Project N°: IST-2002-507424
Acronym: ALLADIN

PROJECT PRESENTATION

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	Univerza v Ljubljani, Fakulteta za Elektrotehniko (SL)
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RESUME

Deliverable 9.1 provides an easy to read/easy to understand overview of what the ALLADIN project is about and why the project is important. It is intended to inform any interested party which has basic understanding of the IST of the 6th Framework Programme but is not necessarily an expert.

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1 Project Summary

1.1 Abstract

The changes occurring today in patient care and chart review demand dynamic, innovative changes in medical record keeping.

The concept of 'Problem-oriented Medical Record', which started several years ago, was the first revolutionary onset of a more organised medical record keeping.

Complex problems encountered in neuro-rehabilitation however ask for a second revolution. Therefore ALLADIN will be developed.

ALLADIN offers a new and the first reliable standard for calculating and predicting the functional recovery of stroke patients, which is a crucial factor in client centred evidence based practice, discharge planning and utilization of rehabilitation resources.

ALLADIN creates labels for conformity in the communication and understanding of neuro-rehabilitation data. This is a prerequisite for taking prompt and right decisions in stroke rehabilitation

ALLADIN makes clinical assessments and quantitative measurements exchangeable and fulfils in this way the wishes of therapists for user friendly, fast but reliable evaluation methods.

ALLADIN outputs a numerical code attached to an operational definition of a milestone or marker for functional recovery analogous with ICD-9-10 codes. It has at the same time a trend-setting function for the further elaboration of the International Classification of Functioning and disabilities (ICF) with the objective to facilitate multidisciplinary responsibility and coordination of interventions.

1.2 List of keywords

- Care of the disabled
- Medical informatics
- Biomedical engineering
- Natural language understanding
- Neuro-rehabilitation
- Stroke
- Physiotherapy
- Data mining
- Taxonomy based patient assessment

- Force mapping of movement planning

- Risk management

- Hospital Information System

1.3 Acknowledgements

ALLADIN is a research project that is funded publicly and jointly funded by its participants and the 6th Framework Programme of the European Commission.

2 Project Details

2.1 Main Objectives

The ALLADIN project focuses on the development of a **user-friendly natural language based decision support software** for neuro-rehabilitation, in particular in stroke. ALLADIN, if implemented provides an adequate and fast solution for a client centred practice, for discharge planning and for utilization of rehabilitation resources. This fulfils the social and political expectation of a substantial but honest cost cutting by measuring therapeutic efficiency in terms of mean quality-adjusted duration.

