Project N°507424

Natural Language Based Decision Support in Neuro-rehabilitation

ALLADIN

SPECIFIC TARGETED RESEARCH PROJECT

PRIORITY 2.3.2.11

Deliverable 6.1:

Clinical validation Deliverable:
User acceptance and satisfaction inquiry

List of Partners:
Arteveldehogeschool (B)
Language and Computing NV (B)
Budapest University of Technology and Economics (HU)
Univerza v Ljubljani, Fakulteta za Elektrotehniko (SL)
Zenon SA, Robotics and Informatics (EL)
University Campus Bio-Medico (I)
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1 Executive Summary & Introduction

1.1 Executive Summary

The objective of this deliverable is to present the results of the user acceptance and satisfaction survey of the Alladin Clinical Standardisation Software (ACSS).
This document reports the results of the pilot study done with 4 physiotherapists and the final validation study with 9 senior physiotherapists working in the area of neuro-rehabilitation.

1.2 Introduction

1.2.1 General

The ALLADIN project focuses on the development of a **user-friendly natural language based decision support software** for neuro-rehabilitation, specifically in stroke. The Technical Annex describes that to achieve this, a low cost 48 channel force/torque-measuring device (ADD) was developed to sample data about the performance of Activity of Daily Living (ADL) in stroke patients. 30 measurements over a period of 6 months post stroke were gathered from 130 patients. Using data mining technique and statistical methods the project proposes to discover at least 10 milestones in stroke discovery and 30 predictive markers for functional improvement post stroke. This will be used for the construction of a rehabilitation specific taxonomy or classification system.

It is proposed that this taxonomy will then be linked with the natural language description, which would result in an ontology-based classification system. This will enable the therapist to use his/her own terminology to describe and upload the patient status into the system and the ALLADIN software will inform the therapist/clinician immediately on the stage of recovery.

1.2.2 User interface: Evaluation & Satisfaction survey

Design of user friendly interface

The user interface is a front end programme which interacts with users and controls an underlying information system [1]. Its aim is to empower the user with capability to operate effectively without an experienced human intermediary. In an end user computing environment decision makers interact directly with the application software to enter information or prepare output reports. Decison support and database applications characterize this emerging end-user phenomenon. Effective functioning of an application depends on its

ease of use or usability. It has been established that the interface design has a significant effect on the system-user, regardless of their familiarity with the task [2]. It has also been established in the early days of computing that utilisation is directly connected to the user commmunities' sense of satisafction with those services [3]. The developers incorporated user-centred design principle in the development of the ACSS end user interface. The end user community was consulted regularly and trial versions were tested at the clinical site. This study proposes to test the final version of ALLADIN software the ACSS.

ACSS has three different roles from the user perspective, infomation input, processing and retrieval. The interface is designed to accomodate all these complex needs. The user evaluation study also sets out to assess the ACSS on all these functionalities.

1.2.3 Content and structure of the document

The document starts with a synopsis of the ALLADIN project. It lists the partner institutions and the clinical trial centres. The aims and objectives of the project are also very clearly stated.

Only a brief description of the ADD used for measuring Force/Torque is given in this deliverable as Deliverable 2.1 contains a detailed account of the system.

The design and functions of the ACSS are briefly described in the next section followed by the description of the process of software integration with HIS at the Trinity College Dublin (TCD) clinical centre, i.e. the Adelaide and Meath Hospital incorporating the National Children's Hospital (AMNCH)

The Validation study describes the pilot study carried out to refine the questionnaire and the main validation. It includes recruitment of participants and the procedure followed during the validation. Finally, the results of the study are reported in a descriptive form.

1.2.4 Use of the deliverable

The primary use of this deliverable is as a reference of proof of the functions of the end product and uses this evidence in the exploitation of the ALLADIN end product, the ACSS.

Secondly the document is a project deliverable as required by contract between the ALLADIN consortium and the European Commission. Thus it enables the verification of the products of the project by the Project Officer, for review purposes.

2 Project Synopsis

2.1 Project details

Title: Natural Language Based Decision Support in Neuro-rehabilitation

Acronym: ALLADIN

This project is funded by the 6th Framework Programme of the European Union.

Project N°: IST-2002-507424

2.2 Participating partners

Arteveldehogeschool, Belgium
Language and Computing NV, Belgium
Budapest University of Technology and Economics, Hungary
Univerza v Ljubljani, Fakulteta za Elektrotehniko, Slovenia
Zenon SA, Robotics and Informatics Greece
University Campus Bio-Medico, Italy
Multitel ASBL, Belgium
Trinity College Dublin
Országos Orvosi Rehabilitációs Intézet, Hungary
Scuola superiore di studi universitari e di perfezionamento Sant'Anna Italy

2.3 Centres participating in the Validation of Alladin software

The validation study was carried out at the Trinity College Dublin clinical site, AMNCH Tallaght, Dublin, Ireland.

2.4 Aims and objectives of the ALLADIN project

1. The development of a low cost, user friendly isometric force/torque measuring instrument that samples data about the performance of ADL of people with stroke. A six-month post stroke collection of clinical data and natural language expressions describing the functional status of people recovering from a first stroke was carried out.
2. The identification of evidence based and significant milestones and predictors during stroke recovery using statistical methods and data mining technique on the sampled force/torque measurements.

3. To link the above generated taxonomy with natural language descriptions and clinical data with the view to the development of an ontology-based classification/recording system for the context of stroke rehabilitation.

2.6 The ALLADIN Diagnostic Device (ADD)

The ALLADIN diagnostic device (ADD) measures isometric force torque (FT) trajectories during the imagination and initiation of the selected ADL tasks. Participants were asked to perform six different common ADL tasks. The isometric FT patterns produced by different body parts are simultaneously measured and recorded by 6-axis FT sensors during the imagination and initiation of each ADL task.

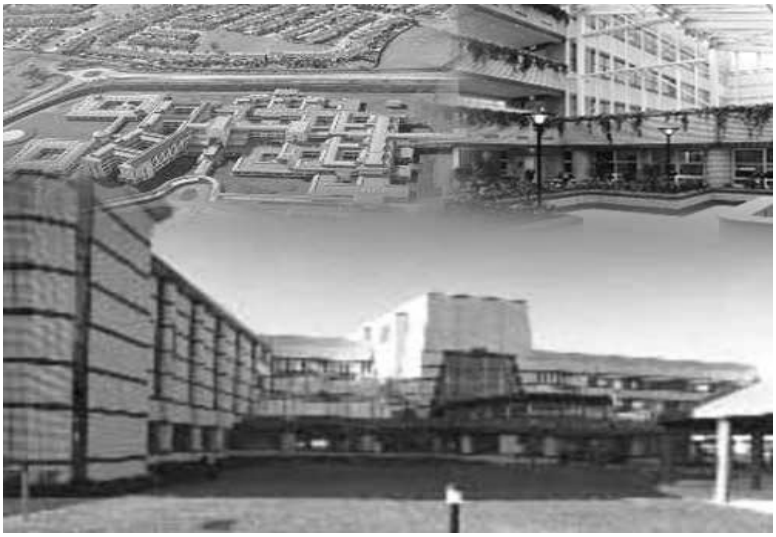
3 Ethical Issues

Before the clinical Validation of the software ethical approval was obtained from the joint ethics committee of the Adelaide and Meath Hospital and St. James's Hospital. The approval was sought and obtained in November 2006. (Annexe-1)

4 Location and Training

The Validation study was based at the *William Stokes Unit* in AMNCH (TCD).

Figure 4.1 Adelaide and Meath Hospital (AMNCH), Tallaght, Dublin



5 Software Installation and Integration with HIS

The final version of ACSS software was extensively tested at the TCD clinical site. First version was tested on a stand alone PC and report sent and discussed with the Zenon software development team. The second version with suggested changes was installed at the clinical site. The AMNCH IT team tested the software and approved for trial connection to the HIS. The first trial version was installed at the clinical site by end January 2007. Though ACSS-HIS link was established there were issues with retrieval and display. The final working version of the ACSS was ready in the last week of March 2007. Figure 5-1 is a diagram of the set up

Only a brief description of the set up and functionalities of the ACSS is given in the next section, since this aspect is dealt with described in detail in **Deliverable 5.3** "End-user (HIS) application with ASR and classification system integrated".

5.1 ACSS/HIS link configuration

After the successful installation of ACSS, the next step was to configure the link between ACSS and HIS (Oracle DB). The IT tea m at the AMNCH (TCD) and the Zenon software team had extensive discussions on the issue and finalised the extent of access to the HIS database, based on the requirements of ACSS and the hospital confidentiality and security policies. The AMNCH (TCD) team followed the guidelines as far as possible. Slight modifications were carried out to accommodate the requirements of the Local DB, and to establish link with HIS database. This was tested successfully in stages from version 1 to the final version ACSS v 1.3.0.1. The guidelines are reproduced below:

1. Download and install required software.
    a. Download and install the oracle client tools (http://www.oracle.com/technology/software/products/database/oracle10g/htdocs/10201winsoft.html)
    b. Download and install the oracle ODBC drivers (http://www.oracle.com/technology/software/tech/windows/odbc/index.html)
2. Setup ODBC connection.
    a. Go to *Control Panel*. Go to *Administrative Tools*. Go to *Data Sources (ODBC)*.
    b. In the *ODBC Data Source Administrator* dialog box, go to the *System DSN* tab. Press *Add*.
    c. In the *Create New Data Source* dialog box, pick the oracle ODBC driver from the list of drivers (it should look like: Oracle in OraHome92) and press *Finish*.

d. Choose the corresponding fields according to your configuration (Data Source Name, TNS Service Name, User ID).

e. Test the new connection by the test button it provides.

3. Finalise the configuration of the connection.

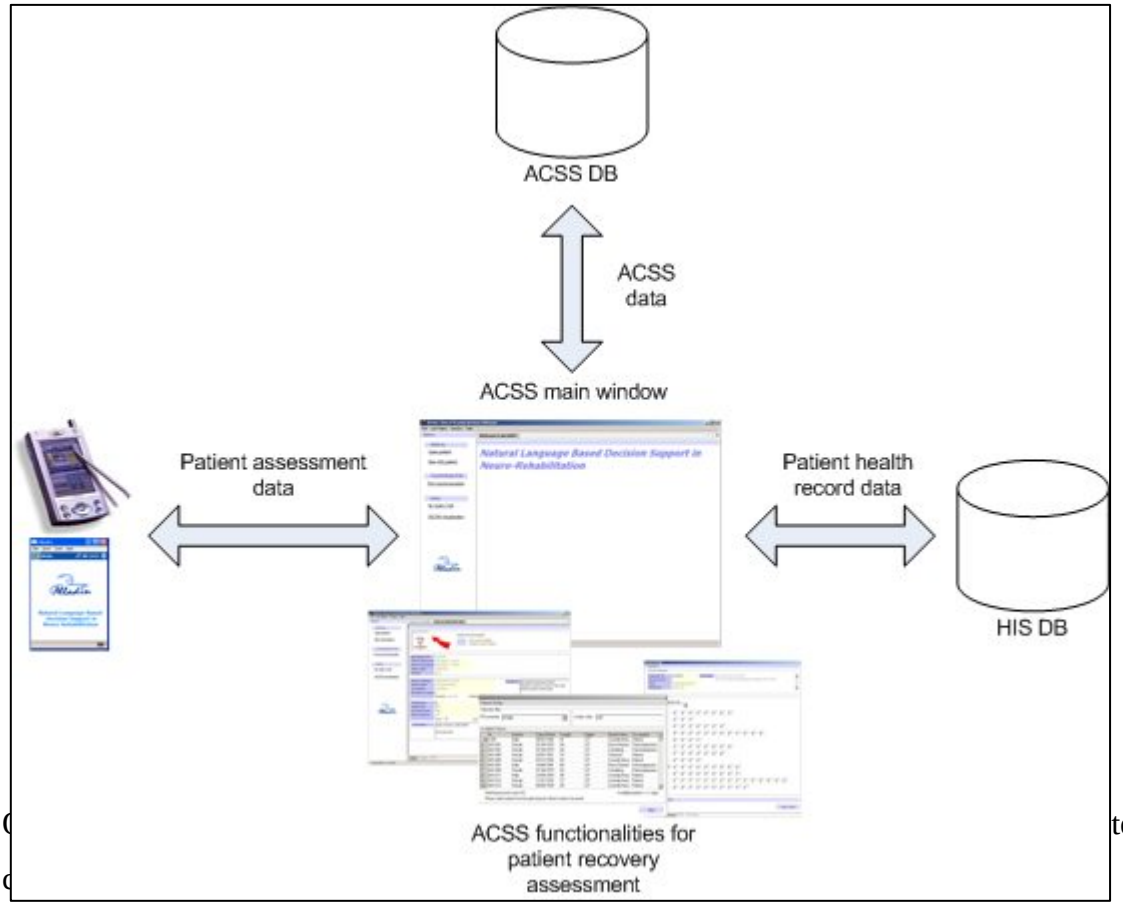
   a. Go to the folder, where you installed ACSS (e.g. C:\Program Files\ALLADIN), and open the file *hisdb.udl*.

   b. In the *Data Link Properties* dialog box, go to the *Connection* tab, and choose to *Use connection string*. Then, press *Build*.

   c. In the *Select Data Source* dialog box, go to the *Machine Data Source* tab, pick the ODBC data source you created in step 2 (previous step) and press *OK*. You will be prompted with a password if one is required by the Oracle database you are trying to access. If needed, enter the password and press *OK*.

   d. In the *Data Link Properties* dialog box, choose *OK* to finish with the process of configuring the connection with Oracle and dismiss the dialog box.

Fig 5-1. Diagrammatic representation of ACSS set up at AMNCH (TCD)



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5.2 Various functions on the ACSS

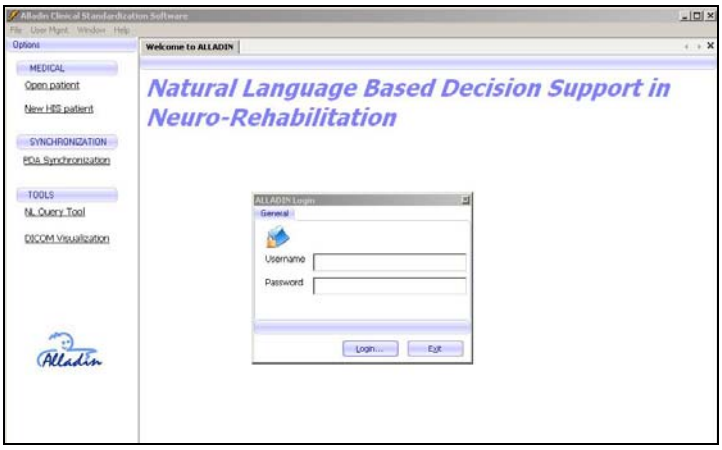
In this section various functionalities available on the ACSS is described in brief.

5.2.1 Login Window

The first window that opens on launching the application is the log in window (fig5-2).like on any application interface. The system administrator has access to user management function, i.e. creating new user and editing existing users. Access to database is also restricted to the system administrator.

System administrator creates and assigns users to either principal investigator or natural language physiotherapist. All the functions on the left pane under options area, Medical, Synchronisation and tools are available to the user (fig 5-2).

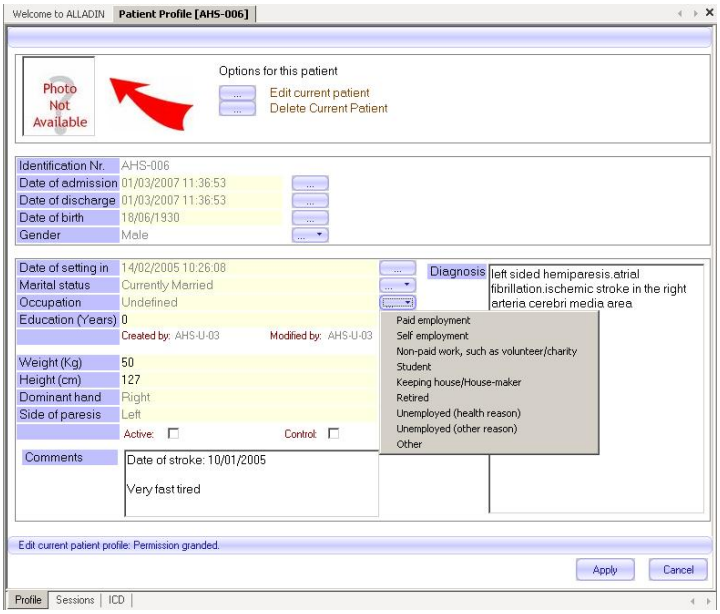
Fig 5-2 login window



5.2.2 Patient profile

This window allows the user to enter and edit patient demographics, clinical notes and comments. However only the system administrator or the principal investigator has the right to delete a patient. (fig 5-3)

Fig 5-3 Patient profile window



5.2.4 Clinical description (Natural Language)

This section has four levels of activity and is accessed from 'PDA Synchronization' button on the left navigation pane. Five distinct step by step procedures are to be followed in the order below.

- synchronise the SD card with the data base to load patients and user profiles on to the SD card (fig 5-4).
- record natural language clinical description of the patient (fig 5-6).
- synchronise SD card to load the natural description on to the Speech transcription manager. for editing (figure 5-7).
- check the audio recording with auto recognised text and edit text on the transcription manager(fig 5-8)
- upload edited description to the database.

Fig, 5.4 synchronising SD card

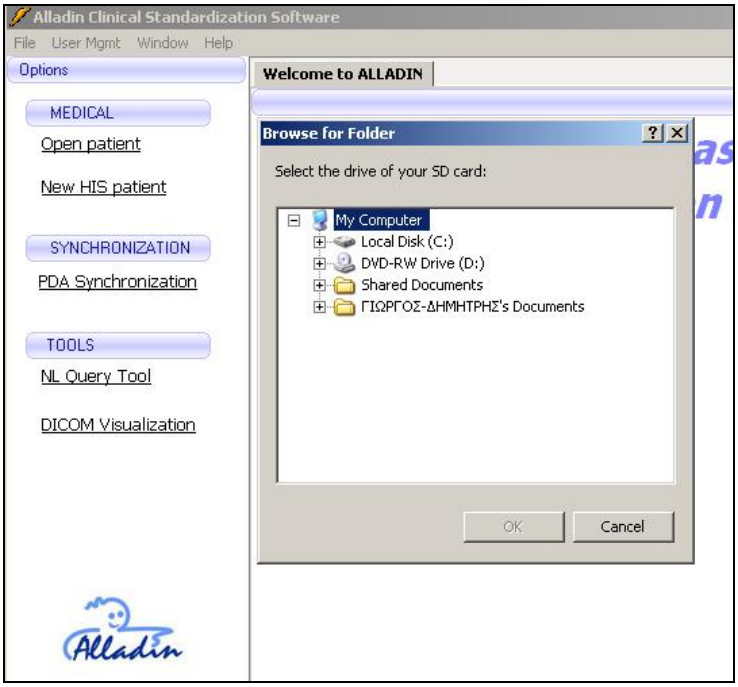


Fig 5.5 Recording clinical description

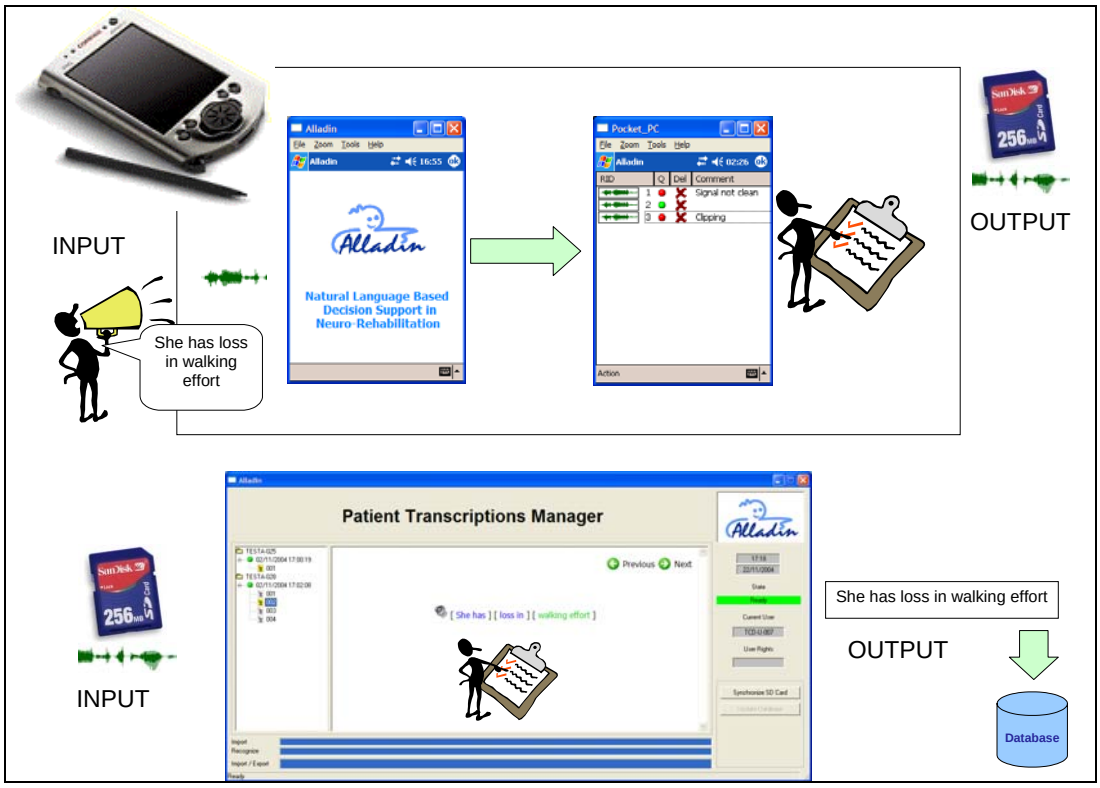
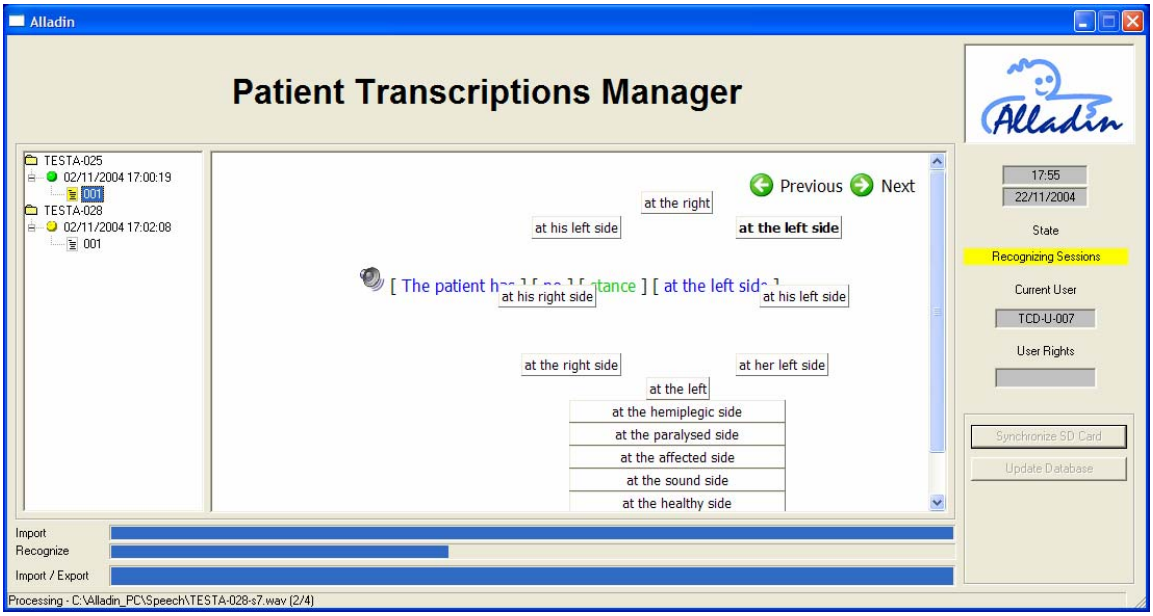


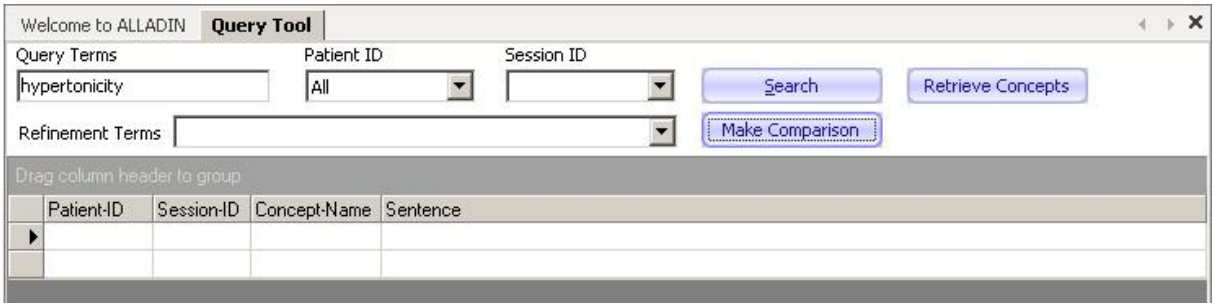
Fig 5.6 editing text: Patient Transcription Manager



5.2.5 NL Query tool

The NL query option allows queries on the NL description in the database. This is based on the concepts of ALLADIN ontology. The query start window is shown in figure 5-7

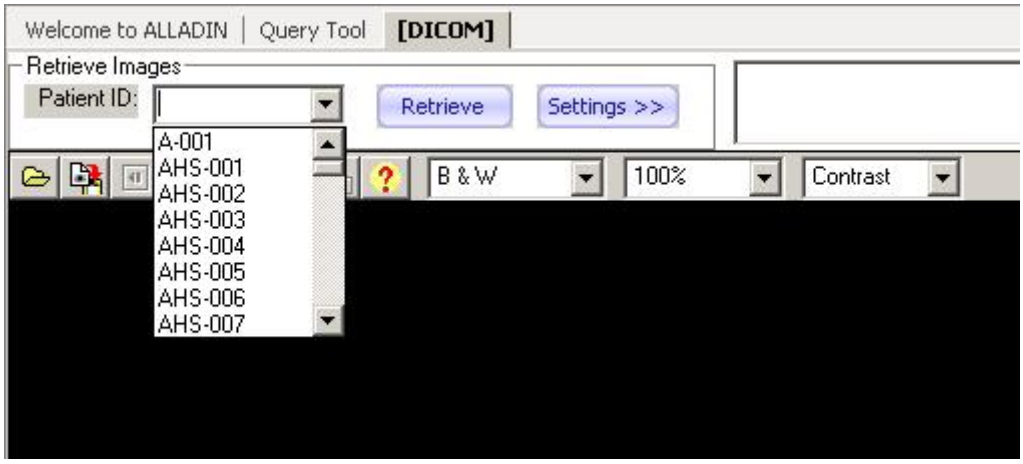
Fig 5-7 Query tool window



5.2.5 **DICOM** (Digital Imaging and Communications in Medicine)

This tool is used to view medical images of the patient (X-rays, CT Scan etc) by linking to the HIS, retrieving and displaying on the ALLADIN PC terminal (fig 5-8). The connection to the imaging server was established and tested by the AMNCH team. Access to this facility could not be granted to the participants in the study since they are not on the hospital network and due to the complex security nature of the set up at the clinical centre. However the IT team reported satisfaction with the link.

