	Educational Level	Return to Work	End users involved
1	0	Primary	Active	P, PS, SW, MD
2			Unemployed	P, PS, SW, MD
3		Secondary	Active	P, PS, SW, MD
4			Unemployed	P, PS, SW, MD
5		University	Active	P, PS, SW, MD
6			Unemployed	P, PS, SW, MD
7	1	Primary	Active	P, PS, SW, MD
8			Unemployed	P, PS, SW, MD
9		Secondary	Active	P, PS, SW, MD
10			Unemployed	P, PS, SW, MD
11		University	Active	P, PS, SW, MD
12			Unemployed	P, PS, SW, MD
13	2	Primary	Active	P, PS, SW, MD
14			Unemployed	P, PS, SW, MD
15		Secondary	Active	P, PS, SW, MD
16			Unemployed	P, PS, SW, MD
17		University	Active	P, PS, SW, MD
18			Unemployed	P, PS, SW, MD
19	3	Primary	Active	P, PS, SW, MD
20			Unemployed	P, PS, SW, MD
21		Secondary	Active	P, PS, SW, MD
22			Unemployed	P, PS, SW, MD
23		University	Active	P, PS, SW, MD
24			Unemployed	P, PS, SW, MD
25	4	Primary	Active	P, PS, SW, MD
26			Unemployed	P, PS, SW, MD
27		Secondary	Active	P, PS, SW, MD
28			Unemployed	P, PS, SW, MD
29		University	Active	P, PS, SW, MD
30			Unemployed	P, PS, SW, MD

Table 24. Return to work depending on educational level and mRS use cases

7 Conclusions

In this report we identify the most relevant scenarios and use cases for each of the patient journey phases, concentrating on the most common and complex questions. Swim lane processing mapping techniques are applied, in which processes and involved participants are grouped visually by placing them in lanes, with one lane for each person, group or relevant sub-process.

Scenarios and use cases will be validated and adjusted on a yearly basis in cooperation with relevant users along the patient journey, thus such iterative process will be represented in the different versions of this document throughout the project. To this aim, we briefly refreshed each of the patient journey phases and the concept of quality of life. Then we identified the most relevant use cases separately for each of the journey phases focusing on most relevant scenarios and involved actors.

8 References

Amarenco P., Philippa, Lavallée C , Labreuche J. One-Year Risk of Stroke after Transient Ischemic Attack or Minor Stroke, New England Journal of Medicine 2016.

Artiola i Fortuny, L., Hermosillo Romo, D., Heaton, R.K., y Pardee III,R.E. (1999). Manual de normas y procedimientos para la batería neuropsicológica en español. Tucson, AZ: m Press

Conners C.K. Conners' Continuous Performance Test. Toronto: Multi- Health System; 2002.

Carey J. R, Durfee W. K., Bhatt E., Nagpal A.,Weinstein S. A., Anderson K. M., Lewis S. M.Comparison of finger tracking versus simple movement training via telerehabilitation to alter hand function and cortical reorganization after stroke". Neurorehabil Neural Repair. 2007;21(3):216–32.

Cicerone K. D., Langenbahn D. M., Braden C., Malec J. F.,Kalmar K., "Evidence-based cognitive rehabilitation: updated review of the literature from 2003 through 2008". Arch Phys Med Rehabil 92:5 2011,19-30.

Collin C, Wade DT, Davies S, Horne V. "The Barthel ADL Index: a reliability study." Int Disability Study.1988;10:61-63.

DiPiro, J. T., & Spruill, W. J. (2010). Concepts in clinical pharmacokinetics (5th ed.) American Society of Health-System Pharmacists (January 1) ISBN-13: 978-1585282418.

Drocton G.T., Luttrull M.D., Ajam A. A., Nguyen X.V. Emerging Trends in Emergent Stroke Neuroimaging, Curr Radiol Rep (2018) 6:22, https://doi.org/10.1007/s40134-018-0282-8

Farrell B, Godwin J, Richards S, Warlow C, et al. (1991). "The United Kingdom transient ischaemic attack (UK-TIA) aspirin trial: final results". J Neurol Neurosurg Psychiatry. 54 (12): 1044–1054. doi:10.1136/jnnp.54.12.1044. PMC 1014676. PMID 1783914.

Feigin V.L., Norrving, B. and Mensah G.A., Global Burden of Stroke Originally published 3 Feb 2017 Circulation Research. 2017;120:439–448.

García-Rudolph A, Gibert K, A data mining approach to identify cognitive NeuroRehabilitation Range in Traumatic Brain Injury patients. Expert Syst. Appl. 41(11): 5238-5251 (2014).