To respond the challenge (Figure 1) ALLADIN can develop a solution along the following objectives:
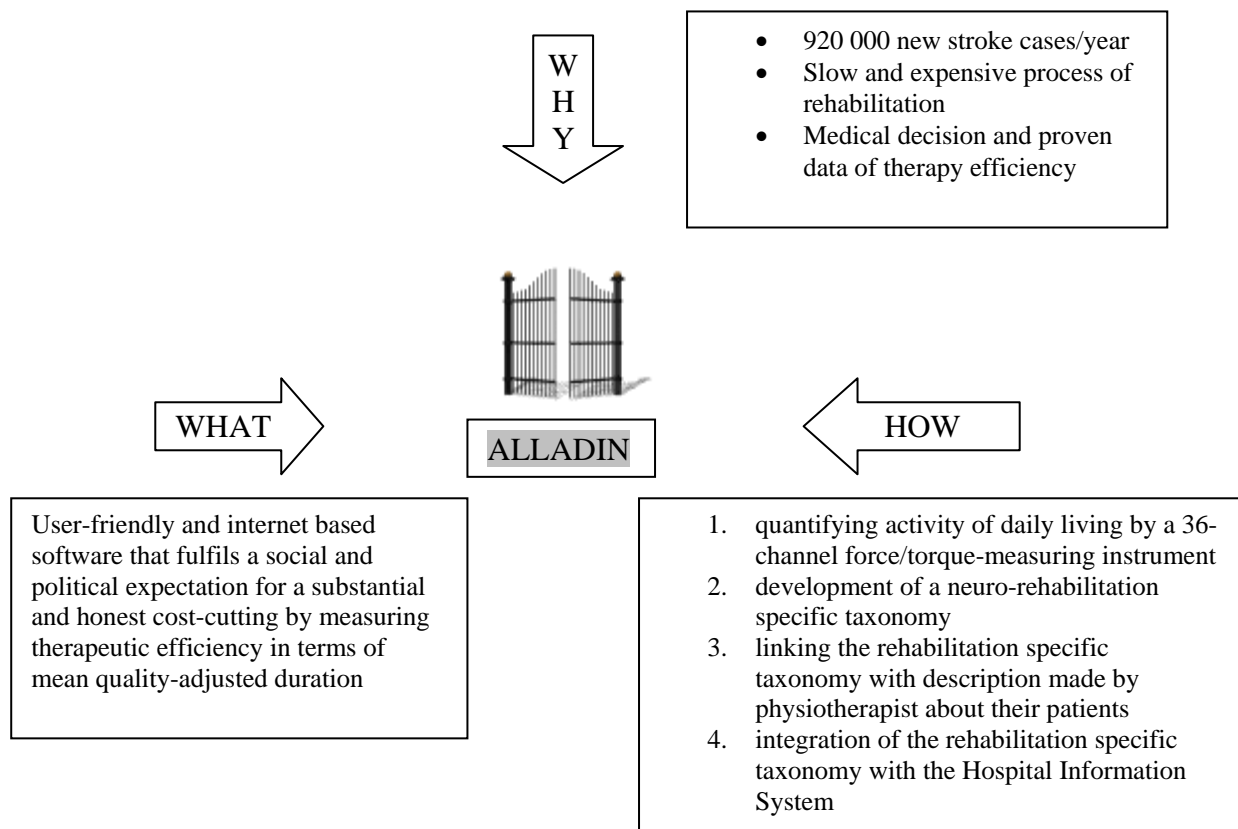

WHY

- 920 000 new stroke cases/year
- Slow and expensive process of rehabilitation
- Medical decision and proven data of therapy efficiency

WHAT

User-friendly and internet based software that fulfils a social and political expectation for a substantial and honest cost-cutting by measuring therapeutic efficiency in terms of mean quality-adjusted duration

ALLADIN

HOW

1. quantifying activity of daily living by a 36-channel force/torque-measuring instrument
2. development of a neuro-rehabilitation specific taxonomy
3. linking the rehabilitation specific taxonomy with description made by physiotherapist about their patients
4. integration of the rehabilitation specific taxonomy with the Hospital Information System

Figure 1 The emergence of ALLADIN

- **To develop a low cost, easy to use, 36-channel force/torque-measuring instrument that samples data about the performance of activity of daily living in stroke patients.**

   Leading to: a **quantitative database** based on the functional performance **of 300 stroke patients** measured at least 30 times during a period of 6 months.

- **To find evidence-based and noteworthy indicators during stroke recovery by using statistical methods and data mining techniques on the sampled data.**

  Leading to: The discovery of at least **10 milestones** in recovery and at least **30 predictive markers** for functional improvement in stroke. This will be the base for the construction of a rehabilitation specific taxonomy or classification system.

- **To link the rehabilitation specific taxonomy with natural language descriptions. This means the development of an ontology-based classification/coding system for the context of stroke rehabilitation**

  Leading to: **a)** An ontology for stroke rehabilitation including at least **250 concepts and 2500 terms**.

     b) An easy to use nomenclature for the rehabilitation professionals. The therapist will be able to use his or her own terminology and the input can be limited to a very accurate description of the patients' actual status. This is important because language is the principal means by which we share knowledge. The Natural Language Understanding (NLU) based software ensures an automatic conversion of the description to the nomenclature. This **unified nomenclature** will optimise and facilitate strikingly the communication between rehabilitation professionals.