Fig 5-8 Image visualisation window



6 The Validation Study

6.1 The Questionnaire

The questionnaire was developed in collaboration with Zenon and approved at the Alladin Overall Control Board (OCB) meeting in Athens (30/11/06-01/12/06). The developed instrument is a five-point Likert type, psychometric response scale often used in questionnaires. This is the most widely used scale in survey research. It is a bipolar scale running from one extreme through a neutral point to the opposite extreme. The respondents specify their level of agreement to a statement [4]. The following guidelines were followed while constructing the questionnaire [5].

1. Review literature in the domain which you wish to measure (e.g. “computer attitudes”).
2. Develop a list of categories (subscales) that you wish to sample from the domain. The domain may be “Computer Attitudes” and the categories may be "ease of use of computer interface”, “usefulness in practice”, “functionalities to be tested”, and “satisfaction”.
3. Write 8 to 10 items/statements (operational definitions) for each category (e.g., "interface was easy to navigate”; “the speed was adequate”).

4. Give the items to experts for classification (Content Validity). The panel of experts will attempt to match the operational definitions with their appropriate categories within the domain.
5. Develop an instrument with the successfully classified items. Use an existing sample Likert scale to design the instrument.
6. Field test the instrument with the populations for which the instrument is being developed.

Closed and open ended questions

Closed questions are useful because they enable questionnaire responses to be analysed easily. From the point of view of respondents, they are also very quick and easy to answer [6]. However, because responses are limited to a set of alternatives, closed questions have the potential to be biased [7]. In addition, respondents may feel the need to provide an explanation about their answer, but are unable to due to the restrictive nature of the question type. When analysing the responses from Likert scales, the data can be treated as quantitative data and is therefore easier to analyse statistically [8].

Open-ended questions are qualitative and allow the exploration of many themes as respondents can write about any issues they wish in response to the question. It is argued that open-ended questions are the most potentially valuable type of survey question as it is usually the only part of a questionnaire where respondents are free to address the issues that concern them, rather than the issues that concern those conducting the survey (Fitzgerald 1996). For example, if evaluating user satisfaction of a service, the open-ended questions often tells what aspects of the service are of most concern to the users. Whereas it is possible that if respondents are asked to rate aspects of service on a scale, they might rate four or five items as low. With an open-ended version of the question, respondents may only have strong opinions about one aspect of the service - this then tells you where to start in improving the service. [9] In answering open-ended questions, respondents may well raise issues that have not been anticipated, or even thought of [10].

Closed questions were used in this questionnaire with a possibility for the respondents to record their views in free text at the end the questionnaire. This method thus has advantages of both closed and open ended questionnaire.

Neutral point and reliability

There is some debate over whether or not to include a neutral point on the scale - some researchers avoid respondents "sitting on the fence" by giving an even number of choices (i.e. 4 or 6), this is known as a "forced choice" method (wikipedia 2006).

The reliability of the Likert scale tends to increase with the number of items used. However as the number of items increases, so does the time taken to complete the question and this may demotivate your respondents. There is no hard and fast rule to determine the final number of items in a scale and this will reflect the nature and complexity of the question [12], but it is generally accepted that between 5 and 7 points on a scale is optimal [13]. We used a 5 point scale including a neutral point to have at least the minimum required points and also to keep distance from point to point equal as intended by Likert in the original scale [4]

Likert scales may be subject to distortion from several causes. Respondents may:

- Avoid using extreme response categories, i.e. points 1 and 5 on the scale (known as central tendency bias).
- Agree with statements as they are presented (known as acquiescence response bias) - i.e. if the statement is positive (e.g. "*I find the library and information service useful*") respondents are more likely to answer in the affirmative.
- Try to present themselves/their opinions in a more favourable light (known as social desirability bias). [11]

A mixture of positive and negative statements were used in an effort to overcome the bias that may occur.

It is generally a good idea to run a pilot survey to check *nuts-and-bolts points*, assess how easily the instructions are followed, how well the format functions and how long it takes to complete the scale [14]. It will also determine the appropriateness of the scale items for the target population. This exercise was also expected to eliminate any ambiguous statements, negative statements or statements which might seem unduly ‘leading’.

The questionnaire asked the respondents to rate their satisfaction of the ACSS interface and specific functionalities by selecting one of the five options as illustrated below. There is evidence that more reliable and valid data is yielded if all the points on the scale are labelled. It also helps to ensure constancy of meaning, as different respondents may attach different meanings to unlabelled points [13]. Also note that the numbers do not have to appear on the

questionnaire that the respondents fill in, it is acceptable for the scale to consist solely of strongly agree, agree etc.

The following options were presented to the participants.

□ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

A questionnaire with 33 statements and two free text items for comments was developed. The statements were categorised based on their grouping on the software package as below

- pre-requisite and training
- user interface and Navigation
- HIS Link
- query tool
- PDA & natural language
- decision support feed-back
- overall satisfaction
- user errors

6.2 Pilot Study

A pilot study with 4 physiotherapists familiar with ALLADIN project was carried out to refine the Validation Questionnaire. Each participant in the Validation performed the following end user roles during the short study:

1. Administrative roles:
    - software installation
    - creating user profiles
    - HIS connection
2. System user roles
    - creating/ importing patient profiles
    - editing patient profiles
    - patient assessment

- natural language clinical description input using PDA
- query tool functionalities test

On completion of these tasks the draft 'user satisfaction survey questionnaire' was checked by the participants. They made suggestions for changes in the questionnaire and procedures.

Suggested changes in the questionnaire and procedure

1 remove sections referring to non functional sub-sections on the interface.

   a. in the query tool section, refined search was non functional and hence statements related to this were removed.

   b. the software generated decision support feed-back sub-section was removed as the present version of ACSS did not have this module incorporated.

2 re-construction or rewording of some statements.

3 the PDA synchronisation was taking over 30 minutes to load the patient data on the SD card and a similar time for uploading the recorded data. There were over 200 patients data on the database and hence this delay. It was suggested that one PC with a complete set of Data be used for Query tool validation sub-section and another PC with only the data of the patients participating in the Validation Study to be used for the rest of the questionnaire.

These suggestions were implemented and changes incorporated in the questionnaire. The final version with 26 statements and 2 free text response areas was used for the study (annexe-2).

6.3 Validation Study

6.3.1 Participants

Nine physiotherapists working in the area of neuro-rehabilitation were recruited to participate in the evaluation process

6.3.2 Protocol

Training

The participants in the study were introduced to the concept of the ALLLADIN project and a brief introduction to the project and its outcome was given. The participants then went through a training session on the use of ACSS with one of the ALLADIN team members who is familiar with the ACSS.

User manual

The user manual (ACSS v 1.3.0.1 User manual v4) was used for the validation study. This manual was very basic and did not have the instructions/information required for clinician using the ACSS for the first time. Information and user manual for the ALLADIN clinical trial was used in addition to real time support from the clinicians familiar with the integrated software. The manual has since been updated to ‘ACSS v 1.3.0.1 User manual v7 ‘(annexe-3)

Procedure

After the training and practice sessions each of the volunteers assessed a post stroke individual and recorded the clinical description in audio format using the ALLADIN software on the PDA. They then proceeded with synchronising and editing the audio files using the ACSS and finally uploaded the edited audio files to the database.

The volunteers then performed various functionalities available on the ACSS.

- creating/ importing patient profiles
- editing patient profiles
- patient assessment
- natural language clinical description input using PDA
- query tool
- use the user manual to assist in these activities

The query tool section was tested on a PC with the complete set of data of 230 patients and the rest on the PC with only the participating client data.

The user satisfaction survey questionnaire was filled out after completion of these activities by each of the participating physiotherapists. Due to the time limitations only one session with each patient could be completed and hence the respondents did not attempt the sub-section on User Errors on the questionnaire which refers to the second or subsequent use of the system.

6.3.3 Duration of the trial

The physiotherapist spent 1 hour on average completing the session for both patient assessment and ACSS use.

The trial was completed over a period of one week in the last week of March 2007. The procedure was performed only once by each participant due to the delayed installation, integration and testing of the ACSS at the clinical site.

6.4 Results

The results are presented under each subsection of the questionnaire.

Numbers were assigned to the responses; the highest level of satisfaction was assigned a value = 5 and the lowest value =1. In the case of positive statements, ‘Strongly agree’ was assigned the highest value and the ‘Strongly disagree’ the lowest value. The Likert scale can also be reversed (University of Salford 2006), ‘Strongly agree’ as the lowest point and ‘Strongly disagree’ to reflect the highest level of satisfaction. As we are assessing the satisfaction level on both types of statements, the values were reversed on negative statements. For analysis, the number assigned to each response was considered the value for that response (Page-Bucci 2003)).

Table 6-1. Values assigned to responses

Assigned Values	1	2	3	4	5
Positive statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Negative statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

The data collected are ordinal: they have an inherent order or sequence, but it cannot be assumed that the respondent means that the difference between agreeing and strongly

agreeing is the same as between agreeing and being undecided (Mogey 2006). However Likert scaled the anchors so as to approximate equal distance between the choices.

Descriptive techniques as below were employed to report the results of the study.

1. Summarise using a median or a mode (not a mean); the mode is probably the most suitable for easy interpretation.
2. Express variability in terms of the range (not the standard deviation).
3. Display the distribution of observations in a bar chart (it can't be a histogram, because the data is not continuous).

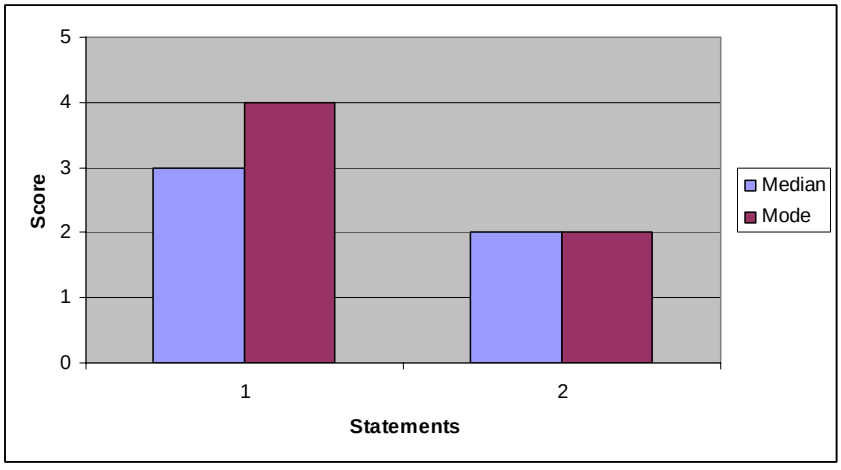
6.4.1 Pre-requisite and training

There were two statements in this section; one dealing with the pre-training and the second statement regarding the user manual. The mean, median, mode and range of the results are presented in table 6.2 & figure 6.1

Table 6-2 Pre-requisites

Statements	Median	Mode	Range
1.Neeed to learn many things before using ACSS	3	4	2-4
2. The user manual is useful	2	2	1-4

Figure 6-1 Pre-requisites



The respondents did not consider prior training a necessary pre-requisite and were of marginally negative disposition towards the user manual. This can be because the manual was not complete in all aspects at the time of the trial. The manual has since been revised to include sections suggested during the pilot study and the trial. .

6.4.2 User interface & navigation

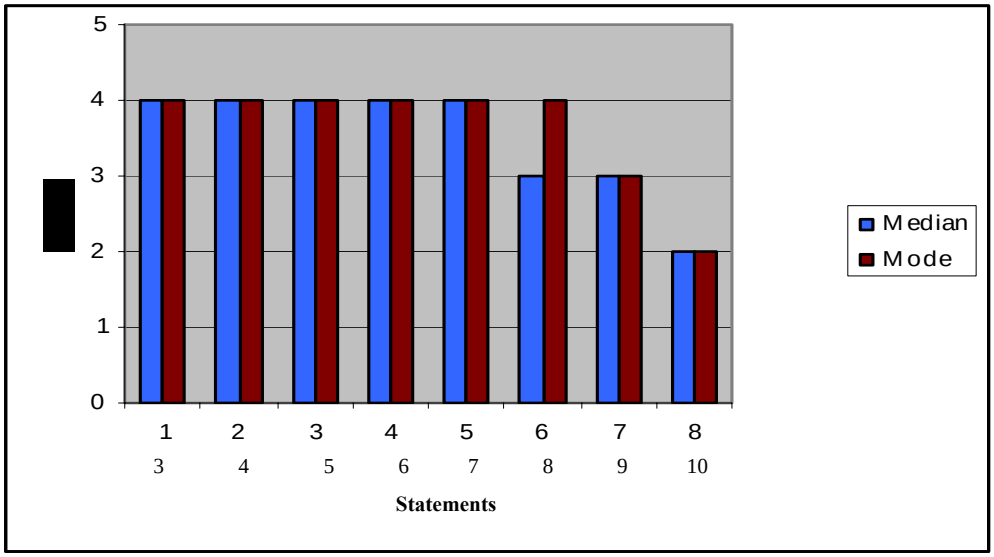
This section was intended to evaluate the appearance, ease of use of the computer interface, the error messages and the speed of the system.

This largest of the subsections had 8 points to respond to and had both positive and negative statements. As described in . The results are on Table 6.3 and Figure 6.2

Table 6-3 user interface and navigation

Statements	Median	Mode	Range
3.Launching the ACSS was easy	4	4	3-5
4. The user interface well laid out and is easy to navigate	4	4	2-4
5. The sequence of screens were confusing	4	4	3-5
6. The messages that appear on the screen are confusing	4	4	2-5
7. Remembering terminology and use of commands was easy	4	4	2-4
8. The ACS speed was too slow	3	4	1-4
9. Error messages are easily understood	3	3	1-5
10. Error messages describe what action is necessary	2	2	1-3

Figure 6-2 user interface and navigation



The results show a high level of satisfaction among all the respondents on all but the error message adequacy.

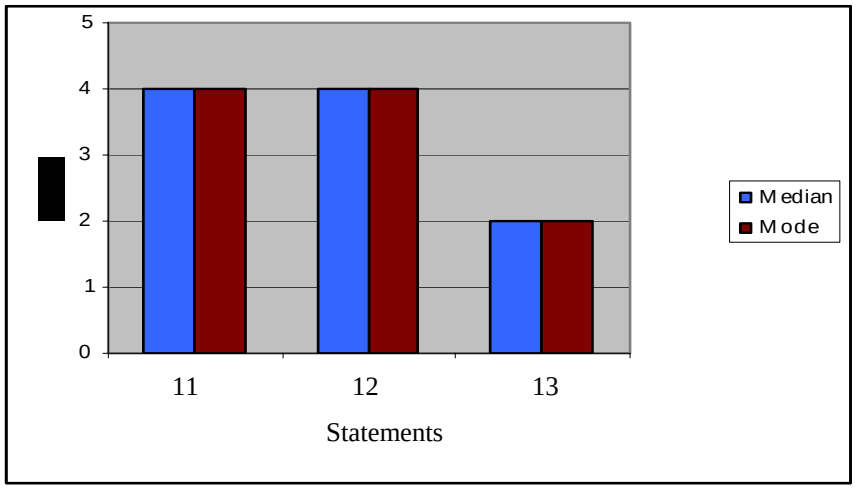
6.4.3 HIS Link

The PC terminal used for the validation was linked to the Hospital Information System via intranet at 100 Mbps. The patient demographic data was retrieved using the unique hospital ID of the individual. This subsection of the questionnaire checks the connection quality by looking for time delay for retrieval, the adequacy of the data retrieved and the user friendliness of the HIS connection window. The summary of results is displayed in table 3 & figure 3.

Table 6 -4 HIS link

Statement	Median	Mode	Range
11. Patient retrieval window was easy to use	4	4	4-5
12. The time taken to retrieve the data was reasonable	4	4	2-5
13. The information received was adequate	2	2	1-4

Figure 6-3 HIS link scores



The scores show a high level of satisfaction except on the adequacy of the retrieved data.

6.4.4 Query tool

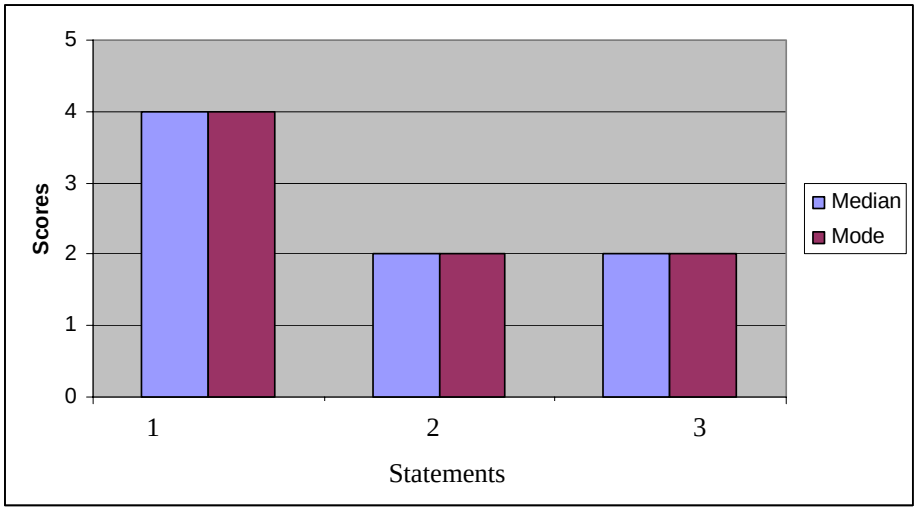
The participating physiotherapists used a different PC as described earlier to complete this section.

The relevance of the results to the query, speed of response and the ease of use of the tool were assessed through the three statements. The results are on Table 4 & Figure 4

Table 6-5 Query tool scores

Statement	Median	Mode	Range
14. The tool is easy to use	3.33	3.44	3-5
15. The tme taken to retrieve the data was reasonable	4	4	2-4
16. The information retrieved was relevant	4	4	2-4

Figure 6-4 Query tool scores



User friendliness and the relevance of the results to the query were highly satisfactory and retrieval time though satisfactory was not as highly rated.

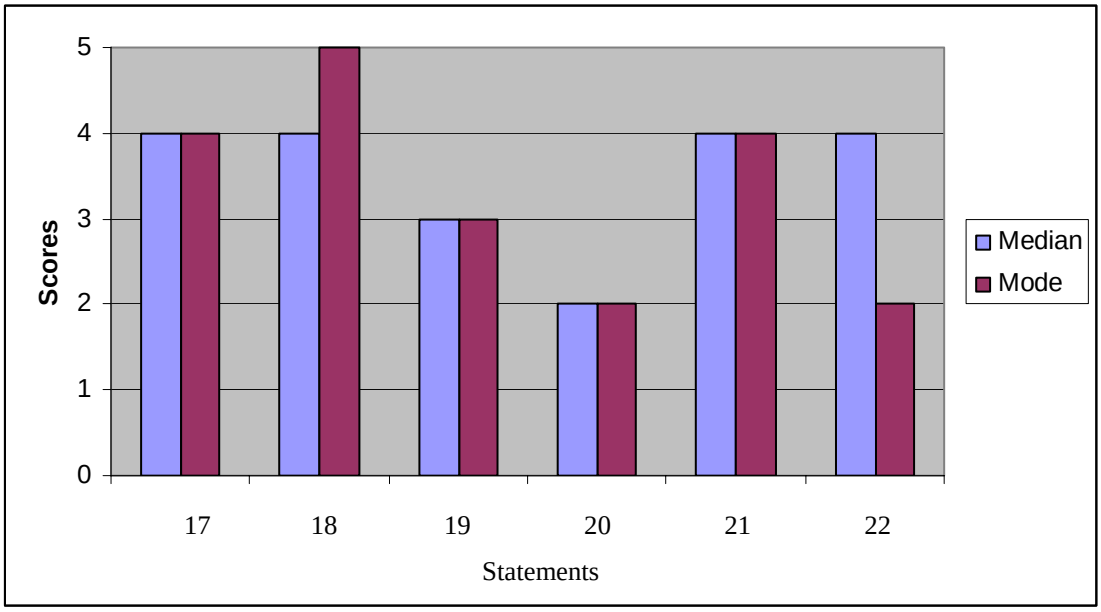
6.4.5 PDA & Natural Language

This section, a very important component of the system was tested on the ease of use, procedures and the editing software. Table 6.6 & Figure 6.5 summarises the findings.

Table 6-6 PDA & natural language score

Statement	Median	Mode	Range
17. I found the PDA easy to use	4	4	3-5
18.Procedure fro recording the session was simple	4	5	3-5
19. Synchronising the SD card with ACSS was easy	3	3	1-5
20. SD card synchronisation speed was reasonable	3	2	1-4
21. I found it difiicult/confusing to edit and validate text	2	2	1-4
8. Updating the database with verified transcriptions was easy	4	4	2-5

Figure 6-5 PDA & natural language



The PDA use was reported to be highly satisfactory but the speech transcription software, synchronisation functions and editing speed were not satisfactory.

As described earlier in section 6.2 only a limited number of patients' data were on the DB for this section. These results confirm the reservations on the time taken for synchronisation, expressed by the participants of the pilot study.

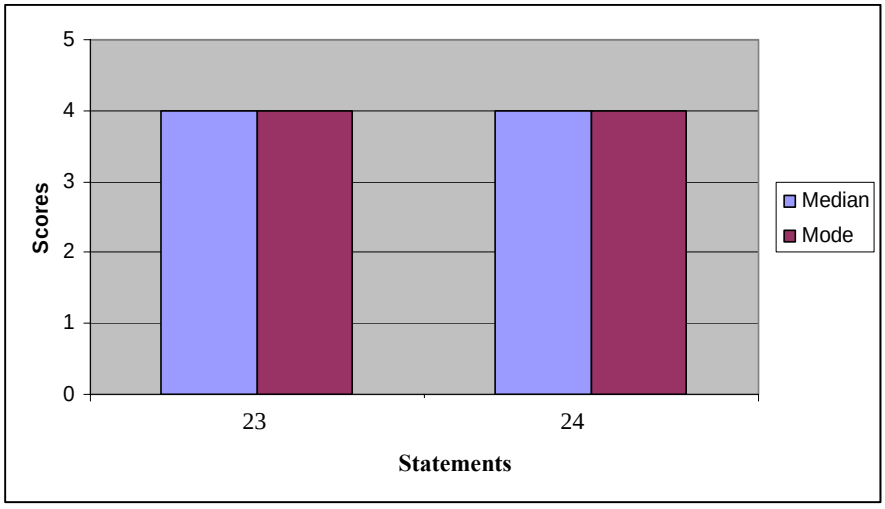
6.4.6 Overall Satisfaction

Questions regarding the ease of use of the system and whether the respondent felt confident using the system as a whole were put to them. The response largely indicated fairly high satisfaction at median 4 on both (table 6-7 and fig 6.6)

Table 6-7 Overall satisfaction

Statement	Median	Mode	Range
23. Overall the product was easy to use	4	4	2-5
24. Overall I was confident to use the system	4	4	2-4

Figure 6-6. Overall satisfaction



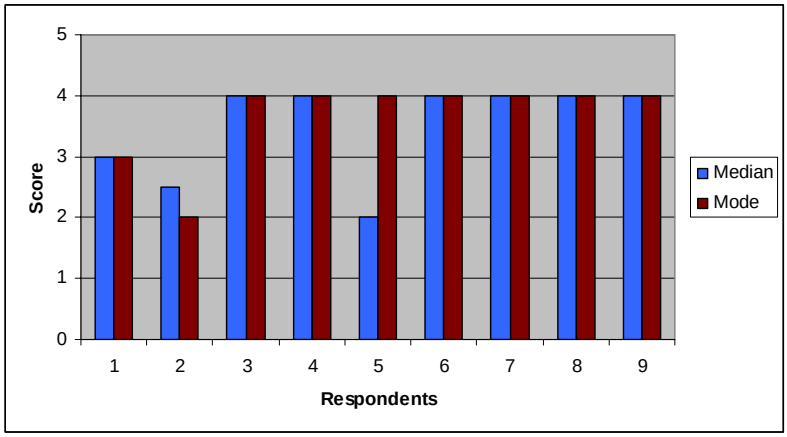
6.4.7 General pattern of response.