Green, C., & Bavelier, D. (2005). In Messaris & Humphreys (Eds.), Digital media: Transformations in human communication.

Heaton, R.K., Chelune, G.J., Talley, J.L., Kay, G.G., y Curtiss, G. (1997). WCST: Test de clasificación de tarjetas Wisconsin. Madrid: Ediciones TEA

Heuschmann P.U., Kolominsky-Rabas P.L., Misselwitz B.,Hermanek P., Leffmann C., Janzen R. W. C., Rother J., Buecker-Nott H., Klaus Berger K., Predictors of In-Hospital Mortality and Attributable Risks of Death After Ischemic Stroke ARCH INTERN MED/VOL 164, SEP 13, 2004

Kaplan, E. F., Goodglass, H., & Weintraub, S. The Boston naming test. Philadelphia: Lippincott Williams & Wilkins, 1983-2001

Katzman R, Brown T, Fuld P, Peck A, Schechter R, Schimmel H. "Validation of a short Orientation-Memory Concentration Test of cognitive impairment." Am J Psychiatry. 1983;140;734-739.

Kernan W.N., Ovbiagele B., Black H. R., Bravata D. M., Chimowitz M.I., Ezekowitz M.D., Fang M. C., Fisher M., Furie K. L., Heck D. V., Johnston S.C., Kasner S.E., Kittner S.J., Mitchell P.H., Rich M.W., Richardson D., Schwamm L.H. and Wilson J.A. A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association and on behalf of the American Heart Association Stroke Council, Council on Cardiovascular and Stroke Nursing, Council on Clinical Cardiology, and Council on Peripheral Vascular Disease. Stroke. 2014;45:2160–2236.

Laska AC, Hellblom A, Murray V, Kahan T, Von Arbin M. Aphasia in acute stroke and relation to outcome. J Intern Med. 2001;249(5):413–22. doi:10.1046/j.1365-2796.2001.00812.x

Lees K.R., Bluhmki E., von Kummer R. et al. Time to treatment with intravenous alteplase and outcome in stroke: an updated pooled analysis of ECASS, ATLANTIS, NINDS, and EPITHET trials. Lancet. 2010; 375: 1695-1703

Linacre JM, Heinemann JW, Wright BD, Granger CV, Hamilton BB. The structure and stability of the functional independence measure. Arch Phys Med Rehabil. 1994. 75: 127-132.

Prigatano GP, Altman IM, O'Brien, KP. Behavioral limitations that brain injured patients tend to underestimate. Clinical Neuropsychologist 1986; 4(2): 163-176.

Rankin J "Cerebral vascular accidents in patients over the age of 60. II. Prognosis". Scott Med J. 2 (5): 200–15. (1957). PMID 13432835.

Reitan, R.M., Wolfson, D. (1993). The Halstead-Reitan Neuropsychological Test Battery: Theory and Clinical Interpretation. Tuscon, AZ:Neuropsychology Press

Rey, A. (1964).L'examen clinique en psychologie. Paris: Presses Universitaires de France

Sohlberg, M. M. (2001). In A. Mateer (Ed.), Cognitive rehabilitation. An interactive neuropsychological approach. Catherine. ISBN: 9781572306134.

Sun, JH, Lan T., L. and Yu JT. Post-stroke cognitive impairment: epidemiology, mechanisms and management, Ann Transl Med. 2015 Aug; 2(8): 80.

Schipper H. (1999), Quality of life. Principles of the clinical paradigm, ‘‘Journal of Psychology and Oncology’’, 23, 8, 171–185.

Sheridan C. L., Radmacher S. A. (1998), Psychologiazdrowia, Institute of Health Psychology of the Polish Psychological Society, Warsaw.

van Swieten J, Koudstaal P, Visser M, Schouten H, et al. (1988). "Interobserver agreement for the assessment of handicap in stroke patients". Stroke. 19 (5): 604–607. doi:10.1161/01.str.19.5.604. PMID 3363593.

Wechsler, D. (1999). WAIS-III. Escala de inteligencia de Wechsler para adultos-III.Madrid, TEA (Original edition, 1997).

WHOQOL Group. Development of the World Health Organization WHOQOL-BREF quality of life assessment. Psychol Med. 1998;28:551–558

Wahlgren N, Ahmed N, Dávalos A et al. Thrombolysis with alteplase 3 to 4.5 h after acute ischaemic stroke in the Safe Implementation of Treatments in Stroke Register (SITS-ISTR): an observational study. Lancet. 2008; 372: 1303-1309.

Wright, J. (2000). The Functional Assessment Measure. The Center for Outcome Measurement in Brain Injury.