- **To integrate the Natural Language Understanding middleware with a Hospital Information System.**

  Leading to: In the final stage of the project the only thing the clinician remains to do is using a speech interface, telling the computer in a descriptive way about the status of the patient. ALLADIN will inform the clinician immediately on the stage of recovery and will support him for further decisions at the rehabilitation level. If a colleague takes over he will understand immediately what to do because ALLADIN provides the physician and therapist with an **easily interpretable and a universal standard report on functional diagnosis and outcome prediction.**

- **To validate the software for health care management in neuro-rehabilitation.**

  1. Leading to: A **measurement of therapeutic efficiency in terms of 'mean quality-adjusted duration'**. With other words the code that was generated from the description done by a physiotherapist and which is linked to a marker of recovery, will inform the medical advisor or the head of a department in an unambiguous way about the patients' condition. This has very practical implications at the level of input of resources.
  2. Leading to: A standard for European health care policy makers.
  3. Leading to: Economical assessment of the use of ALLADIN.
  4. Leading to: Expansion of the natural languages to be used in ALLADIN.

2.2 Key Milestones

The project milestones of ALLADIN are associated with the three phases of the project workplan (Figure 2).

Kick-off milestone: Three Diagnostic Systems for Force-Torque Measurement Based Therapy Assessment

Midterm milestone: Milestones (at least 10) and predictive markers (at least 30) for functional outcome in stroke recovery derived from a quantitative (biomedical measurements

and clinical scales) and qualitative (natural language clinical descriptions) database of 300 European stroke patients

Final milestone: Simple to use, bed side available, speech interface equipped, natural language based stroke patient assessment software tested and assessed in real life situation
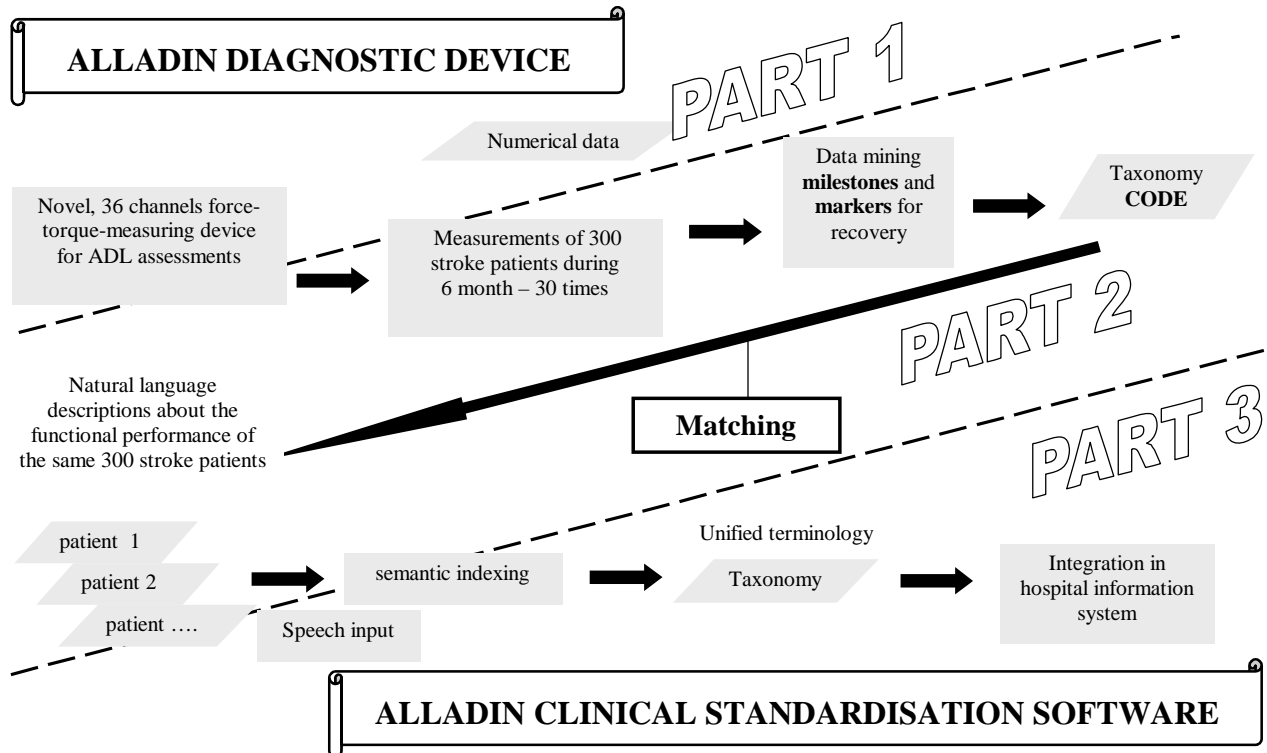
ALLADIN DIAGNOSTIC DEVICE