Looking at all the responses across all the respondents for all statements and each respondent for all questions a very positive disposition is seen (table 6-8 and fig 6-7). The most frequently occurring response was 4 (mode=4) and the median 4. Seven of the nine respondents also expressed a high level of satisfaction (mode=4) and other two, at level 2 & 3.

Table 6-7 response by respondents

Respondents	Median	Mode
all	4	4
1	3	3
2	2.5	2
3	4	4
4	4	4
5	2	4
6	4	4
7	4	4
8	4	4
9	4	4

Figure 6-6 Median and mode distribution by respondents



6.4.7 Suggestions for improvement

Two open ended questions to be answered in free text format were in this sub-section; one to suggest changes for improvements and the second for general comments on the system. The Questions were:

1. **If there were three things you could change in ACSS, what would they be?**
2. **Do you have any comments or suggestions?**

The responses from the respondents in the form of suggestions for changes and comments were directed mostly to the subsection ‘PDA & Natural Language’.

Most of these were for improving the editing software which was found not to be user friendly. The respondents found this to be restrictive in its availability of words, roots, names of nerves and muscles/muscle groups and descriptive words/verbs. Another restriction reported was that the root word determined what other phrases could be used in a given sentence.

All the respondents found the speech transcription manager, especially the synchronisation function to be very slow and suggested speeding up the process.

Other suggestions included

1. provision for adding new words, roots and free text notes on the patient,
2. PDA was found to be very sensitive to external noise. Unless this is improved, use at the patient bed side may not be feasible.
3. hands free use of PDA was also suggested. If the PDA recording functions can be controlled by voice commands e.g. ‘record’, ‘stop’, ‘save’ etc., the recording can be carried out while the assessment is in progress, minimising the disruption to the patient assessment.

The User Manual was reported to be inadequate and many sections were not available in the present version. Assistance from Alladin team was requested repeatedly during the validation process.

6.5 Conclusion

Alladin project sets out develop an efficient, intelligent and easy to use system for health with special aim to develop an intelligent software environment that enables the management of the citizens by assisting health professionals in decision making. To achieve this, the project brought together and merged several IST technologies such as natural language understanding and speech processing and quantitative force/torque measurements and developed the final software, the ACSS.

The results of the user evaluation does indicate positive disposition in most of the functionalities. The deficiencies are of minor in nature and can be expected of a project with such ambitious goals. The deficiencies as indicated in the evaluators feed back can easily be rectified and ALLADIN team has the expertise to take corrective measures. This capacity has already been demonstrated by bringing out an improved version of the user manual

incorporating the suggestions from the pilot study and the feed back from the validation study, between the time of the study and reporting.

Suggestions regarding the speech transcription have been mainly on the speed of the system and the editing software. The synchronisation speed is proportional to the number of patients on the database and the number of users on the system. This can be easily overcome by importing only active patients to the terminal; thus minimising the data to be written to the SD card while synchronising. During the Alladdin clinical trial, a speech processing engine ran on the PC at night. This increased the rate of speech recognition and editing was brought down to a minimum. Incorporating this engine into the ACSS will make the text editing minimal and faster. It si also possible that sessions becomes more efficient as users experience increase [15]

With these and similar improvements and the flexibility of the system to incorporate developments and technology advance, the ALLADIN software will go along way in providing a user friendly decision support system for the neuro-rehabilitation professionals

Appendix 1

THIS NOTEPAPER MUST NOT BE USED FOR PRESCRIPTIONS OR INVOICING PURPOSES

THE ADELAIDE & MEATH HOSPITAL, DUBLIN
INCORPORATING
THE NATIONAL CHILDREN'S HOSPITAL

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TELEPHONE +353 1 4142000

SJH/AMNCH Research Ethics Committee Secretariat
Dan Lynch Ph: 4142860 email: Dan.Lynch@amnch.ie
Ursula Ryan Ph: 4142342 email: Ursula.Ryan@amnch.ie
Secretariat Fax 4142371

Mr A.C. Varghese, Research Fellow
School of Physiotherapy
Trinity Centre for Health Sciences
University of Dublin
St. James's Hospital
James Street
Dublin 8

November 30th 2006

Re: Alladin Project

Please quote this reference in any follow up to this letter: 2006/41/15

Dear Mr. Varghese,

Thank you for your email communication dated November 30th 2006 with which you submitted an amendment for review and approval by the SJH/AMNCH Research Ethics Committee.
The Vice-Chair, Dr. Suzanne Norris, has reviewed this amendment on behalf of the Research Ethics Committee and has given her ethical approval.

Yours sincerely,

Daniel R. Lynch,
Secretary,
SJH/AMNCH Research Ethics Committee

Appendix 2

User acceptance and Satisfaction inquiry

Please indicate the extent to which you agree or disagree with the following statements.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Pre-requisite & training					
1. I needed to learn many things before I could get started with the Alladin Clinical Standardisation Software (ACSS).	☐	☐	☐	☐	☐
2. The user manual is useful.	☐	☐	☐	☐	☐
User interface & Navigation					
3. Launching the ACSS was easy.	☐	☐	☐	☐	☐
4. The ACSS user interface is well laid out and is easy for navigation	☐	☐	☐	☐	☐
5. The sequence of screens was confusing	☐	☐	☐	☐	☐
6. The messages that appear on the screen are confusing	☐	☐	☐	☐	☐
7. Remembering terminology and use of commands was easy.	☐	☐	☐	☐	☐
8. The ACSS speed was too slow.	☐	☐	☐	☐	☐
9. Error messages are easily understood.	☐	☐	☐	☐	☐
10. Error messages describe what action is necessary	☐	☐	☐	☐	☐
HIS Link					
11. Patient retrieval window was easy to use	☐	☐	☐	☐	☐
12. The time taken to retrieve the data was reasonable	☐	☐	☐	☐	☐
13. The information retrieved was adequate	☐	☐	☐	☐	☐
Query Tool					
14. The tool is easy to use	☐	☐	☐	☐	☐
15. The time taken to retrieve the data was reasonable	☐	☐	☐	☐	☐
16. The information retrieved was relevant	☐	☐	☐	☐	☐
PDA & Natural Language					
17. I found the PDA easy to use.	☐	☐	☐	☐	☐
18. Procedure for recording the session was simple .	☐	☐	☐	☐	☐
19. Synchronising SD card With ACSS was easy	☐	☐	☐	☐	☐
20. SD card Synchronisation speed was resonable	☐	☐	☐	☐	☐
21. I found it difficult/confusing to edit and validate the text.	☐	☐	☐	☐	☐
22. Updating the database with verified transcriptions was easy	☐	☐	☐	☐	☐
Overall Satisfaction					
23. Overall, the product was easy to use.	☐	☐	☐	☐	☐
24. Overall, I was confident to use the system.	☐	☐	☐	☐	☐

User Errors	Agree	Disagree
25. After the first session, I frequently made mistakes.?	☐	☐
26. They were often fatal?.	☐	☐

27. If there were three things you could change in ACSS, what would they be?

I
……..
……..……
……..……
……..……
……

II ……..
……..……
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III ……..
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……..……
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28. Do you have any comments or suggestions?

……..
……..……
……..……
……..……
……

Appendix.3

Project No. 507424

ACSS

Natural Language Based Decision Support in Neuro-rehabilitation

SPECIFIC TARGETED RESEARCH PROJECT

PRIORITY 2.3.1.11

ACSS (V1.3.0.1) USER MANUAL

Start date of the project: 1/1/2004 Duration: 36 month

Introduction

The ACSS is a user-friendly natural language based software for neuro-rehabilitation, in particular in stroke, that is integrated with the Hospital Information System (HIS) for patient data exchange. The physiotherapist will use a PDA to record patients' functional recovery so that the physiotherapist is not "bound" to his desk and can perform the assessment close to the patient. These assessments are then transferred to the computer for further evaluation using various ACSS functionalities. The ACSS sub-modules and data flow is illustrated in Figure 0-1.

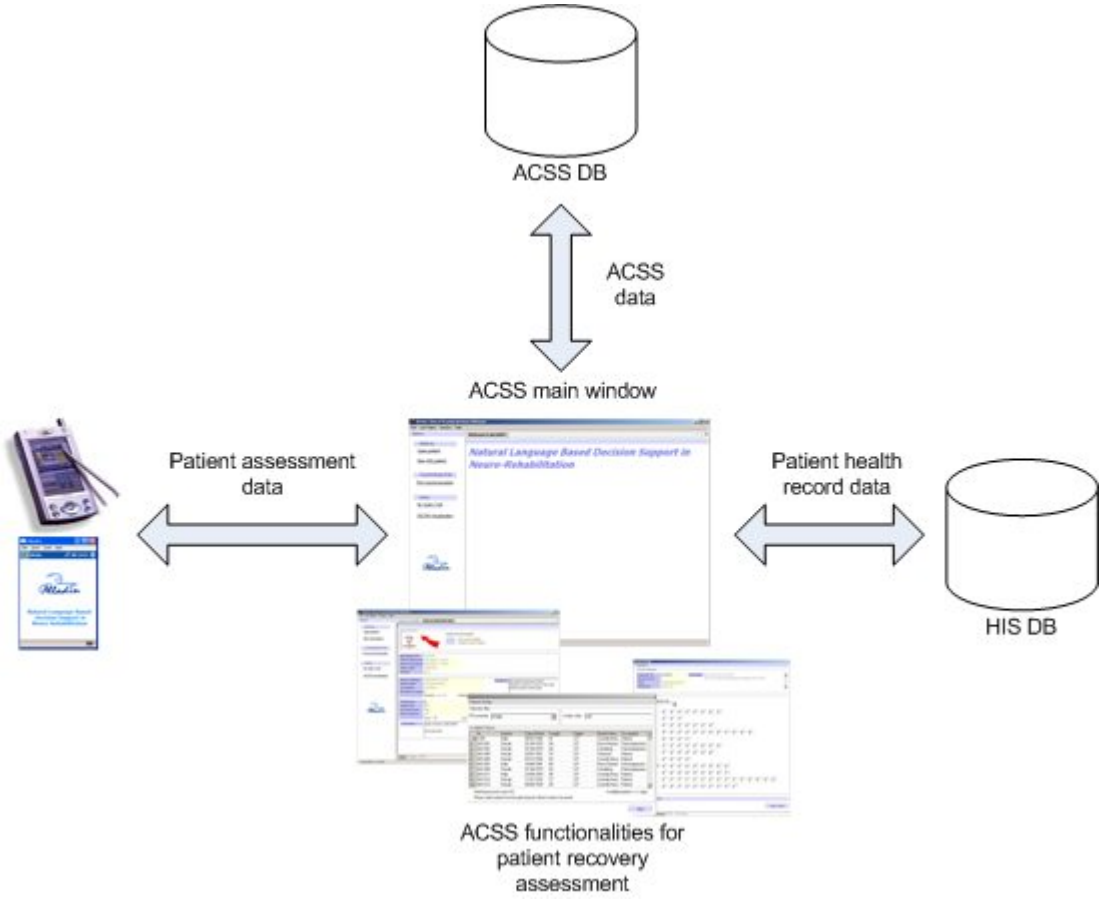


Figure 0-1 ACSS sub-modules and data flow.

This user manual describes how to install and setup the ACSS and how to use the various functionalities of the ACSS.

ACSS Installation

System Requirements

- Microsoft Office 2000/XP
- Minimum ram: 1GB
- Pentium 4 processor or similar
- Display setting: 1280 x 1024

ACSS Installation

To install the ACSS run the setup.exe on the DVD follow the installation steps show in Figure 0-1 to Figure 0-7.

Figure 0-1 Welcome screen, click next.

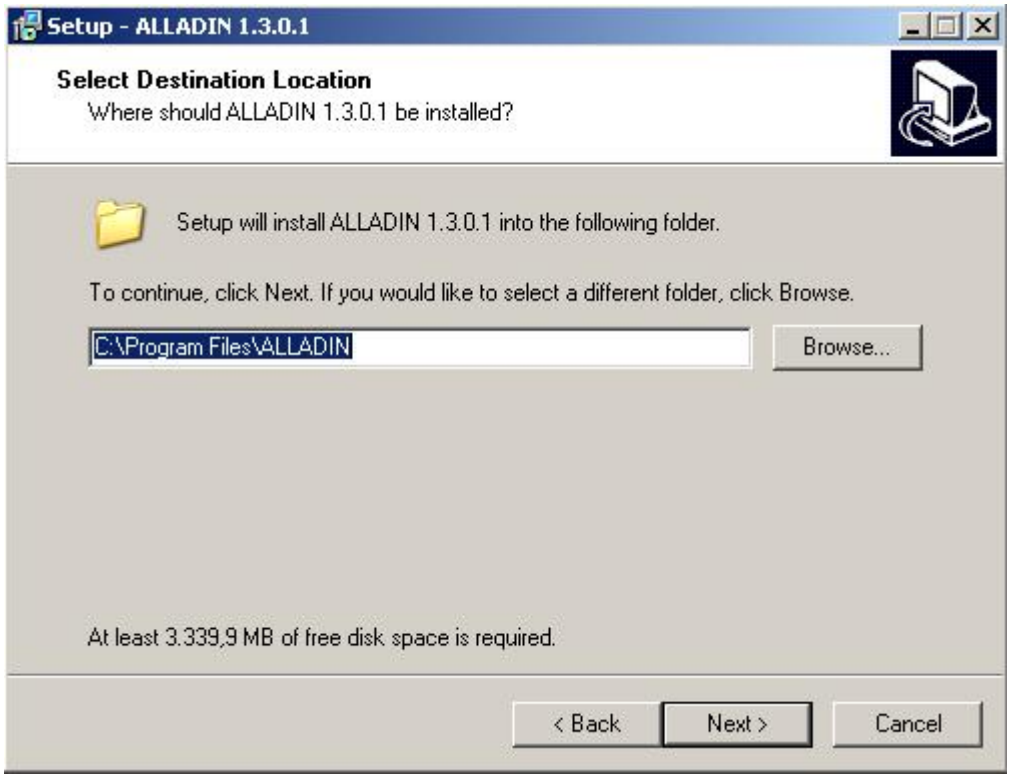


Figure 0-2 Select destination folder for the ACSS.

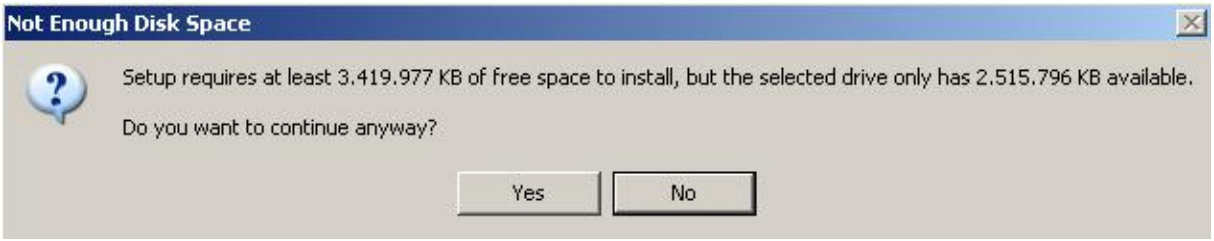


Figure 0-3 If not enough disk space is available on the drive, click 'No' to cancel the installation.

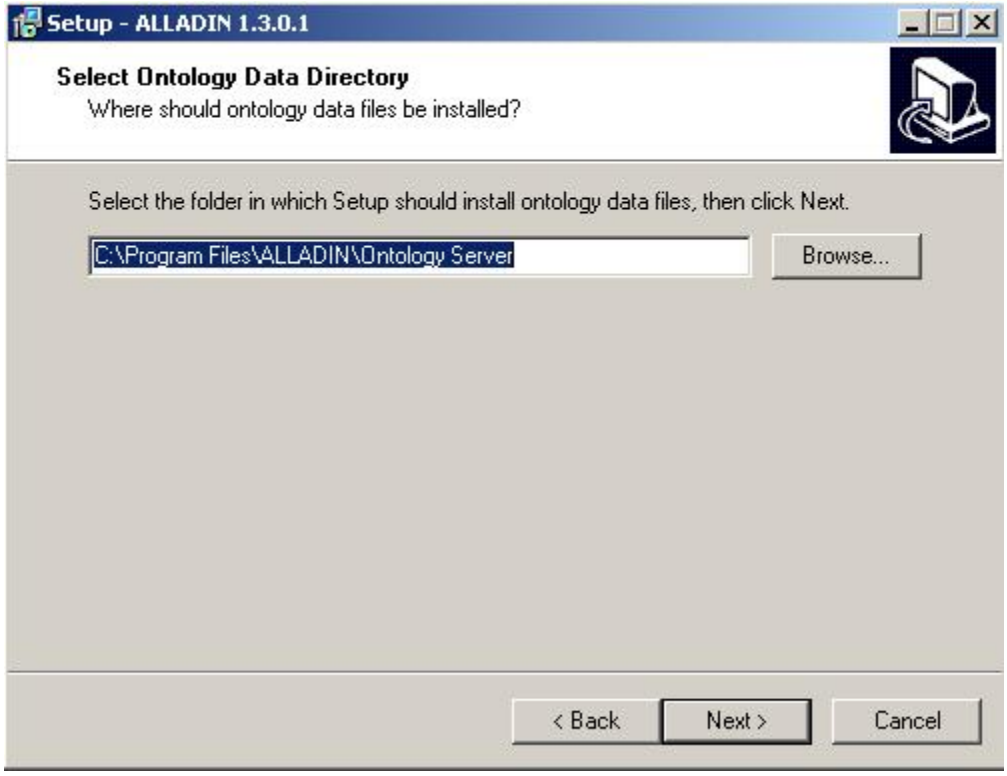


Figure 0-4 Select destination folder for the Ontology server.

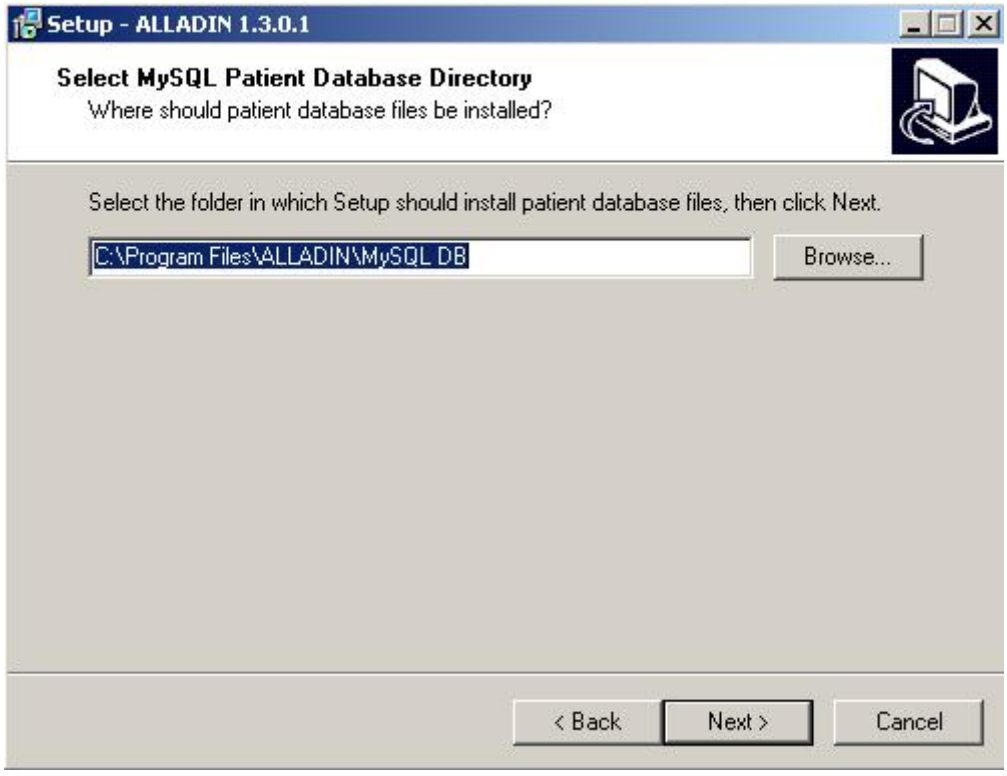


Figure 0-5 Select destination folder for the MySQL database.

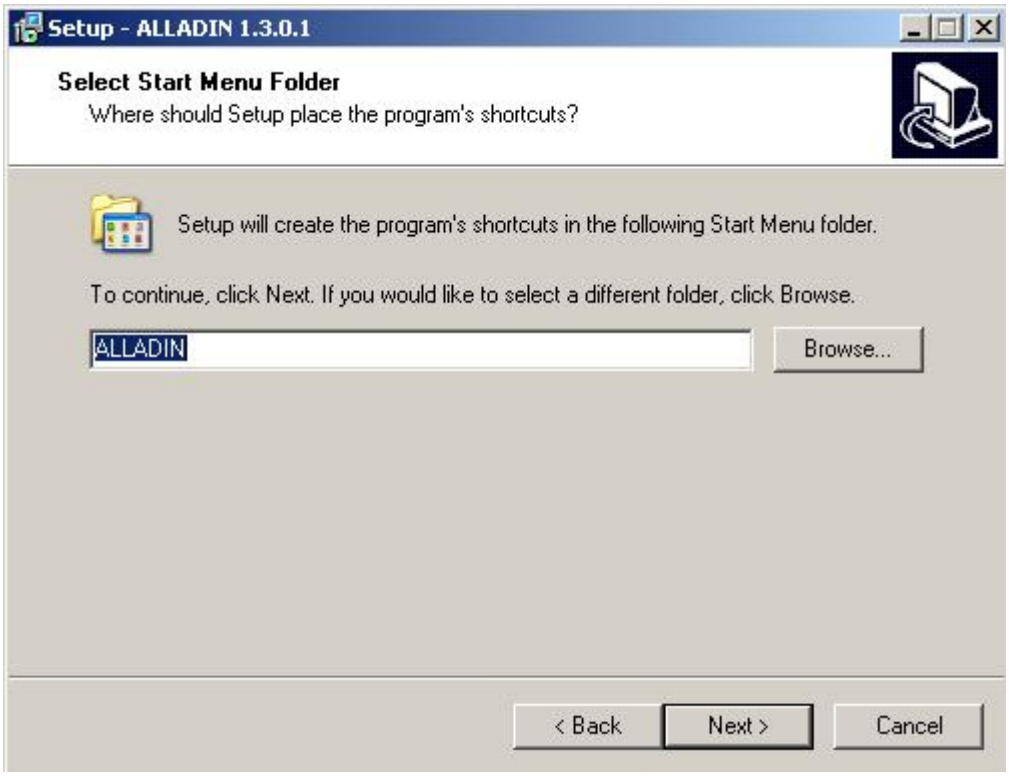


Figure 0-6 Select destination and name ACSS shortcut.

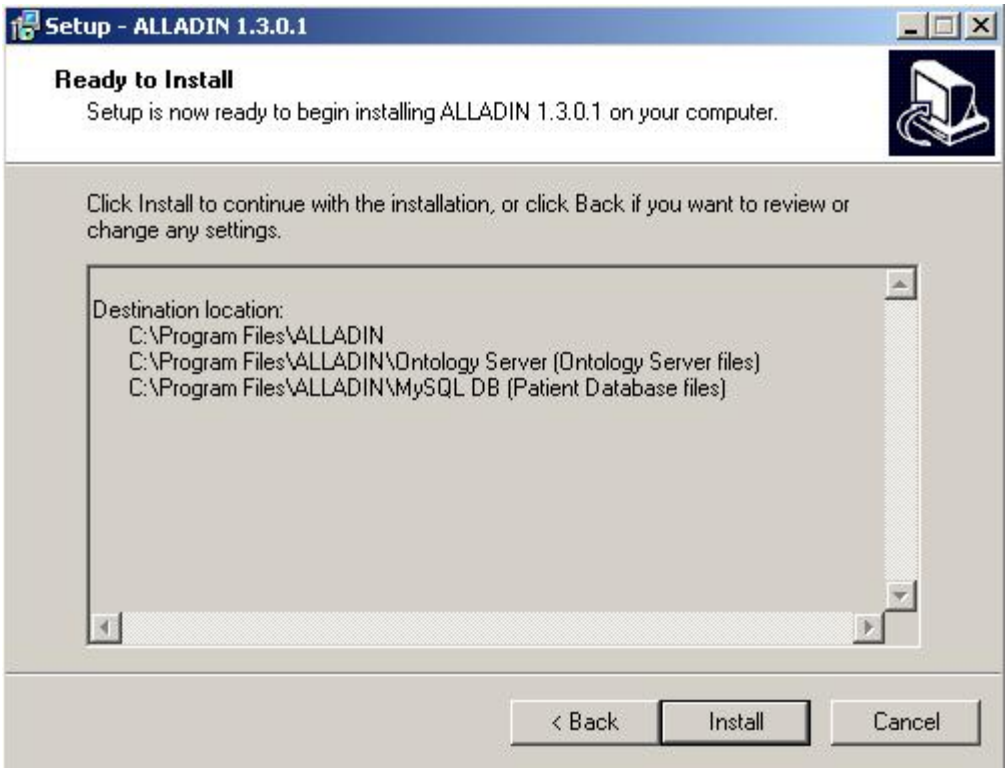


Figure 0-7 Click 'Install' start the installation procedure and reboot when prompted at the end of the installation.