PART 1

Numerical data

Novel, 36 channels force-torque-measuring device for ADL assessments

Measurements of 300 stroke patients during 6 month – 30 times

Data mining **milestones** and **markers** for recovery

Taxonomy **CODE**

PART 2

Natural language descriptions about the functional performance of the same 300 stroke patients

Matching

PART 3

patient 1

patient 2

patient ….

semantic indexing

Speech input

Unified terminology

Taxonomy

Integration in hospital information system

ALLADIN CLINICAL STANDARDISATION SOFTWARE

Figure 2 The development of ALLADIN

2.3 Major Innovations

Current clinical techniques for patient assessment routinely rely on **subjective and labour intensive** techniques involving gross rating scales or the application of motor behavioural tasks using motor proficiency test batteries. Applying current assessment techniques to complex problems encountered during neuro-rehabilitation is impossible. The used scales **lack reliability and are unable** to provide the healthcare professional with a good prediction of possible impairments and disabilities nor the healthcare provider with an **estimate of the cost and outcome of the treatment**. Complex measurements such as motion analysis or brain image technologies (CT, MRI, fMRI, SPECT) are reliable but very expensive and also time consuming. Using them on a regular base for the evaluation of patients and **steering neuro-rehabilitation** is impossible

Review of randomised trials shows once more the urgent need to structuring rehabilitation care for stroke patients. **The only key to structured rehabilitation care is a reliable prediction system** that can rapidly discover markers for recovery to assist in the difficult decision to choose between continuing therapy, changing or stopping it. The innovation of the ALLADIN project cannot be marked in a particular technology. The development of ALLADIN is **the integrated solution** of a combined European effort governing areas of clinical neurology, restorative neurology, neuro-computing, sensor technology, language,

speech and communication technology, Artificial Intelligence technology, software development and deployment, telecommunication and health economy. The key standalone technologies are the followings:

- Multiple-channel isometric force/torque-measurements of stroke patients

- Data mining techniques to detect excellent rehabilitation markers

- Speech technology and natural language understanding to serve automated conversion between normalized quantitative measurements, and descriptions made by therapists

ALLADIN will bring revolution in steering neuro-rehabilitation when it will be integrated with the Hospital Information System. From that moment on the therapist can **freely describe to a computer the status of the patient at bedside**, knowing that this will automatically generate the ALLADIN code linked to the marker for recovery. This will reassure the clinician that a colleague or a health care provider will correctly understand the message and that the patient will receive the right medical approach.

Expected innovations from the ALLADIN project go beyond the current state-of-the-art in the assessment of impairments and disabilities in terms of:

- ALLADIN offers a new and first **reliable standard** for calculating and predicting the functional recovery of stroke patients, which is a crucial factor in client centred evidence-based practice, discharge planning and utilization of rehabilitation resources.

- ALLADIN creates **conformity** in the communication and understanding of neuro-rehabilitation data. This is a prerequisite for taking prompt and right decisions in stroke rehabilitation.

- ALLADIN makes clinical assessments and quantitative measurements **exchangeable** and fulfils in this way the wishes of therapists for user-friendly, fast and reliable evaluation methods.

ALLADIN outputs **a code** attached to an operational definition of a milestone or marker in functional recovery comparable with the **International Classifications of Diseases** (ICD) and has at the same time a trend-setting function for the further elaboration of the **International Classification of Functioning and Disabilities** (ICF) with the objective to improve further multidisciplinary responsibility and coordination of interventions

2.4 Expected Benefits

Prevention and treatment of stroke have become recognized health priorities in most European countries. Epidemiological studies have shown that incidence, prevalence and mortality **differ widely through Europe** (Figure 3), and that the increasing socio-economical burden resulting from stroke disability also shows marked differences between eastern and western European countries.
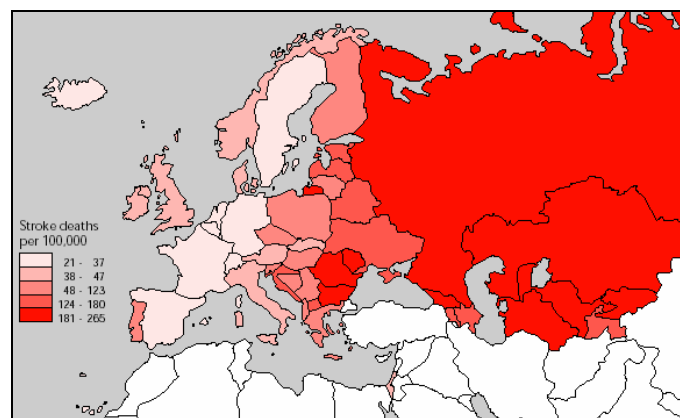
Figure 3 Stroke death rates in Europe and in Middle Asia

Stroke patients, healthcare professionals, and healthcare providers are the key players who would benefit from the project developments.

Stroke patient: The rehabilitation professional examines the patient and tells his/her findings to the computer in a descriptive way. The computer replies automatically with a message, which is **a marker or milestone for recovery** for that particular patient and this message helps to decide what to do next. For example a patient is progressing very slowly, but the ALLADIN code is indicating that the patient's way of recovery is going in the direction of compensatory movements. With other words the ALLADIN code informs the healthcare professional to put no longer effort in a neurodevelopment approach but to work on functional compensations to make a return to the home situation possible. To know this very early will improve the outcome for that particular patient and will speed up discharge.

Healthcare professional: Because neuro-rehabilitation is strongly branched in different therapeutic approaches it makes evidence based practice very difficult. Two solutions can be offered for this problem: **1**. Impose strict guidelines of evidence-based therapy or **2**. Accepting freedom of therapy choice controlled by the new easy to use ALLADIN evaluation instrument. In the actual situation where there is a scarcity of empirical evaluation of effectiveness in neuro-rehabilitation, it will not be that important which therapy is the best, but in which way we can demonstrate adequately that the actual therapy is not useful anymore and has to be altered or stopped.

Healthcare provider: Cost cuts arisen from using ALLADIN can be grouped as follows: Radically reduced time and human/equipment resources for patient assessment. **60% reduction is foreseen.** Early decision support on the suitable therapy, and in consequence a better cost and resource planning within the healthcare organisation. **20% reduction** in the relative rehabilitation cost per patient is foreseen. Increase of the patient turnover. With optimisation of the therapy delivery more patients can be seen, which will reduce waiting lists, in some countries **with at least 20%**. The ALLADIN approach **withstands** the imminent tendency of **pruning expenses for rehabilitation using only 'time spent in therapy'** as a decision-making criterion

Healthcare policy maker: To strengthen **the evidence base for a health strategy** such as neuro-rehabilitation, is important because National health services all over Europe have been underlining very strongly the importance of improving **effectiveness** in healthcare by decision making that affect the care of patients are taken with due weight according to all valid, relevant knowledge. ALLADIN outputs **a code** attached to an operational definition of a milestone or marker in functional recovery comparable with the **International Classifications of Diseases** (ICD) and has at the same time a trend-setting function for the

further elaboration of the **International Classification of Functioning and Disabilities** (ICF) with the objective to improve further multidisciplinary responsibility and coordination of interventions.