ACSS/HIS link configuration

Given the successful setup of ACSS, the next step is to configure the link between ACSS and HIS (Oracle DB). In order to achieve this, follow the guidelines below:

4. Download and install required software.
    a. Download and install the oracle client tools (http://www.oracle.com/technology/software/products/database/oracle10g/htdocs/10201winsoft.html)
    b. Download and install the oracle ODBC drivers (http://www.oracle.com/technology/software/tech/windows/odbc/index.html)
5. Setup ODBC connection.
    a. Go to *Control Panel*. Go to *Administrative Tools*. Go to *Data Sources (ODBC)*.
    b. In the *ODBC Data Source Administrator* dialog box, go to the *System DSN* tab. Press *Add*.
    c. In the *Create New Data Source* dialog box, pick the oracle ODBC driver from the list of drivers (it should look like: Oracle in OraHome92) and press *Finish*.
    d. Choose the corresponding fields according to your configuration (Data Source Name, TNS Service Name, User ID).
    e. Test the new connection by the test button it provides.
6. Finalize the configuration of the connection.
    a. Go to the folder, where you installed ACSS (e.g. C:\Program Files\LLADIN), and open the file *hisdb.udl*.
    b. In the *Data Link Properties* dialog box, go to the *Connection* tab, and choose to *Use connection string*. Then, press *Build*.
    c. In the *Select Data Source* dialog box, go to the *Machine Data Source* tab, pick the ODBC data source you created in step 2 (previous step) and press *OK*. You will be prompted with a password if one is required by the Oracle database you are trying to access. If needed, enter the password and press *OK*.
    d. In the *Data Link Properties* dialog box, choose *OK* to finish with the process of configuring the connection with Oracle and dismiss the dialog box.

Depending on the HIS DB, slight modifications to establish data link with HIS have to be undertaken.

PDA Software Installation

To install the PDA Software,

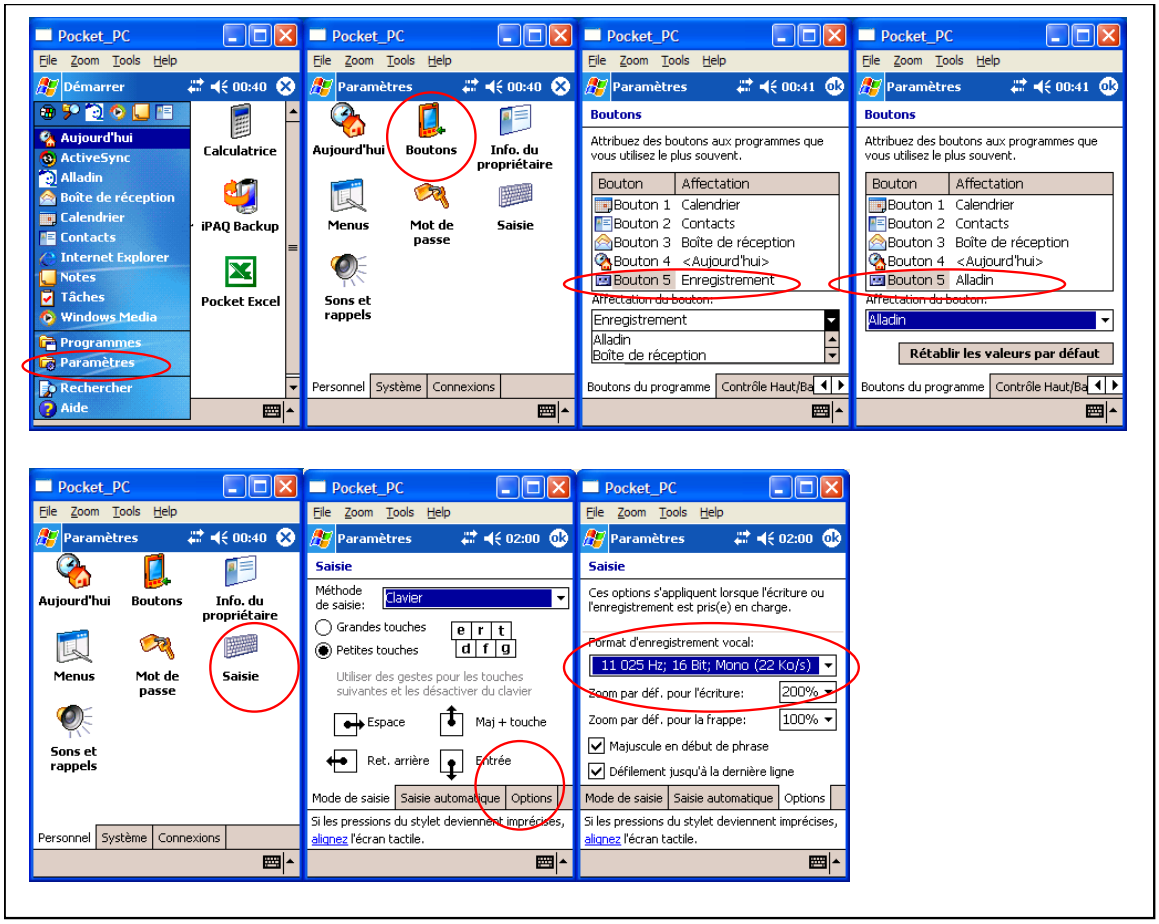
1) Plug the PDA with the USB cable.
2) Launch *Soft_A_Setup.exe* and follow the instructions.

Once you have installed the software on the Pocket PC, you need to configure the PDA in order to be sure that you the optimal settings for the recordings.

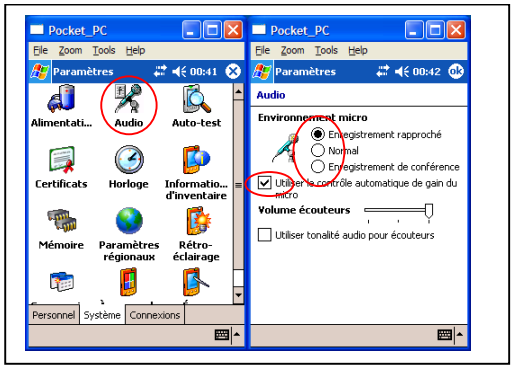
Click on the *START MENU*, then on settings like below. Then, click on *BUTTONS* and change the fifth button from recorder to **Alladin**.

After that, click on *OK* and return to the personal settings.

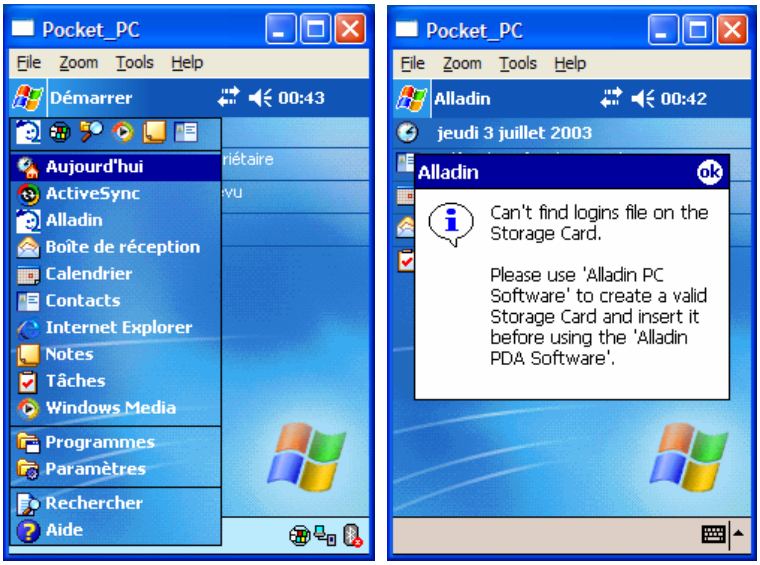
Click on "*Input* (the small keyboard icon)", then *OPTIONS* and select the value **11025 Hz; 16 Bit; Mono (22 Ko/s)** so that you have the right parameters.



Click once more on *OK* and select the *SYSTEM* tab. Click on *AUDIO settings*, then set "***Near recordings***" and check the "***Automatic Gain Control***".



Now that you have configured the different settings, you can launch the PDA Software. If you do not have unzipped the file "Soft_A_StorageCard.zip" and copy the content to the "Storage Card" of the PDA, you will get the following snapshot which invites you to use the ACSS (Alladin PC Software) to create a valid "Storage Card" ready to be used with the PDA Software, see Section 0 Option – PDA Synchronization for instructions.



The ACSS Application

The following sections describe the functionalities offered by the ACSS Cover Application. The Cover Application has been developed in order to allow the user to record the different information related to each patient and the data which come out from the measurements.

The ACSS Log In

At start up, the ACSS software presents a popup window, which allow the user to log in, by inserting username and password. (Figure 0-1)

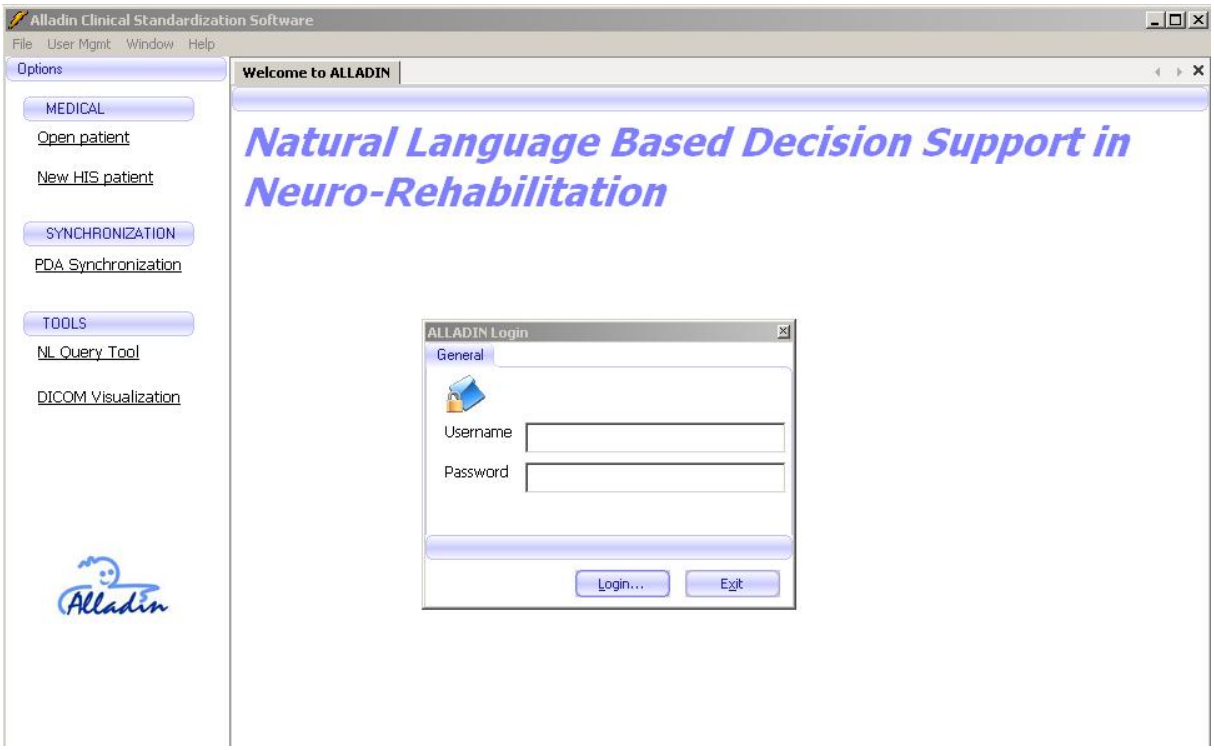


Figure 0-1 The login window.

The ACSS Main Window

After pressing the Login button, the main window is presented. (Figure 0-2)

The main window is divided in:

- Menu bar (top)
- Option area (left)
- Option display area (right)

In the Option area, the following options are available:

- Medical
  - Open patient – Opens the patient record for patients existing in the ACSS database
  - New HIS patients – Imports patient data from the HIS to create a patient record in the ACSS database
- Synchronisation
  - PDA Synchronisation – Interfacing the ACSS database with the PDA interface
- Tools
  - NL query tool – Query the NL description of the patients and session
  - DICOM visualization – Display medical image that conforms to DICOM standard

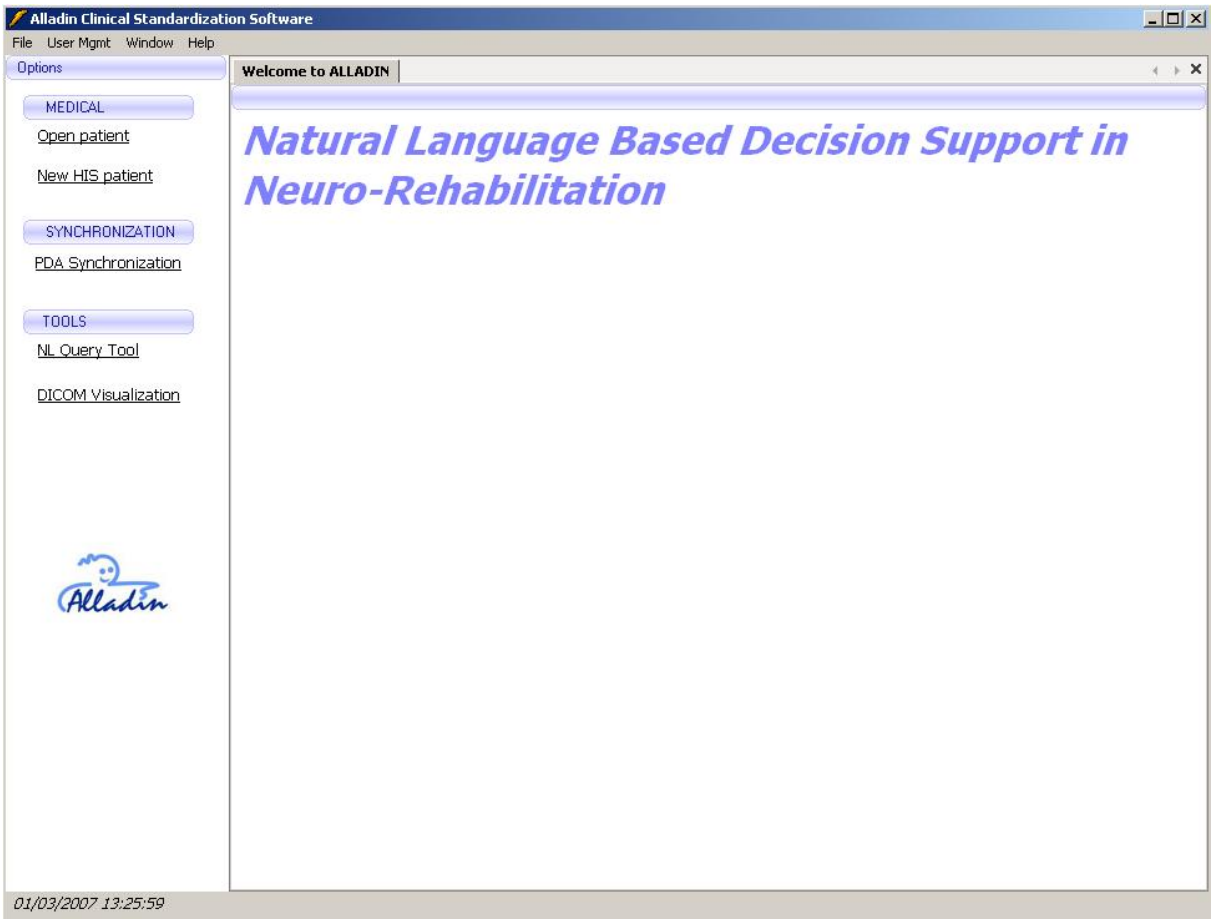


Figure 0-2 The main menu window.

Option - Medical

The option Medical has the following functionalities:

- Open patient – Opens the patient record for patients existing in the ACSS database
- New HIS patients – Imports patient data from the HIS to create a patient record in the ACSS database

Open Patient

Selecting 'Open patient' opens the patient selection window, see Figure 0-3.

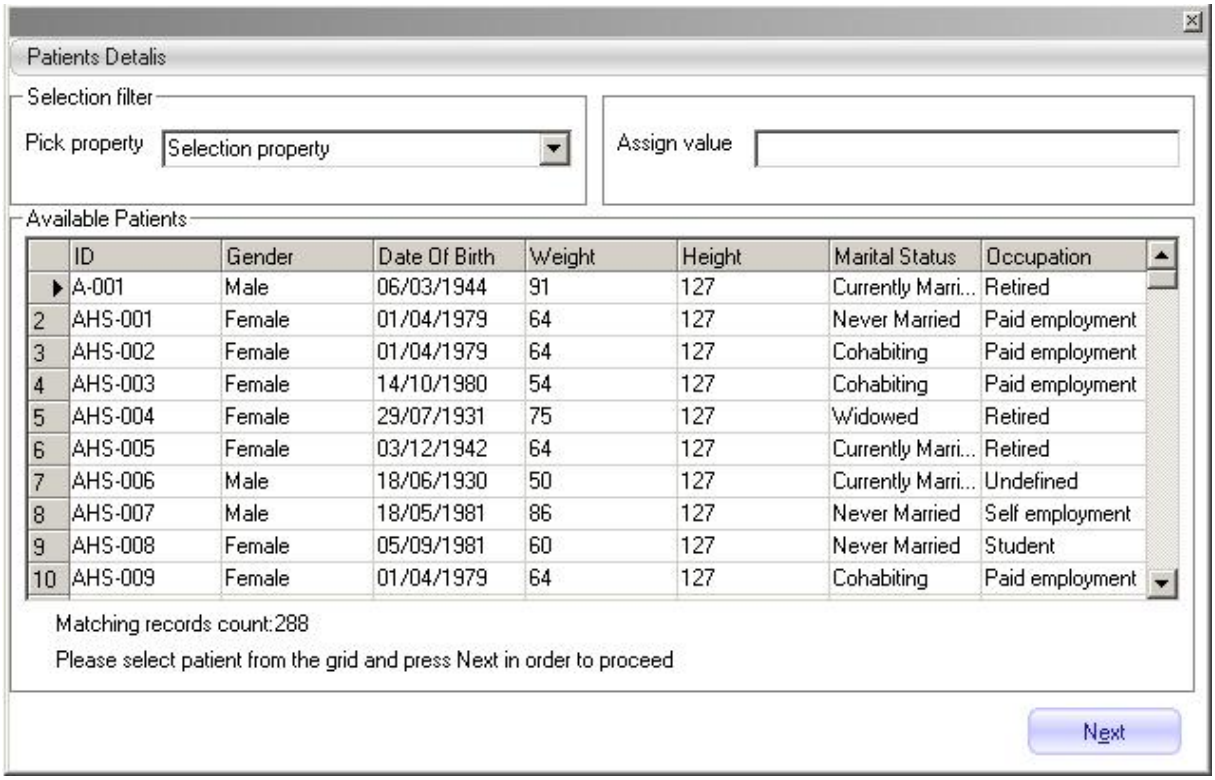


Figure 0-3 Patient selection window.

To select a patient, scroll down the patient list and click on the number left to the ID to highlight the patient "blue", see Figure 0-4, and press the button 'Next' to open the patient record.

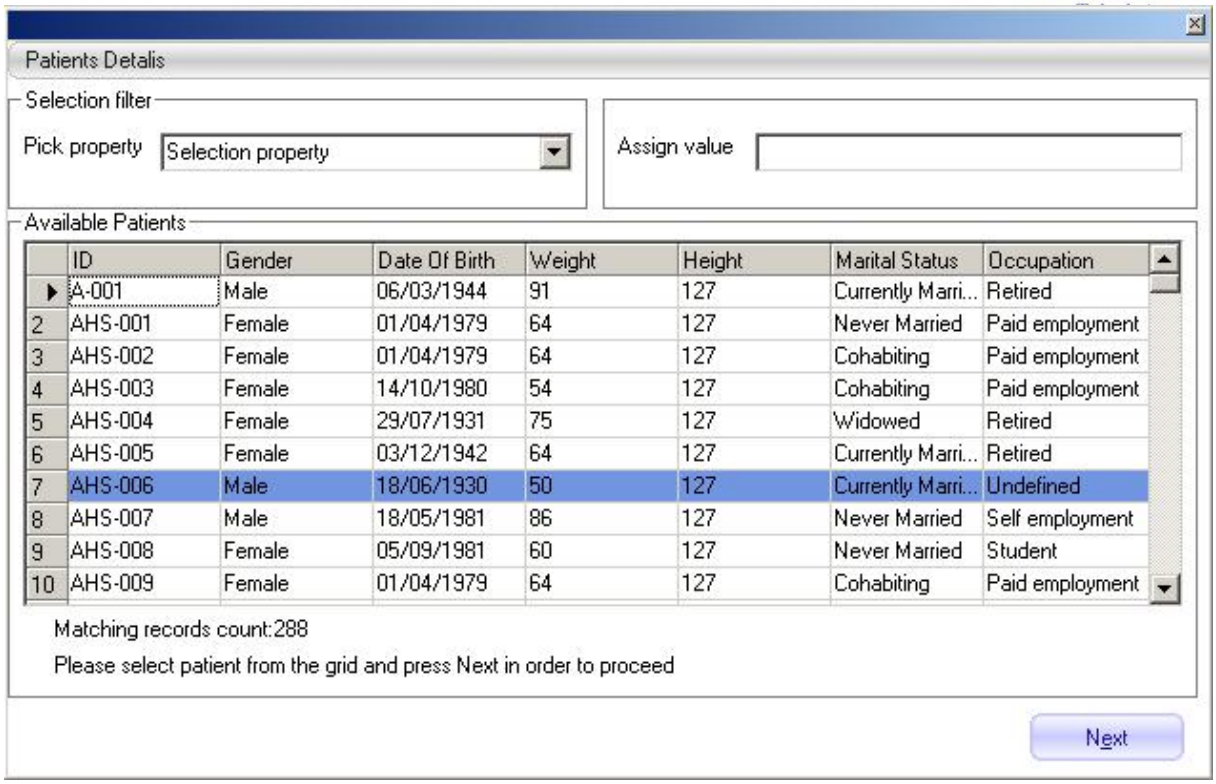


Figure 0-4 Patient selection window.

Before selecting a patient, the patients can be filtered according to different properties, see Figure 0-5, and values, see Figure 0-6.

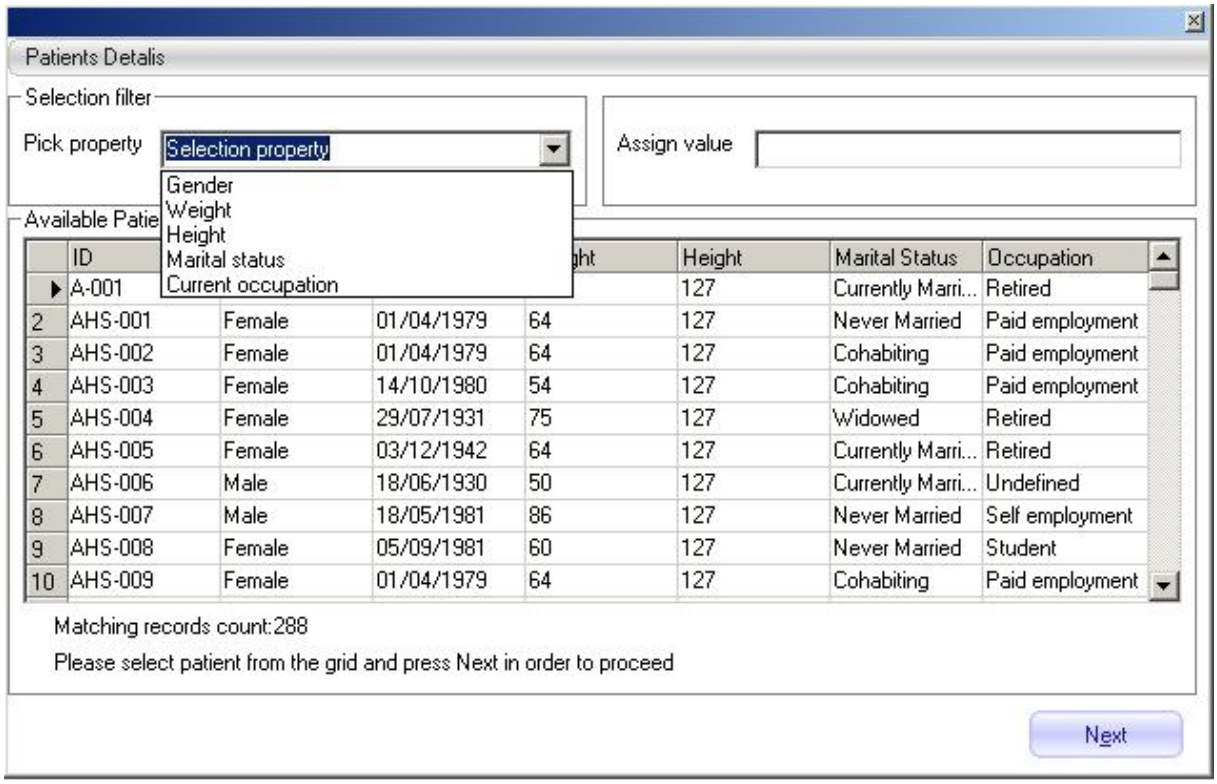


Figure 0-5 Patient selection filter – property selection.