An important **ethical issue** in Europe is the wide variation in practice across countries. To estimate future European trends in neuro-rehabilitation and to compare their quality, a **unified system for** patient **assessment** and **decision support** in stroke must be developed. This system can **only be created when several countries, with different health policies are involved** in the development of the new instrument. For that reason 3 hospitals from different **European Member** states as well as a hospital from an **Associated State** are included in clinical data collection. These hospitals are the St.James Hospital in Dublin, Ireland, the Maria Middelares Hospital in Gent, Belgium, and the Szent János Hospital in Budapest, Hungary. **Best practices** reflect the optimum intensity of therapy, the optimum timing of an intervention and the identification of the benefit of a particular intervention for a patient in view of his personal and societal desires. With ALLADIN a versatile and situation oriented assessment technique is offered to every physiotherapist to achieve this goal and at the same time it subscribes strongly the latest research recommendation of "**unpacking the black box of rehabilitation**". Indeed this black box hampers the development of a European rehabilitation management plan. ALLADIN however enforces such a plan at each echelon and will create coherence in European physiotherapeutic best practices ().
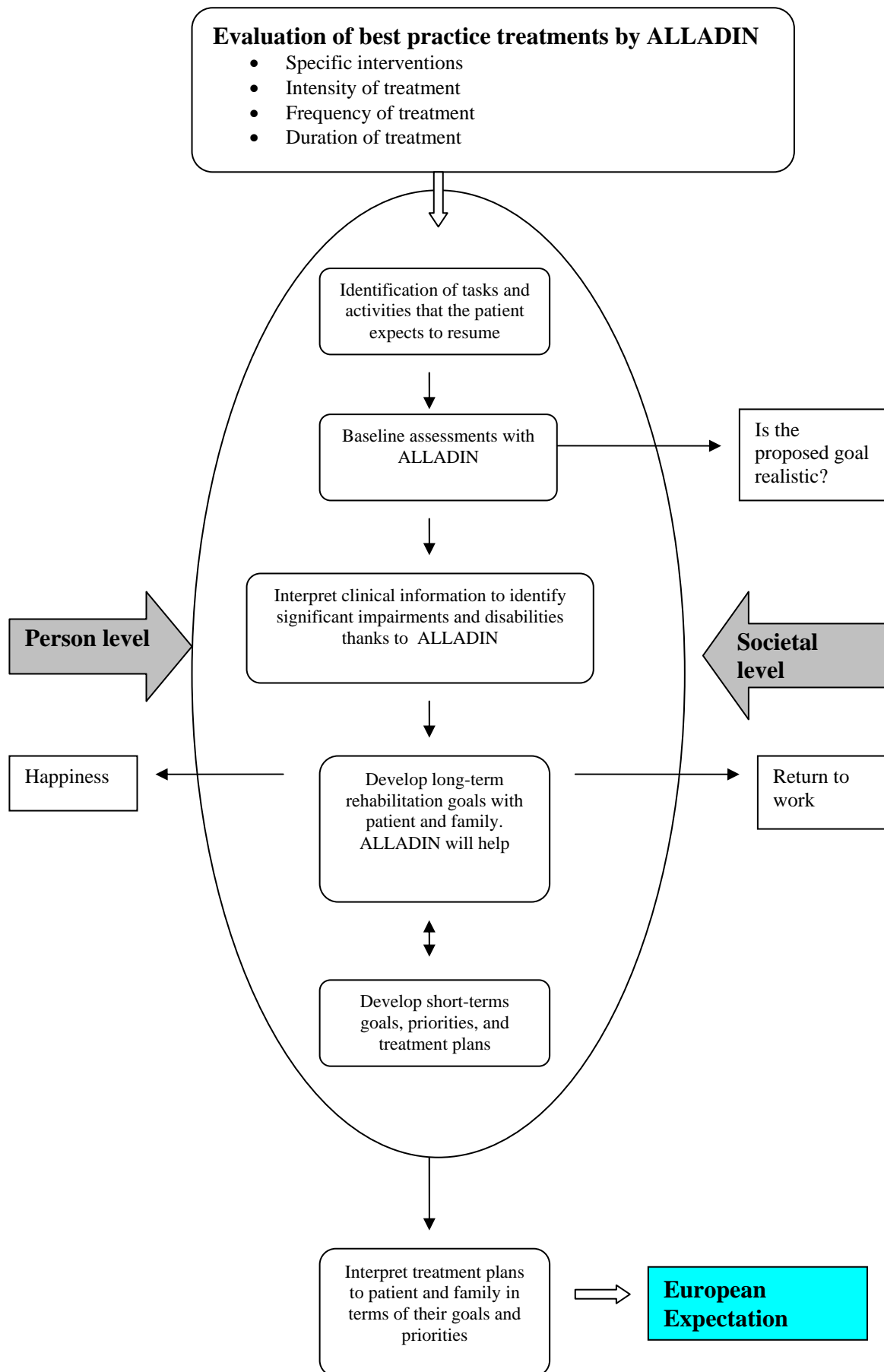
Evaluation of best practice treatments by ALLADIN
- Specific interventions
- Intensity of treatment
- Frequency of treatment
- Duration of treatment