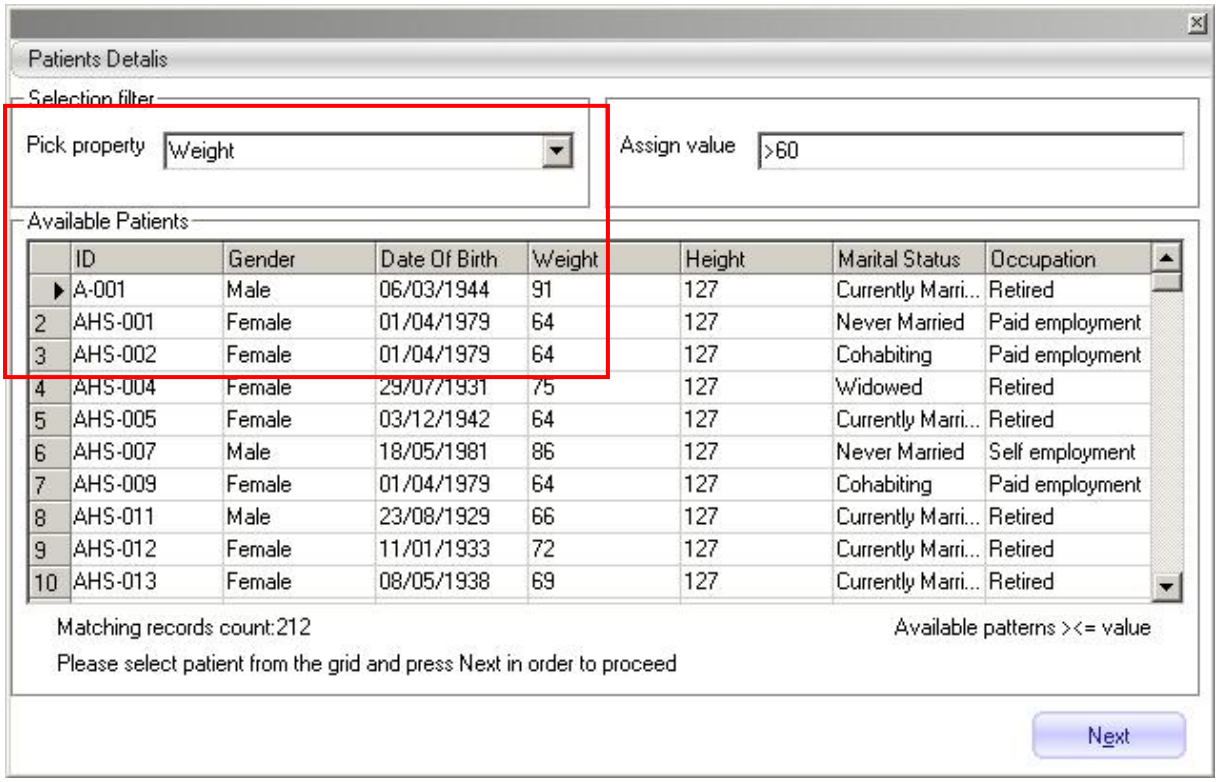


Figure 0-6 Patient selection filter – value assignment.

After selecting a patient and pressing 'Next', the patient profile will be opened. The profile has three tabs at the bottom; Profile, Sessions, ICD, see Figure 0-7.

- Profile tab – General patient information
- Sessions tab – Information for available patient sessions
- ICD – **NOT FUNCTIONAL**

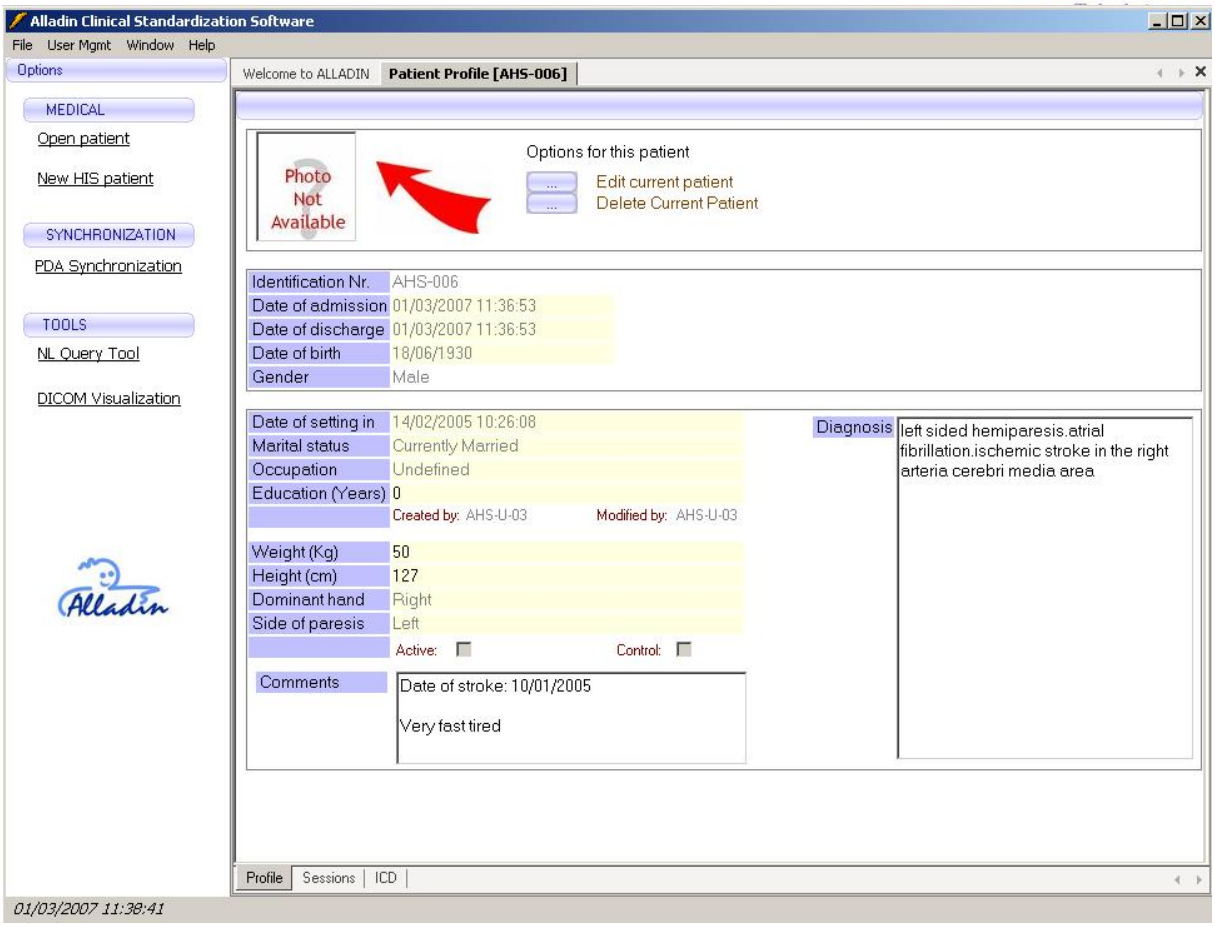


Figure 0-7 Patient record.

If the user has the permission, the user can edit the patient information or delete the current patient, see Figure 0-8.

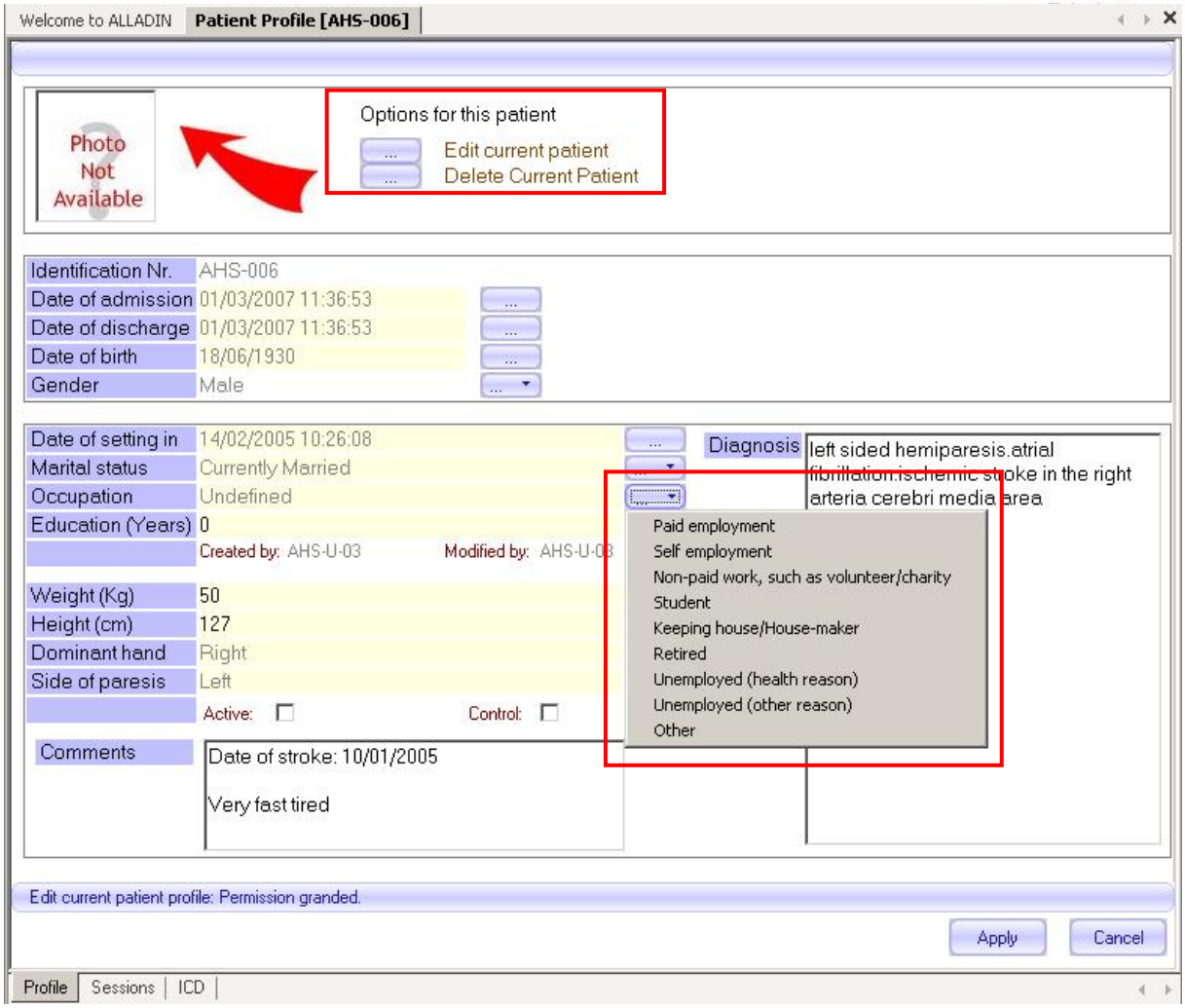


Figure 0-8 Editing a patient record.

The Sessions tab contains the following areas:

- Advanced – Contains link to session details (NL, Fugl-Meyer, MAS) - **FUNCTIONAL** - and description of existing session milestones and markers – **NOT FUNCTIONAL**.
- Session Information
- Session comments
- Session translated text
- Play sound file

Until a session is selected in the Session Information area by clicking on the number in the column left to the Session ID column, all other areas are empty, see Figure 0-9. To select a session, scroll down the session list and click on the number left to the

Session ID to highlight the session “blue” and all relevant information is displayed, see Figure 0-10.

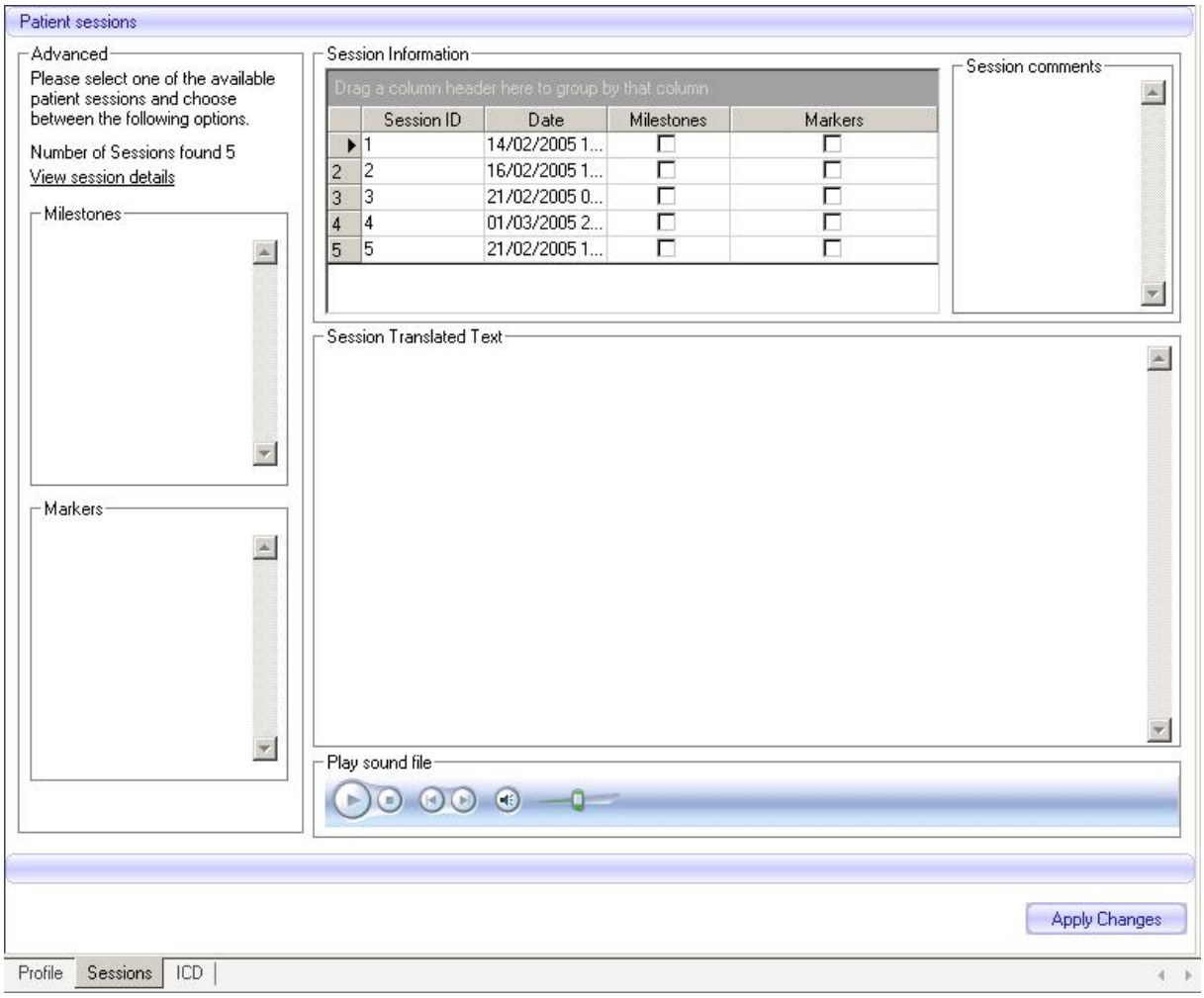


Figure 0-9 Session information area.

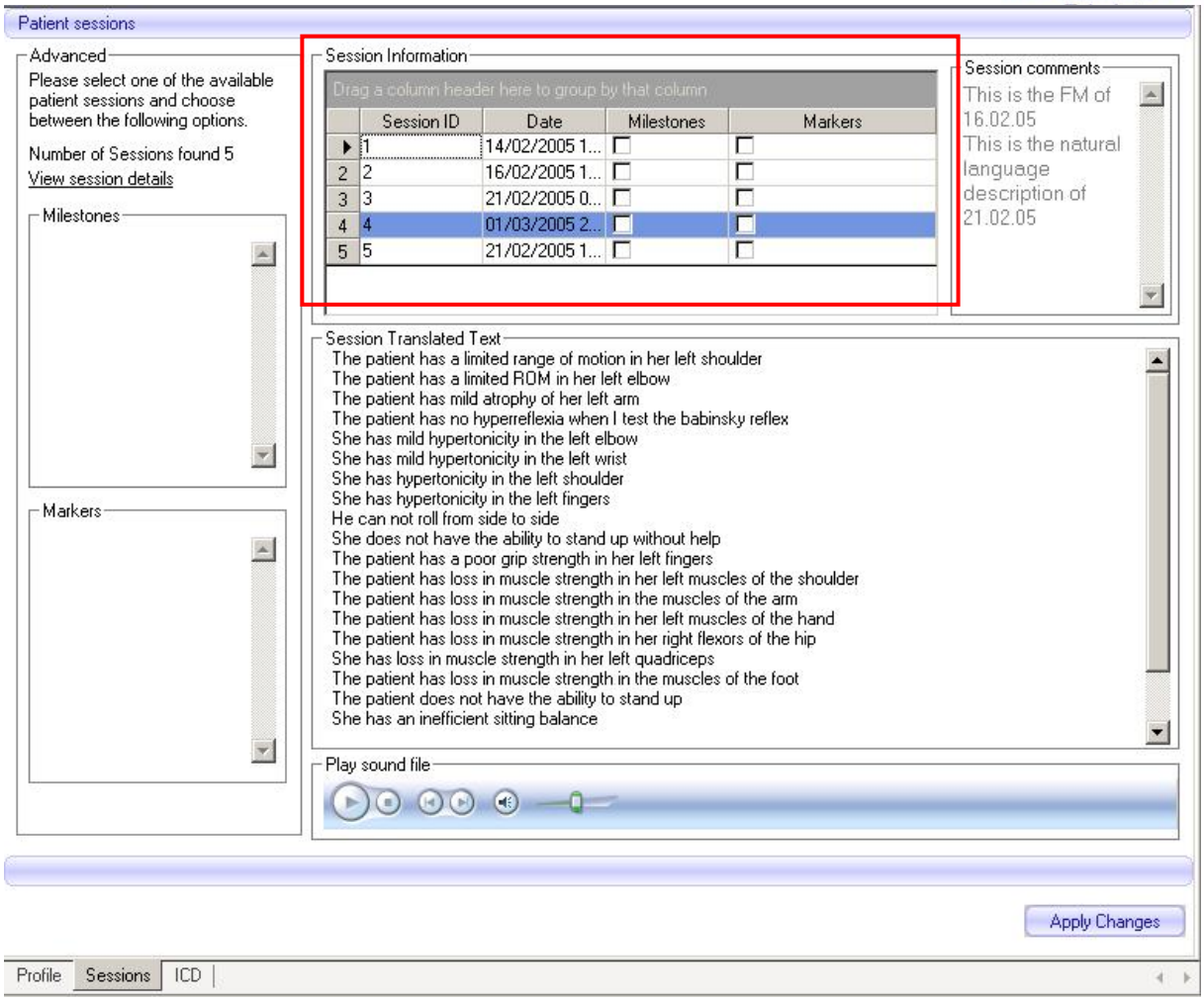


Figure 0-10 Session selected.

To view all the session details for a selected session click ‘View session details’ that opens the window displaying the NL description, shown in Figure 0-11. Click on the tabs in the lower left of the window to view the Fugl-Meyer (Figure 0-12), MAS (Figure 0-13), and SIS scores (Figure 0-14) descriptions. Click the ‘Apply Changes’ button to save a description that has been edited.

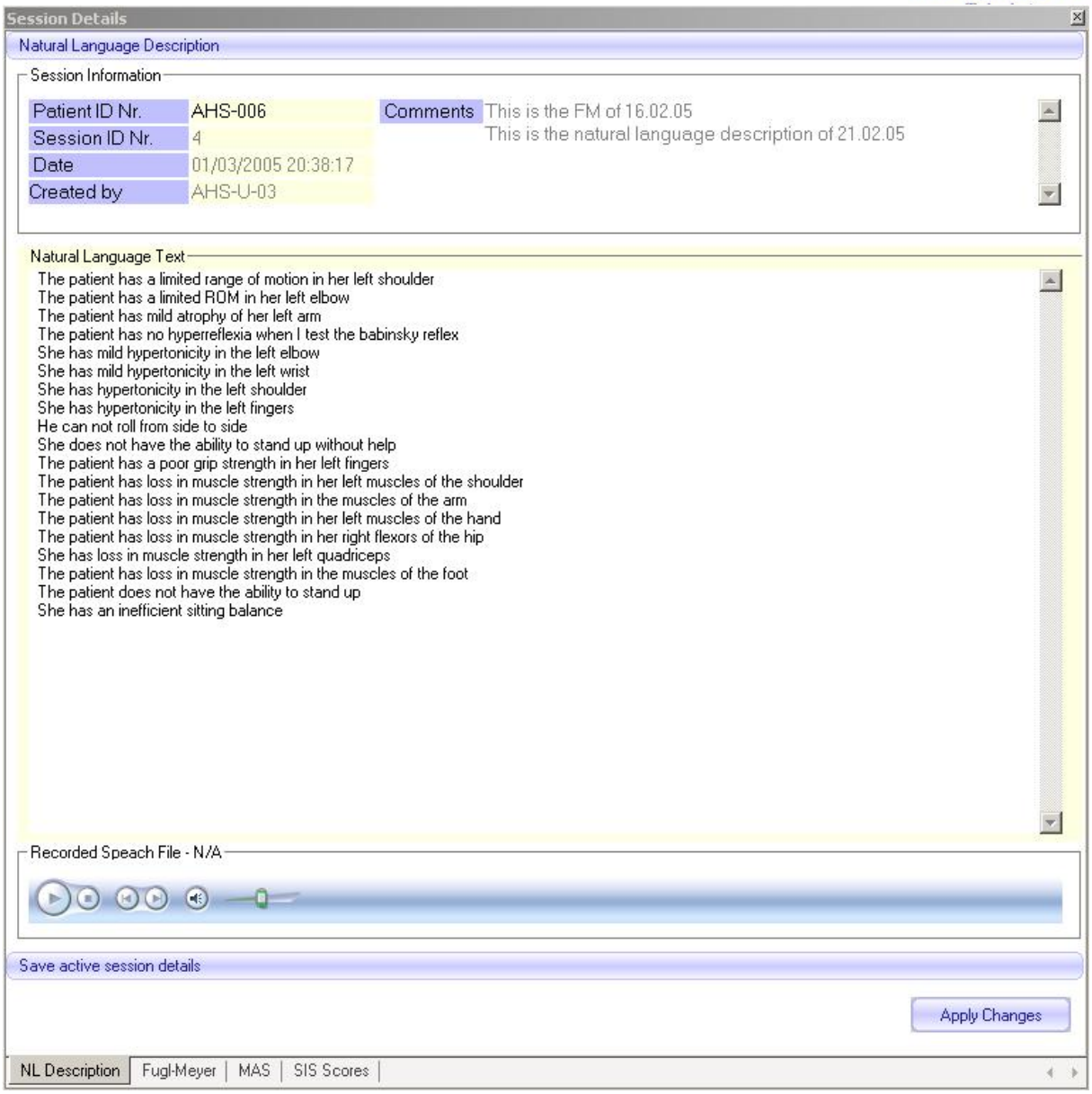


Figure 0-11 NL Description.

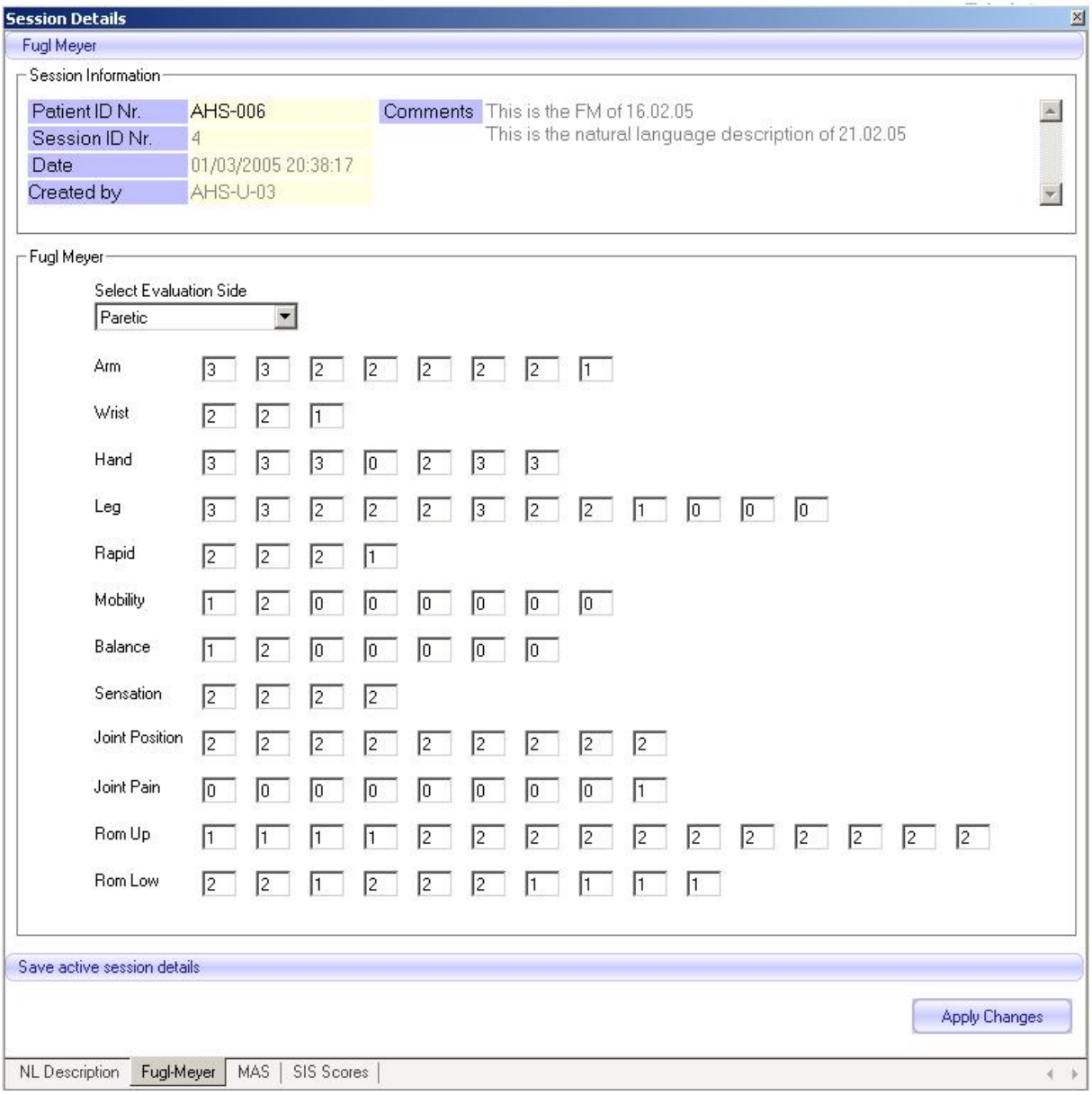


Figure 0-12 Fugl-Meyer Description.