Identification of tasks and
activities that the patient
expects to resume

Baseline assessments with
ALLADIN

Is the
proposed goal
realistic?

Interpret clinical information to identify
significant impairments and disabilities
thanks to ALLADIN

Person level

**Societal
level**

Happiness

Develop long-term
rehabilitation goals with
patient and family.
ALLADIN will help

Return to
work

Develop short-terms
goals, priorities, and
treatment plans

Interpret treatment plans
to patient and family in
terms of their goals and
priorities

**European
Expectation**

Figure 4 ALLADIN helps spreading of best rehabilitation practice in Europe

2.5 Target Markets

In addition to the scientific community, three major audiences are particularly important for the commercial exploitation: HIS vendors, healthcare organisations/professionals, and healthcare financing organizations. The majority of commercial HIS solutions are modular. A HIS vendor must be convinced of the added value if to include the ALLADIN Clinical Standardisation Software in the vendor's solution. This is only possible if there is a concrete demand for the **ALLADIN Clinical Standardisation Software** from healthcare organisations/professionals. Another product to be developed during the project that will be exploited after the project end is the **ALLADIN Diagnostic Device**. The initially foreseen potential customers to be targeted for each product during the exploitation is summarised in .

Table 1 List of foreseen potential customers of ALLADIn products

Customer	Clinical Standardisation Software	Diagnostic Device
Hospital	X	X
Clinics	X	
Rehabilitation Centres	X	
Research Institutes	X	X
Private Practices (Physiotherapists, Occupational Therapists)	X	
HIS Vendors	X	

ALLADIN's user friendliness addresses an important **new Healthcare Information Technology market**: **decision support at bedside**, which has at this moment a very low implementation (Figure 5). In terms of figures, the exploitation plan of ALLADIN approximates **30 installations of ALLADIN in 3 years subsequent to the project** in English speaking countries like in the UK and in Ireland.

Figure 5 Level of implementation of the functions of medical information systems in a sample of 68 large European hospitals from the UK, Germany, Spain, Italy, France, Denmark, Belgium, Luxembourg

The market for the ALLADIN **Clinical Standardisation Software** comprises Hospital Information System vendors. The project **exploitation actions** will result in transparent economic and clinical impacts of ALLADIN Clinical Standardisation Software that will attract venture capital investment from the side of large HIS vendors shown in Table 2. The ALLADIN software toolkit will be implemented only **in the English language**. Successful integration and proven cost/benefit ratio can pave the way to a commercial exploitation, i.e. to include other European languages in ALLADIN and integrate ALLADIN with other Hospital Information Systems.