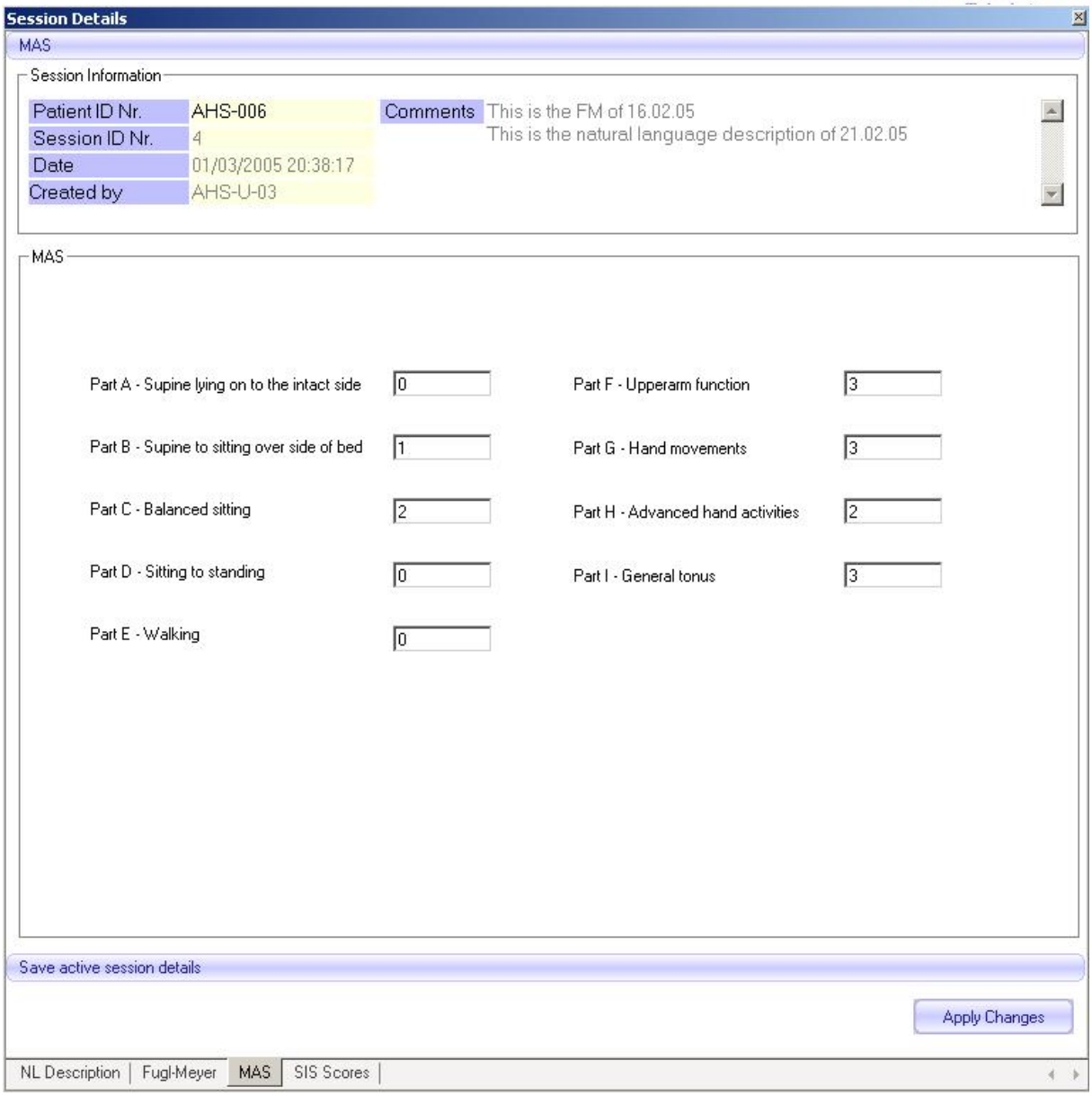


Figure 0-13 MAS Description.

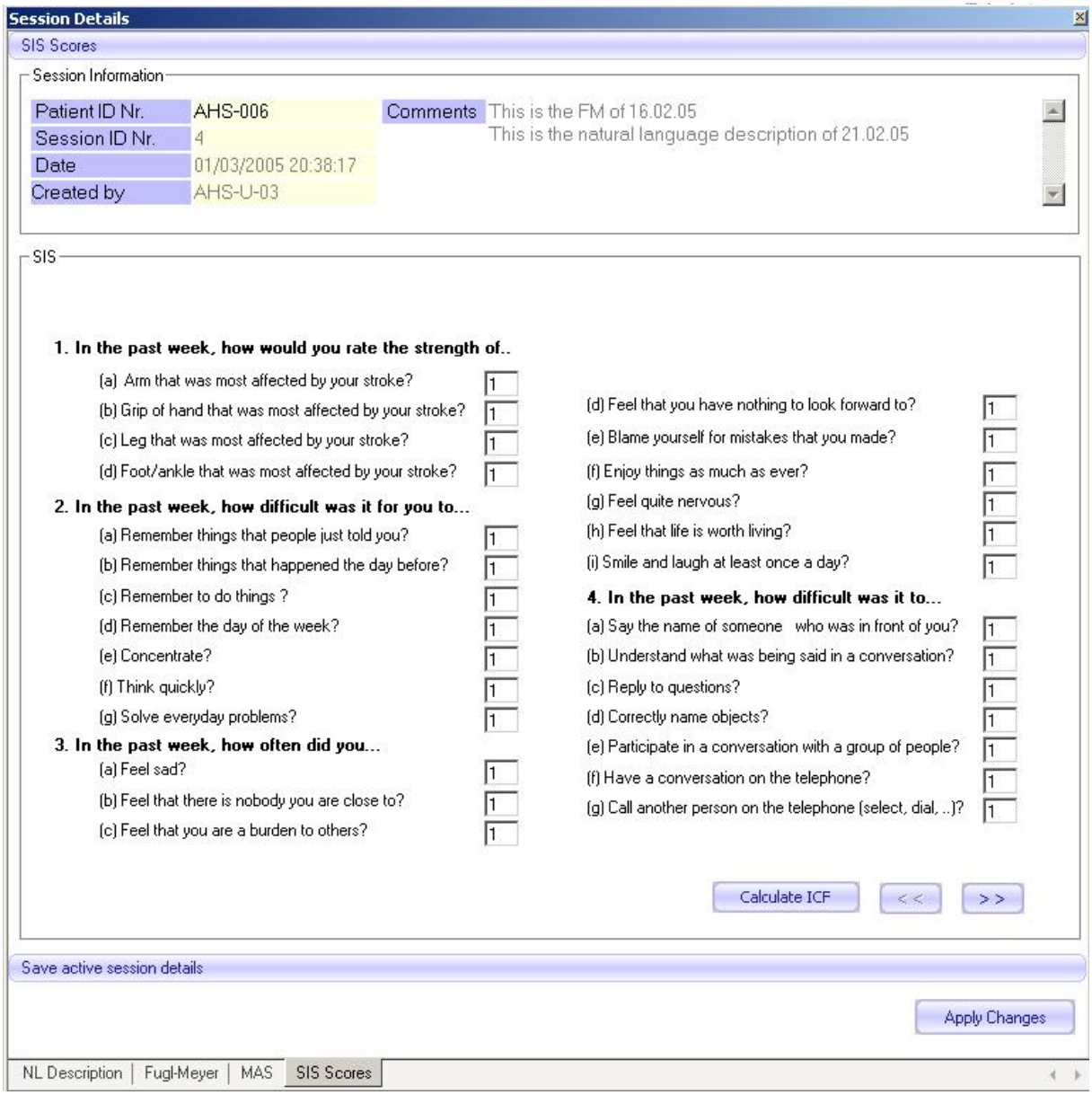


Figure 0-14 SIS Scores Description.

New Patient

Selecting 'New patient' opens the Fetch HIS Patient selection, see Figure 0-15. To import patient details to the ACSS from the HIS fill in the HIS patient ID and press the button 'Fetch...'

Figure 0-15 To import patient detail to the ACSS from the HIS.

Option – PDA Synchronization

One of the goals of the ALLADIN project is to use natural language descriptions to do the assessment of the patients. These assessments are recorded on PDA so that the physiotherapist is not “bound” to his desk and can perform the assessment close to the patient.

To store these assessments into the ACSS database there is the need to convert the speech into text. This part is performed using speech recognition engine provided by the Multitel. It can be seen as a way to transcribe the physiotherapist natural language diagnostics faster than having to type it directly using a keyboard.

The physiotherapist will use a PDA to record patients’ functional recovery. The therapist will pronounce the sentences quasi naturally and use the PDA interface to convert speech into text.

The PDA Synchronization option provides the functionalities for interfacing the ACSS database with the PDA interface and starts the patient transcription manager (PTM) that is a module dedicated to automatically import speech audio recordings from the PDA and use a speech recognition engine to transcribe it into text. Before the launch of the PTM the user needs to select the drive of the SD card, see Figure 0-16.

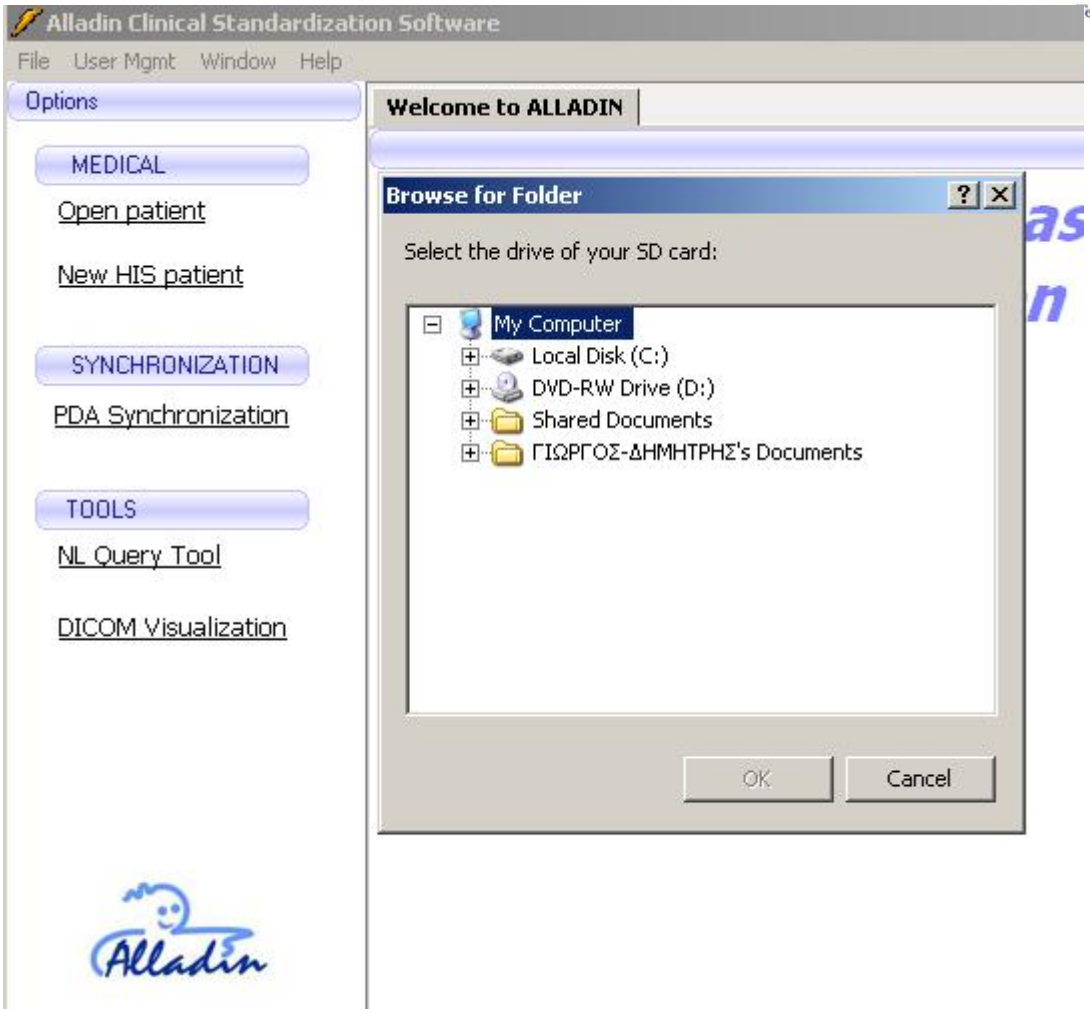


Figure 0-16 Selecting the drive of the SD card to synchronize the ACSS and the PDA.

The PTM module is easy to understand:

- On the one hand, you have audio recordings of speech, which were recorded per session / patient / physiotherapist. The audio quality of these recordings is immediately verified by the PDA software.
- On the other hand, you have the speech to text module embedded into the ACSS which:
  - Automatically import the audio recordings,
  - Performs speech recognition analysis and translates speech into text,
  - Let user manually validate the results,
  - Stores the verified results into the ACSS database.

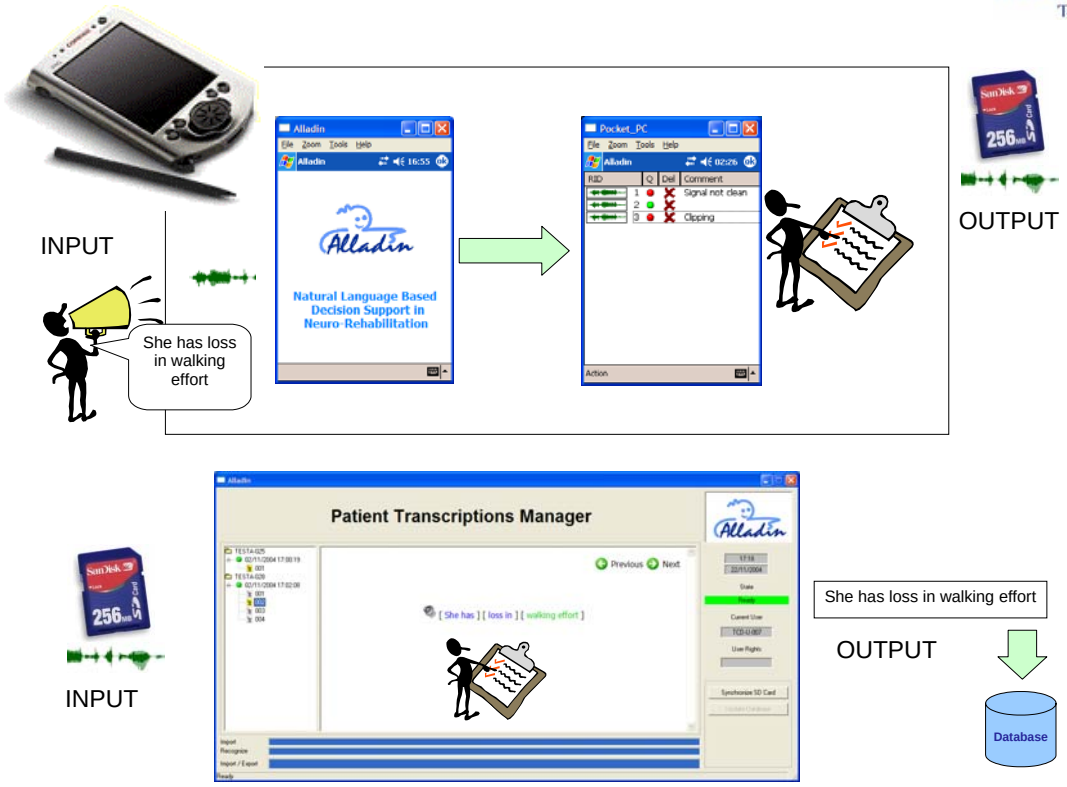


Figure 0-17 The PDA interface

The user interface helps to transcribe speech into text faster than having to type text on keyboard. When a physiotherapist is logged on the ACSS, he can use the PDA interface to:

- **Synchronize** the SD Card sessions with the ALLADIN database,
- **Check and validate** the audio recordings,
- **Update** the ACCS database with the verified transcriptions.

The PDA user interface helps physiotherapist to easily check and validate each recordings created on the PDA using a multimodal user interface. The therapist has access to the recordings he has created with the PDA Software, he can listen to these recordings and compare them with the text output of the speech recognition engine. When there is a mistake, he is able to correct the sentence and store the output in the database.

Typical use of the patient transcription manager

When using the patient transcription manager:

- Launch the patient transcriptions manager (PDA interface),

- Put the SD Card in the SD Card Reader of the PC,
- Push the Synchronize SD Card button to **create the patient files** on the PDA from the ACSS database,
- Remove the SD Card from the SD Card Reader of the PC and put it in the PDA slot above the device,
- Use the PDA Software to record diagnostics.

Once sessions are recorded:

- Launch the patient transcriptions manager.
- Put the SD Card in the SD Card Reader of the PC.
- Push the Synchronize SD Card button in order to:
    - **Update the database**,
    - **Create the patient files** on the PDA.

During the synchronization, the recognition engine will process all the recordings one by one in the background. The user can select the transcriptions in the left panel of the user interface and verify/validate them in parallel with the recognition process.

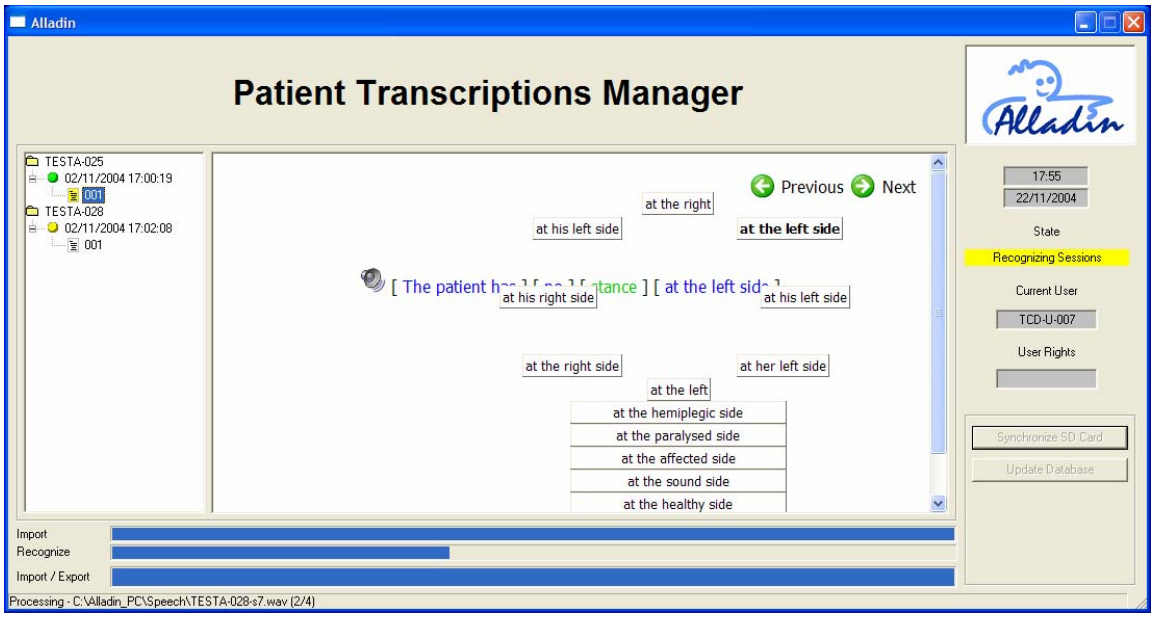


Figure 0-18 The Patient Transcriptions Manager interface

Figure 0-18 illustrates how a user can correct a sentence. Here, the user said “The patient has no stance at his left side”. The interface enables him to set “at his left side” instead of “at the left side”.

Although the meaning of the two sentences is the same, these audio recordings will be reused afterwards by the speaker adaptation module to improve gradually the recognition system during usage.

Several progress bars show the status of the global recognition/synchronization process:

- "Import" indicates the status of the synchronization of the current logged physiotherapist user.
- This progress bar indicates the status when copying files from SD Card to a local temporary working directory of the PC.
- "Recognize" gives the recognition engine status.
- This progress bar indicates the overall status of the recognition engine processing all the data imported. When it is complete, no more files have to be processed.
- "Import/Export" gives information regarding the SD Card readiness.
- This progress bar indicates the import status of all users who recorded sessions with the same SD Card. It shows also the status of the patient file creation. When this last progress bar is complete, the physiotherapist user can safely remove the SD Card from the SD Card Reader and use it with the PDA Software to record new diagnostics.

When the physiotherapist has verified the session, the selected icon's colour changes to notify him. In order to update the database, the user will have to verify all sentences of the session.

The following procedure can be followed to correct a sentence:

- Move the mouse pointer over the sound icon to listen to the diagnostic.
- If a word or group of word was not well recognized, move the mouse pointer over the faulty word or group of word (like described in the above figure) and select the right value.

When all progress bars are complete. The user can quit the application if he prefers to verify the sentences afterwards.

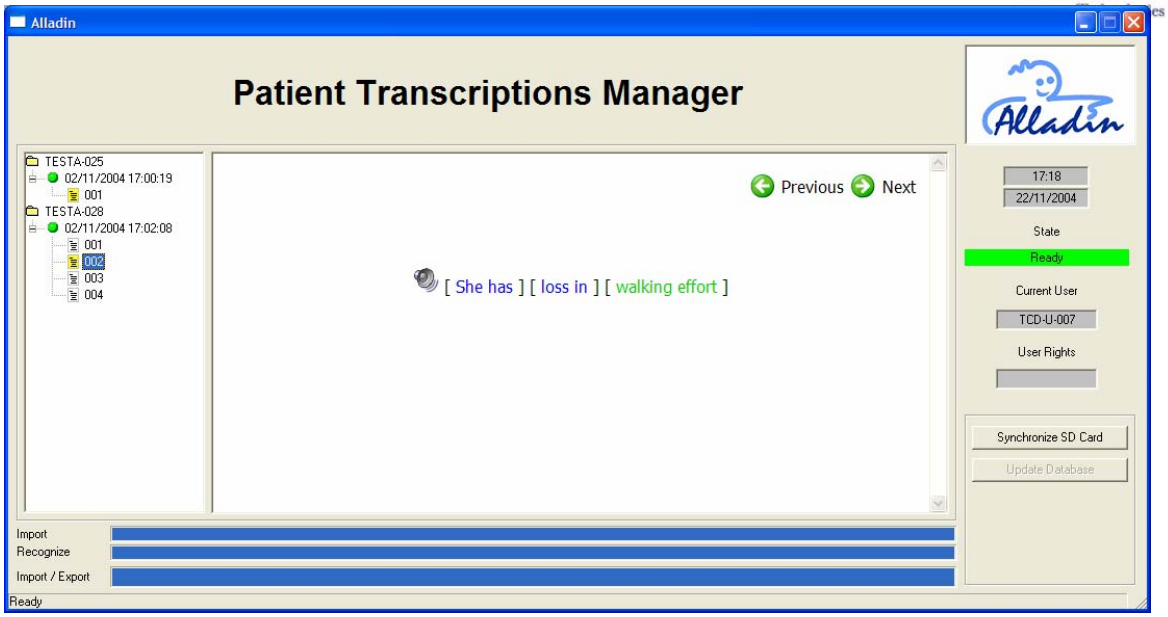


Figure 0-19 The Patient Transcriptions Manager interface

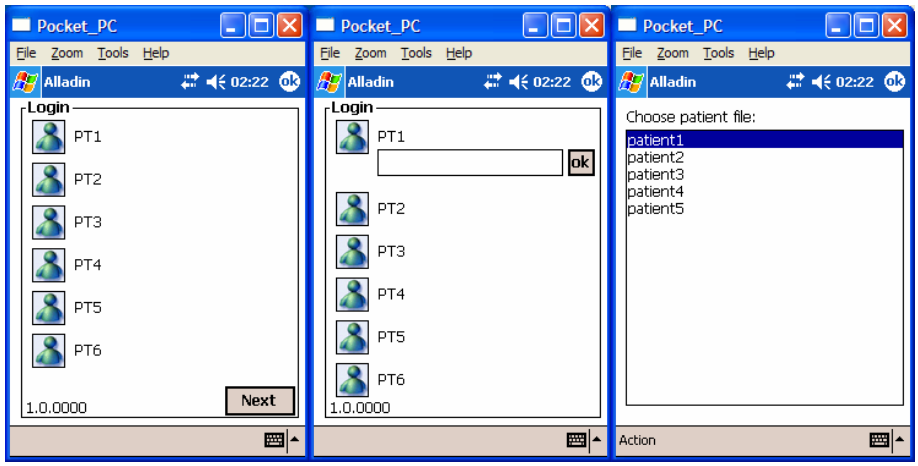
When he logs in the next time, all the sessions which were not verified remain listed in the sessions column.