Table 2 Large European HIS vendors and their products

Hospital Information System vendor	Product name
Siemens AG	Lifetime Clinical Record®
Philips Medical System	former HSG products
Cerner Corporation (GE Medical owns share)	HNA Millenium
System C Healthcare	MedWay
ComMedica	PIRILIS
Torex Health	PatientCentre EPR
ISOFT	i.Patient Manager
McKesson	Trak's
Capula Elan	Oasis

Further to the completion of the proposed project, Zenon, L&C, and Multitel, the three SMEs of the ALLADIN project form an Exploitation Team that will undertake the commercial exploitation of the content and the infrastructure produced throughout the project in their respective business areas: integration with HIS and sale of the ALLADIN Diagnostic Device for Zenon, the natural language based **ALLADIN Clinical Standardisation Software** for L&C, apart from the Automated Speech Recognition technology which belongs to Multitel.

3 Co-ordinator Contact Details

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4 Project Synopsis

IST 2002 507424.
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Budget in Euro
Total cost: 4.030.347
EC contribution: 3.300.000

Time table:
Start date: 01/January/2004
Duration :   36 months

Keywords:
care of the disabled, medical informatics, biomedical engineering, natural language understanding, neuro-rehabilitation, stroke, physiotherapy, data mining, taxonomy based patient assessment, force mapping of movement planning, risk management, hospital information system

Natural language based decision support in neurorehabilitation

Why ALLADIN?

Every year there are over 920,000 new stroke cases in Europe and a remarkable upward trend of demand for rehabilitation is on the way. This will lead to a steady growth in expenses for rehabilitation in Europe.

Three fourths of the physiotherapists find it difficult to exchange information on the recovery of neurological patients, because no clear standards are in use. They welcome a universal coding system that is independent of a therapeutic approach. Only a minority accepts the existing measuring scales as sufficient to describe and predict the evolution of a patient. Moreover the majority is convinced that they can describe their clinical findings in natural language (NL) descriptions.

This highlights that applying current assessment techniques to complex problems encountered during neuro-rehabilitation is inefficient and a new approach is needed.

What does ALLADIN offer?

ALLADIN offers a user-friendly natural language based decision support software for neuro-rehabilitation, in particular in stroke. This support is offered through an innovative human like communication with a computer. The rehabilitation professional examines the patient and tells his/her findings to the computer in a descriptive way. The computer replies automatically with a message, which is a marker or milestone for recovery for that particular patient. These markers and milestones result from the analysis of force mapping of functional movement planning and are correlated with the natural language expressions used by the physiotherapist. The message generated by the computer helps to decide what to do next. It opens perspectives for the determination of individual therapies and accurate monitoring of the individual rehabilitation progress with knowledge-based techniques. This is a brand new method for decision support and risk management in neuro-rehabilitation. Moreover it provides fast solutions for a client centred practice, discharge planning and utilization of rehabilitation resources by supporting health professionals in taking promptly the best possible decision for diagnosis and treatment. Consequently it assists in the individualisation of treatment. Another purpose is to strengthen the evidence base for neuro-rehabilitation. This is important because National health services all over Europe have been underlining very strongly the importance of improving effectiveness in healthcare by 'evidence-based healthcare' in which decisions that affect the care of patients are taken with due weight according to all valid, relevant knowledge.

An example

Catherine works as a physiotherapist in the St. Johns Hospital in Ireland. She treats Maria, group leader of a local seniors citizens' club in London, who came on vacation in Dublin. Maria got a stroke during her stay and was hospitalised. After 4 weeks she preferred to go home and continue rehabilitation in a specialized centre in London. Catherine used ALLADIN to assess Maria and spoke frequently about Maria's performance with her portable digital assistant, connected through a wireless LAN with the hospital information system. Each time ALLADIN produced automatically an updated marker or milestone for recovery. When Maria left the hospital those markers were safely sent on line to the rehabilitation centre in London. Before seeing Maria the neurologist in London already knew about the chances of Maria for a successful outcome and informed his staff on the needed requirements for further rehabilitation.

Project Participants

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Scuola superiore di studi universitari e di perfezionamento Sant'Anna (**I**)