The user can update the ACSS database by selecting a session, by clicking on the "Update Database" button. A popup message asks for confirmation. When the user has clicked YES, the database is updated and the session is removed from the GUI panel.

How to use the PDA software

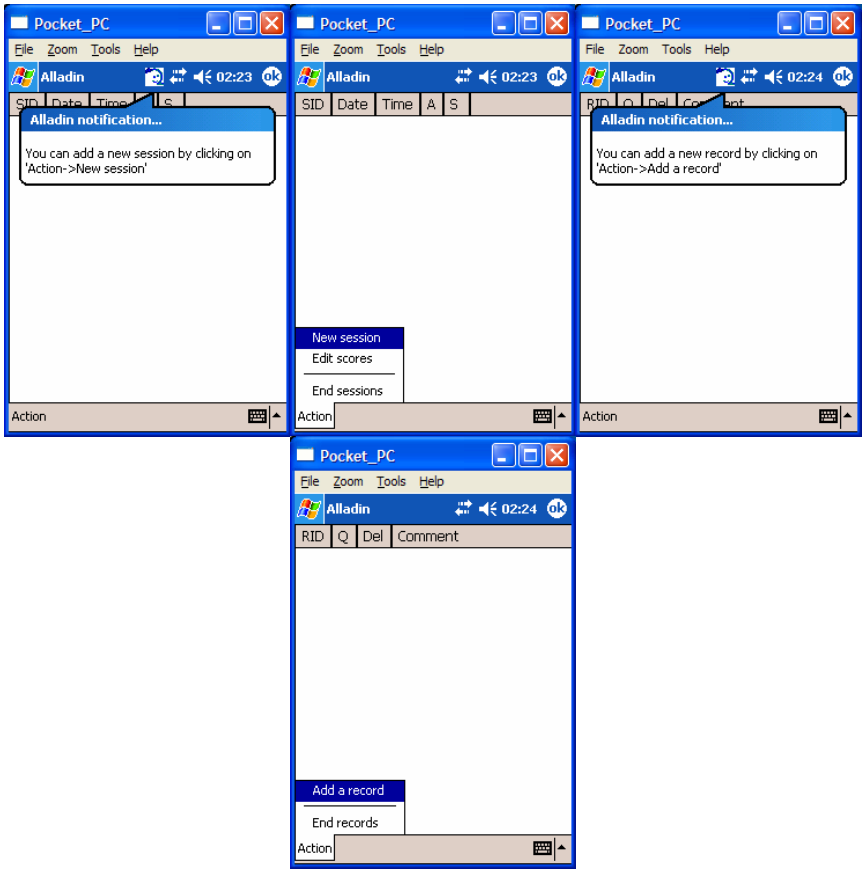
Now that we have installed the software and configured everything, we can launch the PDA Software.

If you well followed the above procedure, you should get the following 1st snapshot. Click on PT1 (for the moment, only PT1 was created for the demo), then OK (For the moment, you do not enter any password).

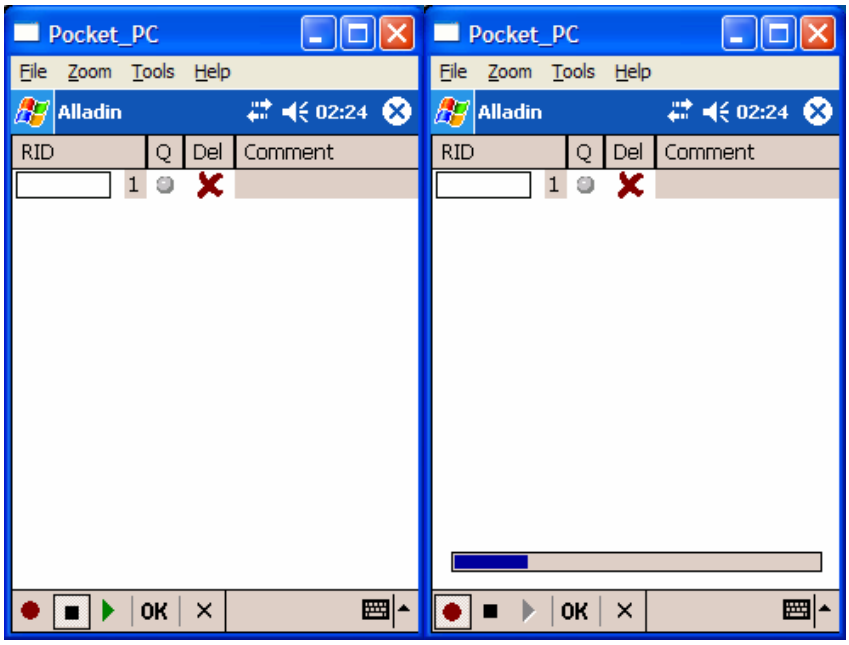


You can now select a patient file. To do so, either *DOUBLE CLICK* on it, or click on the *Action Menu->Edit Patient File.*

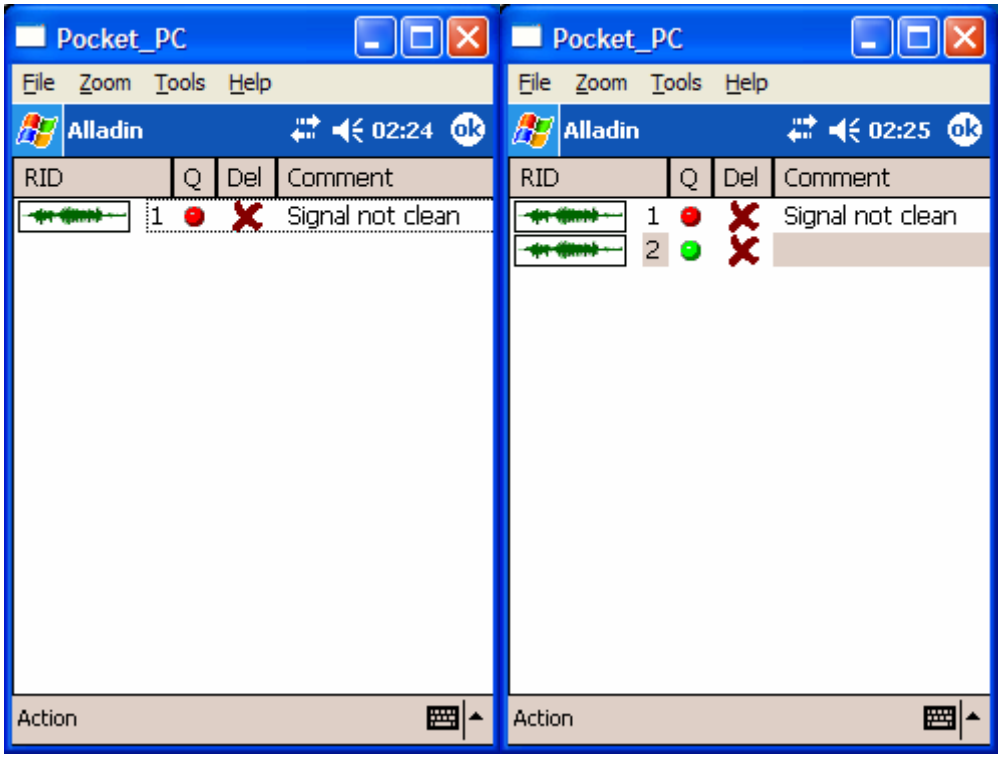
Once you get there, if no action is done during 5 seconds, a help popup appears to help you: it is ALLADIN ☺. To create a new session, you just have to click on Action Menu -> New Session. Then, click on Action Menu -> Add a record to add a patient record.



The following snapshot is showing the recording interface. To record something, just click on the record button. When finished, just click on *STOP*.



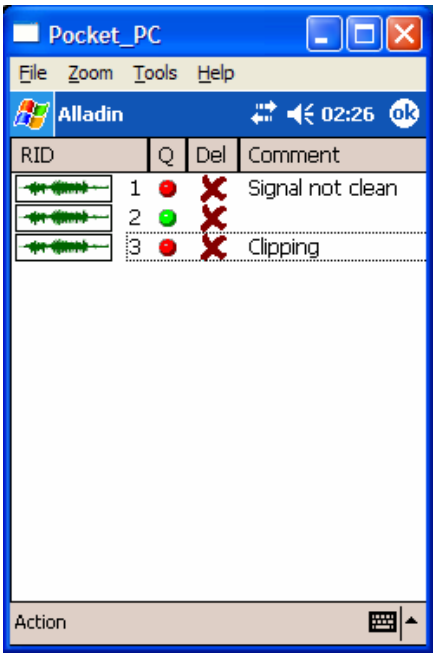
The end-user is informed about the quality of the signal on the right of the screen. If you did not say anything, you should get “Signal Not Clean” message and a red light is then shown. If you spoke well, you should get a green light. You need to press the OK button after the STOP button in order to validate the audio recording.



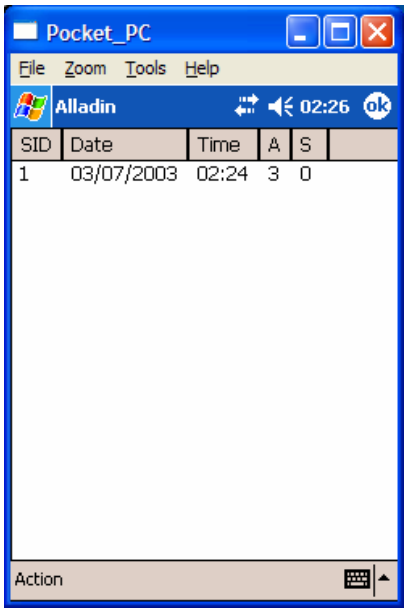
Some other error messages can appear during recordings such as “Clipping”, for instance. The following table summarizes these messages which may appear after a recording session.

Error Message	Meaning
Clipping	Talk less loudly. Avoid tapping on the PDA while talking
No signal	No signal captured on the microphone (not enough signal)
Signal not clean	Talk more loudly
Length not ok	There is not enough data to recognize.
No start Silence	You talked before starting the record: there is not enough silence in the beginning.
No end Silence	You stopped the recordings while talking: there is not enough silence in the end.

Table 1 Meaning of the error messages in the ALLADIN PDA Software

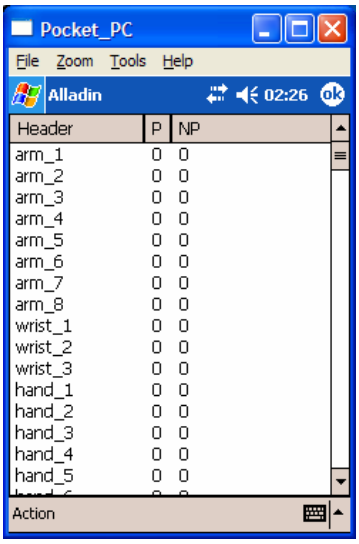


Once you have recorded everything, you can click on *OK* (or *Action->End Recordings)*, to go back to the session management. You can notice that there is now the date and time of the session. You are also informed about the number of audios present in this session.

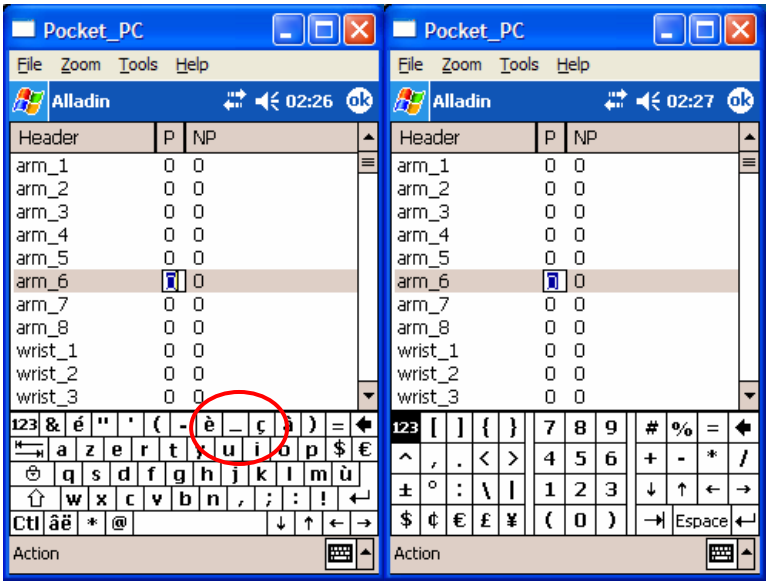


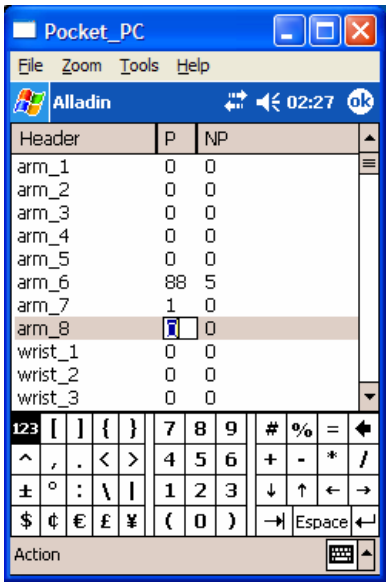
The physiotherapist can either *DOUBLE CLICK* on the session newly created or click *Action Menu -> Edit Scores* to have access to the score sheet. To edit this sheet, he has to click on the field of his interest. A popup keyboard will appear so that he can enter the values. The user can select the “numeric pad” mode at the upper left corner of the virtual keyboard in order to type digits faster. If he uses <ENTER> keystroke to validate the data, the next field will be automatically selected.

When the session exists, the therapist can enter score sheet information (Fugl-Meyer, MAS, ICD)..

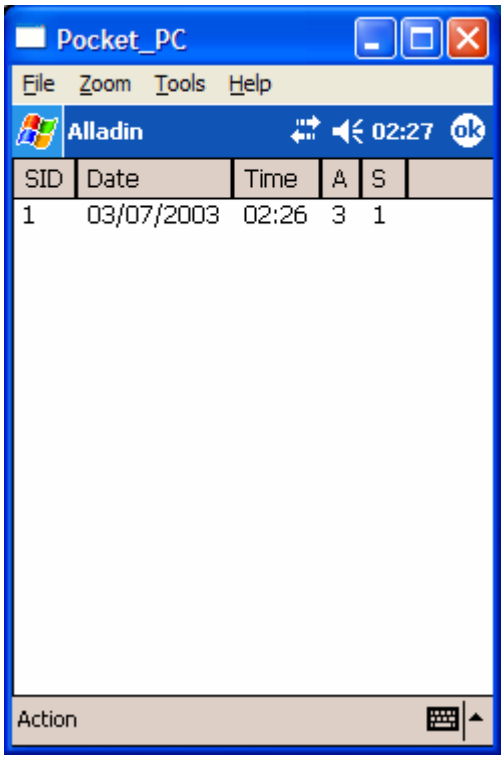


To edit this sheet, just click on the field of your interest. A popup keyboard will appear so that you can enter the values expected. As pointed out on this snapshots, you can select the “numeric pad” mode at the upper left corner of the virtual keyboard in order to type digits faster. Use <ENTER> keystroke to validate the data a step automatically to the next one.





Once you have finished and clicked on OK, you are informed that the score sheet has been modified (1 means modified).



After closing the session, all information is stored into a XML file which is ready to be synchronized using the PDA interface on PC.

The grammatical structure

As mentioned before, the physiotherapist will record the clinical phenomena using a natural language description. The descriptions were manually selected from the physiotherapist literature and organized in a fixed grammatical structure so that these descriptions are well suited for speech recognition. Indeed, the speech recognition problem consist in mapping the acoustic speech signal onto a sequence of words.

Here is an example of 5 sentences that a physiotherapist can say:

- She has impairing hypertony when I fastly move her right upper limb
- She has disabling hypertony when she moves her left elbow
- The patient has severe hypertonicity when he moves his right toes
- He has perturbing hypertony at the affected side
- He has a lot of spasticity in the affected biceps

The grammatical structure was chosen as follows:

[Subject][Qualifier 1][Qualifier 2][Root][Circumstance][Person][Action][Side][Body location]

Some category are optional, some are mandatory. As example, we will map this structure on the 5 sentences above.

- [She has][impairing][hypertony][when][I][fastly move][his right][upper limb]
- [She has][disabling][hypertony][when][she][moves][her left][elbow]
- [The patient has][severe][hypertonicity][when][he][moves][his right][toes]
- [He has][perturbing][hypertony][at the affected side]
- [He has][a lot of][spasticity][in the affected][biceps]

Thus, you can remark that the naturalness of speech input depends on the grammar format. Here a great effort was performed to carefully build the sentences.

Option - Tool

The option Tool has the following functionalities:

- NL query tool – Query the NL description of the patients and session
- DICOM visualization – Display medical image that conforms to DICOM standard

NL query tool

The NL query tool allows queries of the NL description based on concepts of the ALLADIN ontology. The start window of the tool is shown in Figure 0-20.

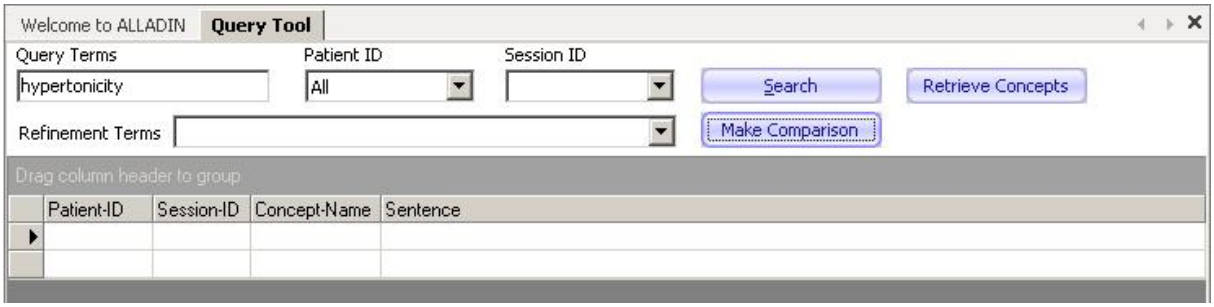


Figure 0-20 Starting window of the NL query tool.

The tool has the following functionalities:

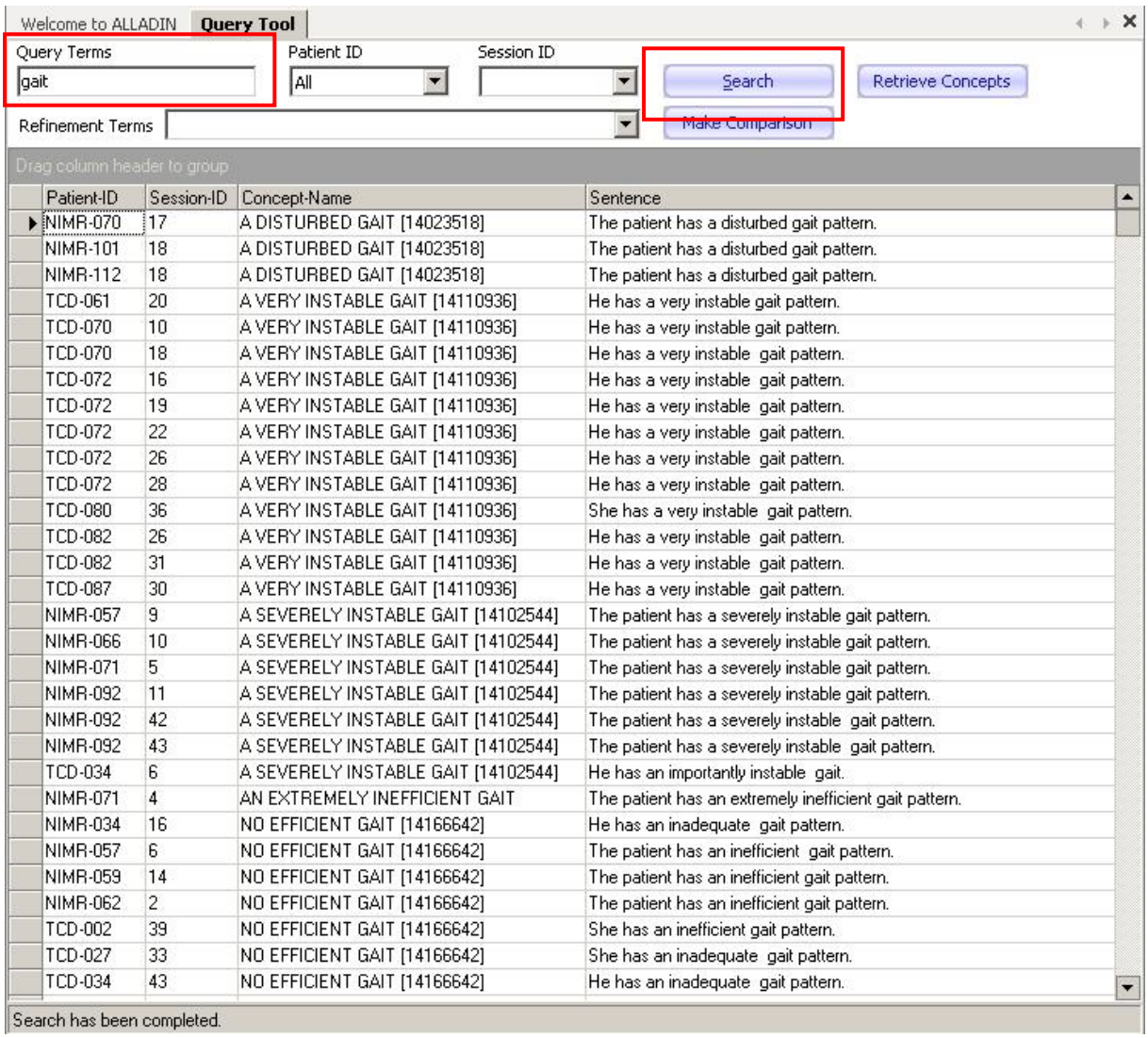
Query – Insert concept in 'Query Terms' field and press the button 'Search' to execute the query, see Figure 0-21. A query always has to contain a so-called root: basically this is a pathologic entity (e.g., hypertonicity, sensory loss,…). Possible queries therefore are:

- mild sensory loss
- sensory loss arm
- balance problems when walking
- mildly limited in the forearm
- active flexion
- mild pain at the left side

- a normal passive range of motion
- disabling spasticity in the left elbow

A list of root concepts can be found in Annex 1.

The time to execute the query depends on the number of sessions and length of descriptions (appr. two minutes for querying 200 sessions with 20 sentences in each description). The size of the cells can be re-sized similarly to MS Excel by dragging the edges of the column or row.



Patient-ID	Session-ID	Concept-Name	Sentence
NIMR-070	17	A DISTURBED GAIT [14023518]	The patient has a disturbed gait pattern.
NIMR-101	18	A DISTURBED GAIT [14023518]	The patient has a disturbed gait pattern.
NIMR-112	18	A DISTURBED GAIT [14023518]	The patient has a disturbed gait pattern.
TCD-061	20	A VERY INSTABLE GAIT [14110936]	He has a very instable gait pattern.
TCD-070	10	A VERY INSTABLE GAIT [14110936]	He has a very instable gait pattern.
TCD-070	18	A VERY INSTABLE GAIT [14110936]	He has a very instable gait pattern.
TCD-072	16	A VERY INSTABLE GAIT [14110936]	He has a very instable gait pattern.
TCD-072	19	A VERY INSTABLE GAIT [14110936]	He has a very instable gait pattern.
TCD-072	22	A VERY INSTABLE GAIT [14110936]	He has a very instable gait pattern.
TCD-072	26	A VERY INSTABLE GAIT [14110936]	He has a very instable gait pattern.
TCD-072	28	A VERY INSTABLE GAIT [14110936]	He has a very instable gait pattern.
TCD-080	36	A VERY INSTABLE GAIT [14110936]	She has a very instable gait pattern.
TCD-082	26	A VERY INSTABLE GAIT [14110936]	He has a very instable gait pattern.
TCD-082	31	A VERY INSTABLE GAIT [14110936]	He has a very instable gait pattern.
TCD-087	30	A VERY INSTABLE GAIT [14110936]	He has a very instable gait pattern.
NIMR-057	9	A SEVERELY INSTABLE GAIT [14102544]	The patient has a severely instable gait pattern.
NIMR-066	10	A SEVERELY INSTABLE GAIT [14102544]	The patient has a severely instable gait pattern.
NIMR-071	5	A SEVERELY INSTABLE GAIT [14102544]	The patient has a severely instable gait pattern.
NIMR-092	11	A SEVERELY INSTABLE GAIT [14102544]	The patient has a severely instable gait pattern.
NIMR-092	42	A SEVERELY INSTABLE GAIT [14102544]	The patient has a severely instable gait pattern.
NIMR-092	43	A SEVERELY INSTABLE GAIT [14102544]	The patient has a severely instable gait pattern.
TCD-034	6	A SEVERELY INSTABLE GAIT [14102544]	He has an importantly instable gait.
NIMR-071	4	AN EXTREMELY INEFFICIENT GAIT	The patient has an extremely inefficient gait pattern.
NIMR-034	16	NO EFFICIENT GAIT [14166642]	He has an inadequate gait pattern.
NIMR-057	6	NO EFFICIENT GAIT [14166642]	The patient has an inefficient gait pattern.
NIMR-059	14	NO EFFICIENT GAIT [14166642]	The patient has an inefficient gait pattern.
NIMR-062	2	NO EFFICIENT GAIT [14166642]	The patient has an inefficient gait pattern.
TCD-002	39	NO EFFICIENT GAIT [14166642]	She has an inefficient gait pattern.
TCD-027	33	NO EFFICIENT GAIT [14166642]	She has an inadequate gait pattern.
TCD-034	43	NO EFFICIENT GAIT [14166642]	He has an inadequate gait pattern.

Figure 0-21 Query results using the concept gait.

Refined query **NOT FUNCTIONAL** – after the first concept query a second refined query can be made by selecting a refinement term from a list of related concepts, see Figure 0-22.

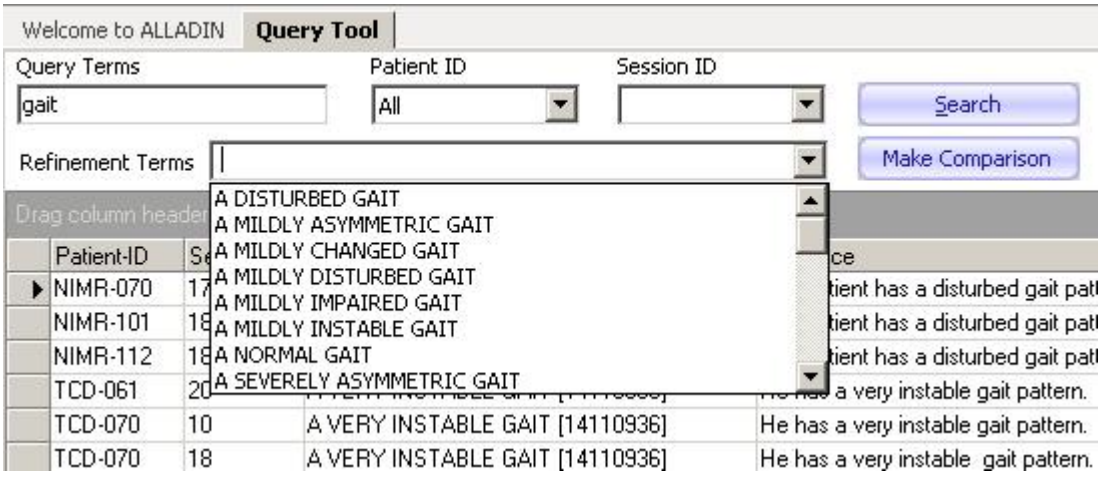


Figure 0-22 Refined query.

Filtered query – Select a patient from the Patient ID and/or a session from the Session ID drop-down list before pressing the button 'Search' to execute a filtered query.

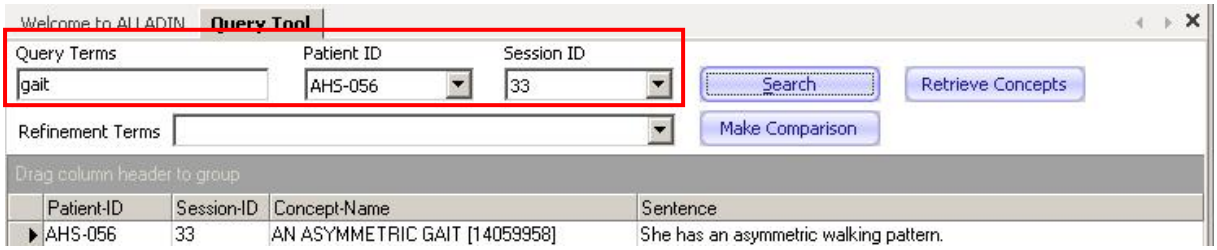


Figure 0-23 Filtered query.

Sort results – The results can be sorted by dragging the column header to the grey area labelled 'Drag column header to group', see Figure 0-24.

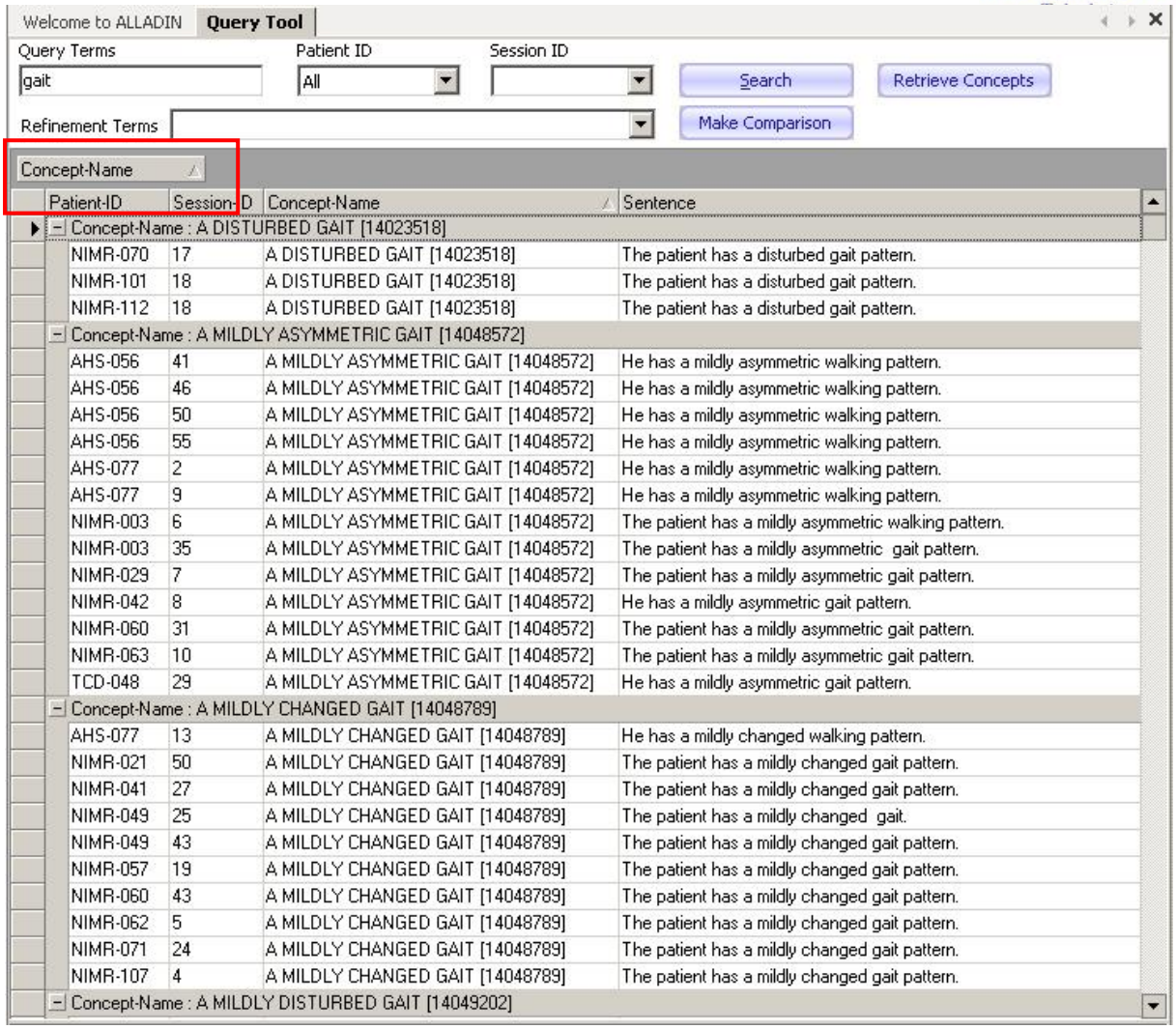


Figure 0-24 Sorted results.

Two simultaneous queries – Click the button ‘Make Comparison two split the window in two query areas, see Figure 0-25 and Figure 0-26.

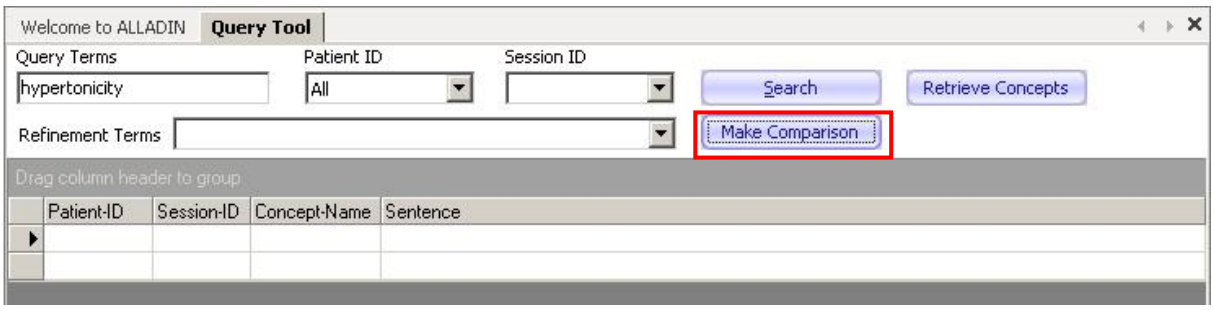


Figure 0-25 Query of two different concepts.

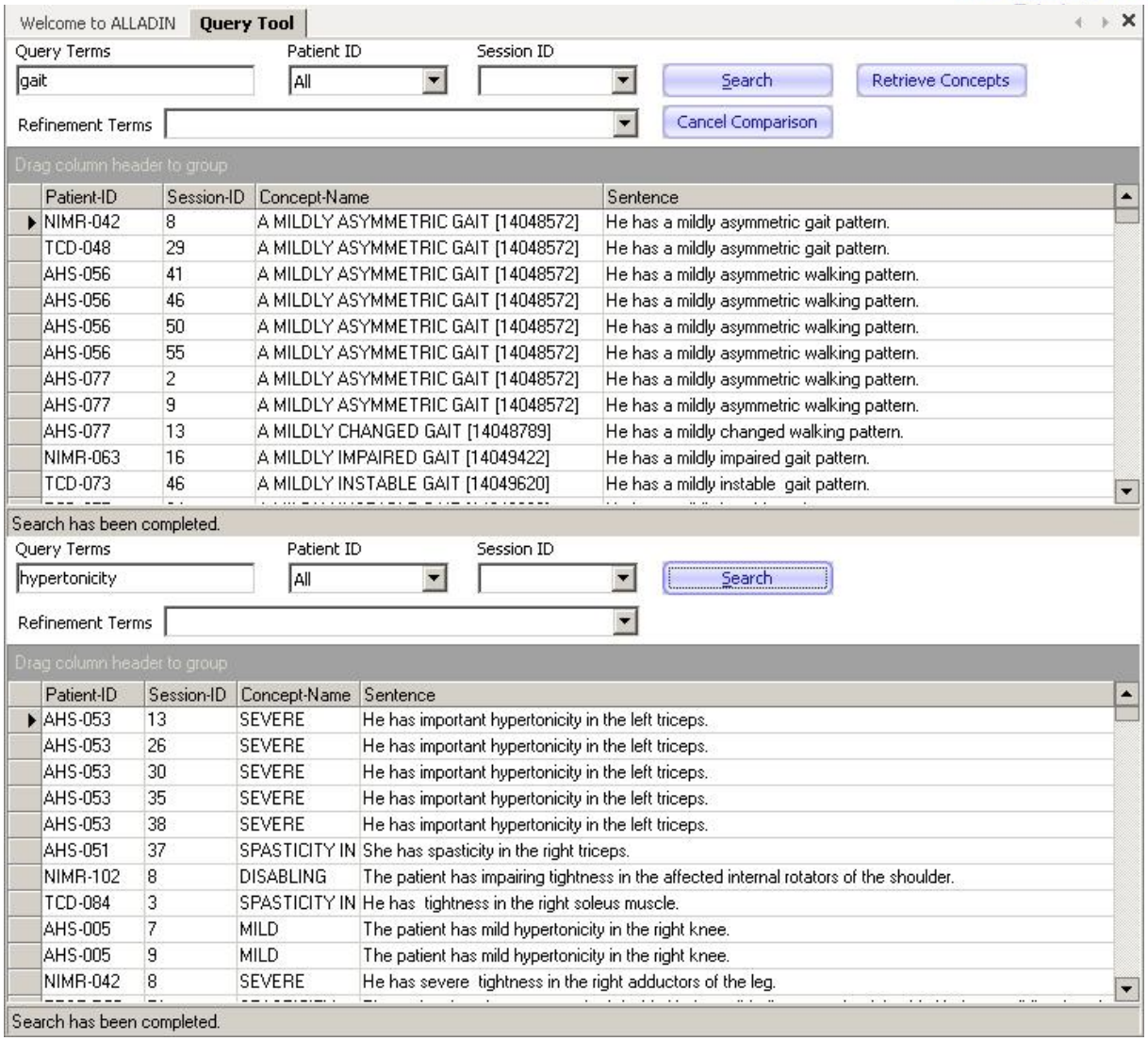


Figure 0-26 Query results of two different concepts.

Retrieve concepts – Click the button 'Retrieve Concepts' to update the database with the concepts for a new NL description of a patient. The time to update the database depends on the number of existing sessions and length of descriptions (appr. 30 minutes for updating 200 sessions with 20 sentences in each description).

DICOM visualization

The DICOM (Digital Imaging and Communications in Medicine) tool is used for the viewing of medical images. To setup the connection to a PACS server click the button 'Settings' and insert the IP of the server and the port. Click 'Test Connection' to verify the established connection and 'Save Connection' to save the settings, see Figure 0-27.

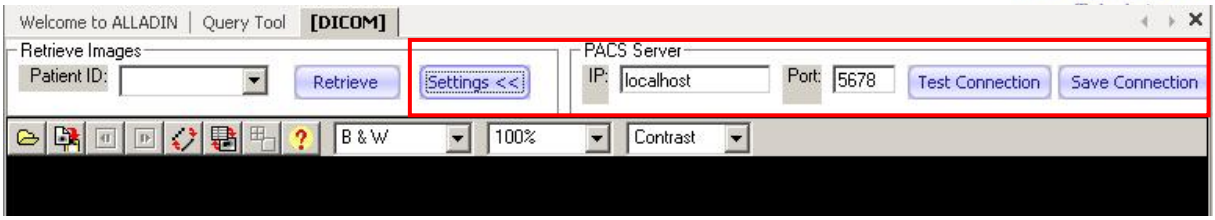


Figure 0-27 Set up of connection between ACSS and PACS server.

To view medical image insert the patient ID or select the patient from the list and click the button 'Retrieve', Figure 0-28.

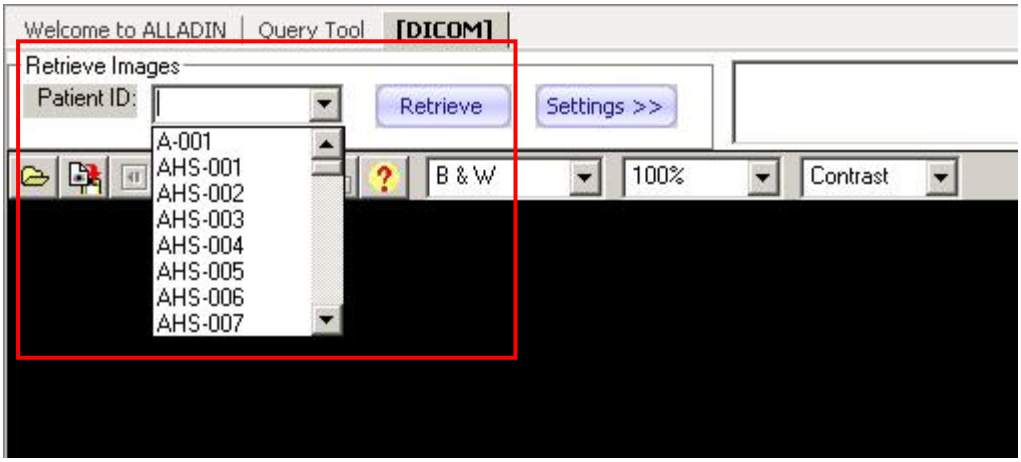


Figure 0-28 Display patient images.

Menu bar

The menu bar consists of the following menus:

File – Patient selection and exit

User Mgmt – View, edit, new user

Window – Switch between open options

Help - **EMPTY**

File Menu

In addition to exit the ACSS, the file menu has the functionalities as the Option Medical

- Open patient – Opens the patient record for patients existing in the ACSS database
- New HIS patients – Imports patient data from the HIS to create a patient record in the ACSS database

Figure 0-29 File menu.

User Management Menu

The User Management Menu provides the functionalities for viewing current user (Figure 0-31); create a new user (Figure 0-32); and editing an existing user (Figure 0-33).

Each User Profile included the following details:

- User ID: uniquely identifies the user through a unique user ID. The user must insert at User ID when a new user profile is created.
- Name: name of the user.
- Password: password the user must insert at login together with the name.
- Group: Natural language PT, Principal Investigator, and Administrator. Each user must be assigned by the System Administrator to one group among the previous ones.
- Language model: can be chosen between British English (ENUK) and American English (ENUS). It is used by the speech recognition software.

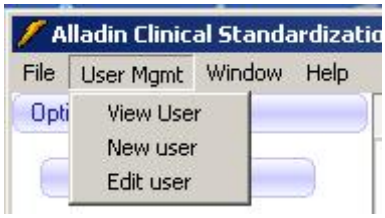


Figure 0-30 User Management menu.

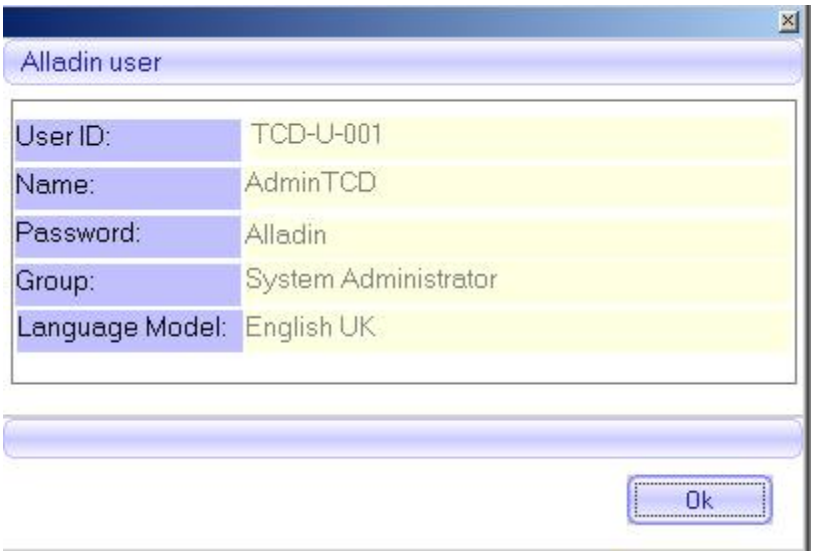


Figure 0-31 View current user.

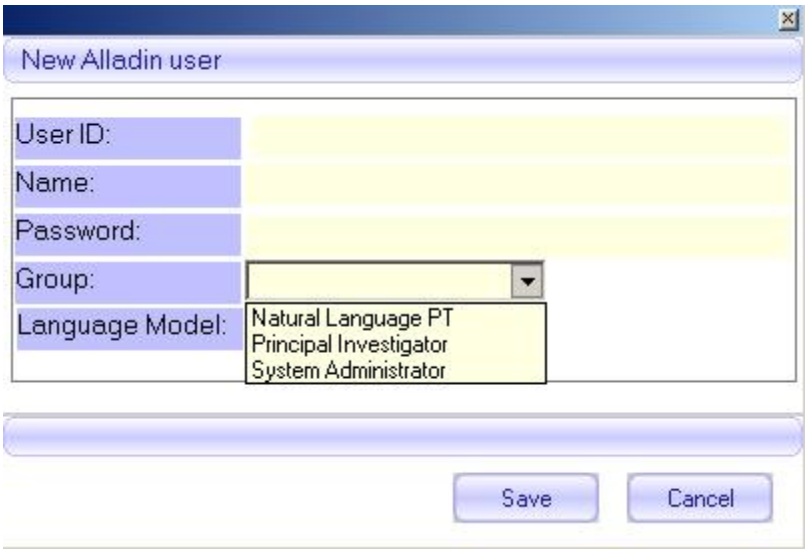


Figure 0-32 Create new user.

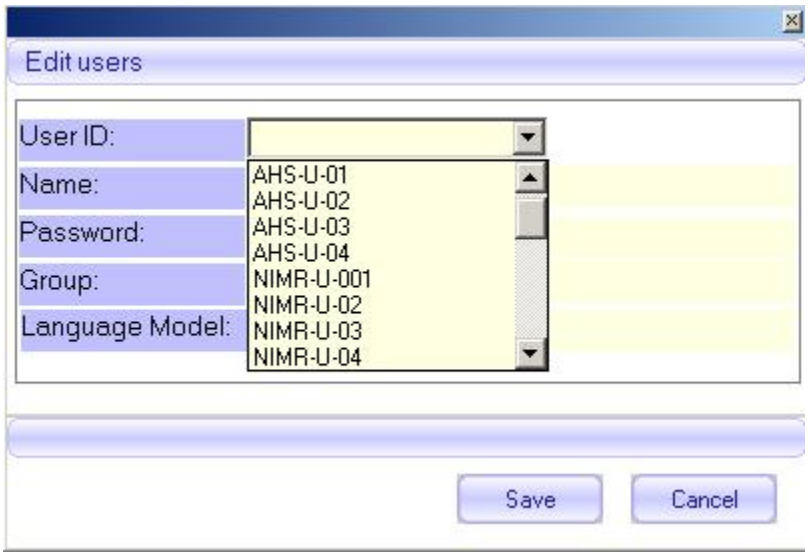


Figure 0-33 Edit user.

Window Menu

The window menu allows for switching between open options in the display area, see Figure 0-34.

Figure 0-34 Window menu.

ANNEX 1

ABDUCTION
ACHILLES REFLEXES
ADDUCTION
APRAXIA
ATAXIA
ATROPHY
BABINSKY REFLEXES
BALANCE
BALANCE PROBLEMS
BASE OF SUPPORT
CIRCUMDUCTION
CLONUS
COLD SENSATION
CONSCIOUSNESS
CONTRACTION
CONTROL OF FREE ABDUCTION
CONTROL OF FREE ADDUCTION
CONTROL OF FREE EXTENSION
CONTROL OF FREE FLEXION
CONTROL OF FREE ROTATION
CUTANEOUS SENSATION
CYLINDRICAL GRASP
DEPRESSION
DRESSING APRAXIA
DYSARTHRIA
ELEVATION
EVERSION
EXTENSION
FEAR OF FALLING
FINE CONTROL
FLEXION
FLEXION CONTRACTURE
GAIT
GAIT SPEED
GRASPING FUNCTION
GRIP STRENGTH
GROSS CONTROL
GROSS MOVEMENTS

HEEL STRIKE
HEMIANOPIA
HEMINEGLECT
HEMISENSORY DEFICIT
HOT SENSATION
HOT/COLD SENSATION
HYPERREFLEXIA
HYPOREFLEXIA
HYPOTONY
INVERSION
JOINT RATE
LOSS OF BALANCE
MEMORY IMPAIRMENT
MOBILITY
MOVEMENT SENSE
MUSCLE JOINT SENSE
MUSCLE TONE
NEGLECT
OEDEMA
PAIN
PALMAR REFLEXES
PATELLA REFLEXES
POSTURAL REACTION
PRONATION IN THE FOREARM
PRONATION IN THE WRIST
PROPRIOCEPTIVE SENSE
RANGE OF MOTION
REFLEXES
REST TREMOR
RIGHTING REACTIONS
ROMBERG TEST
ROTATION
SCAPULOHUMERAL RHYTHM
SENSATION
SENSE OF MUSCULAR POSITION
SENSE OF TOUCH
SENSORY DISCRIMINATION
SENSORY DISTURBANCE
SENSORY LOSS
SITTING BALANCE

SPASM
SPASTICITY
SPATIAL HEMIANOPIA
SPEECH IMPAIRMENT
STANDING BALANCE
STEREOGNOSIS
STIFFNESS
STRENGTH
STRIDE LENGTH
STROKE
SUBLUXATION OF THE SHOULDER JOINT
SUPERFICIAL SENSATION
SUPINATION
SURFACE SENSATION
SYNERGY
TACTILE IMPAIRMENTS
TEMPERATURE SENSATION
THE POSSIBILITY TO
THE PUSHER SYNDROME
TO CREATE
TO INITIATE
TO RESIST
TO START
TOE OFF
TREMOR
TRENDELENBURG
UNILATERAL VISUAL INATTENTION
WALKING DEFICITS
WARM SENSATION
WEIGHT BEARING

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