BD2Decide

Big Data and models for personalized Head and Neck Cancer Decision support

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0.3	19.12.2016	A. Fioravanti L. Hernández, L Lopez, G. Fico M. T. Arredondo	Draft mock-up visualisations of the Visual Analytics Tool
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1.0	04.01.2017	V. Tountopoulos	Final version
1.1	07.01.2017	E. Martinelli	Final revised version by coordinator

Addressees of this document

This document is addressed to the BD2Decide Consortium and accompanies Deliverable D5.2, which is a demonstrator. The main part of deliverable is a set of screens for the BD2Decide tools comprising the platform environment for supporting clinicians in making decisions across the head and neck cancer treatment process and researchers in accessing big datasets of clinical and population data. This document supports the presentation of the screens embodying the mock-up version of the visualisation concepts for the BD2Decide environment. As such, the document links this deliverable with the previous project deliverables, towards the implementation of a user centric design approach.

To this end, the main result of this deliverable is a set of mock-up screens, which conceptualise the expected visualisation components of the BD2Decide platform. These screens integrate the design considerations of the technical partners with the perceived outcome of the project, as this is reflected from the clinical partners.

The deliverable is an official result of the project and it will be delivered to the European Commission through this document.

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Abbreviations and definitions

CDSS	Clinical Decision Support System
DPEE	Digital Patient Exploration Environment
e-CRF	Electronic Clinical Record Format
HN	Head and Neck
HNC	Head and Neck Cancer
ICT	Information and Communication Technologies
IPDA	Interactive Patient Decision Aid
PDS	Patient Documentation System
QoL	Quality of Life
TBCE	Tumor Board Collaboration Environment
UCD	User Centric Design
UI	User Interface(s)
VAT	Visual Analytics Tool

Abstract

The engagement of the end users in the development of the BD2Decide platform is a principal direction of the software implementation tasks in the project. The perception of the platform stakeholders on which functionalities will be presented in the platform user interfaces and how they will be able to interact with them is critical, since it offers guidance on the way that development will achieve to align with existing business practices in the clinical domain and modernise the way that clinicians and other health professionals follow their patients' progress within the head and neck cancer treatment process.

The user centric design approach that was defined in the BD2Decide Deliverable D2.2 is being implemented in this deliverable. Starting from the user interaction design sketches, we present the mock-up implementation of the various screens that the BD2Decide stakeholders will eventually browse to consume those functionalities that the project introduces towards assisting them in providing assessments and making decisions for their patients' treatment.

In this sense, the deliverable focuses on the Clinical Decision Support System and elaborates on the visualisation concepts, which implement the requirements of the health professionals for supporting the decision making tasks in the head and neck cancer treatment process, enabling them to collaborate in the form of tumor board meetings and assessing the quality of life of their patients. It, also, emphasises on the clinical research tasks that the respective researchers are performing in their everyday exercises and practices and presents the visualisation concepts for the Visual Analytics Tool. The latter implement the requirements of this group of BD2Decide stakeholders for browsing and visualising big datasets aggregating clinical and population data.

1 ABOUT THIS DOCUMENT

1.1 Introduction and scope

This document is the second deliverable of WP5 and aims to present a first approach for the conceptual visualisation of the BD2Decide platform prototype. The deliverable builds on top of the work in the user interaction design in task 2.2 and implements the last steps of the usability design phase in user centric design process that the project follows in order to develop the BD2Decide components.

In order to ensure that the development of the clinical decision support processes and the researchers' tasks are in line with the expectations of the target BD2Decide end users, in this document, we elaborate on the mock-ups, which implement a conceptual visualisation flow of the project outcome. The result of this process should be a set of screens that implement the initial sketches of the user interaction design, presented in task 2.2 and exhibit a conceptual representation of the main tasks that the end users will execute through the use of the Clinical Decision Support System and the Visual Analytics Tool.

1.2 Structure of the deliverable

Following the objectives set for this deliverable, the document is structured as follows:

- Section 2 makes an overview of the BD2Decide platform, the target end user roles and how the contents of this deliverable relate to the wider concept of the project and the BD2Decide architecture.
- Section 3 elaborates on the conceptual visualisations for the Clinical Decision Support System. It defines the interactions for exploring data from patients involved in both retrospective and prospective studies, supporting health professionals in assessing their patients' status along the treatment process and making prognosis for their survival rate, according to different prediction models. It, also, presents the conceptualisation of the front end functionalities for facilitating the clinicians' collaboration in the context of organising tumor board meetings.
- Section 4 analyses the visualisation concepts for the screens that are being developed for the Visual Analytics Tool. Specifically, the section emphasises on the actions that the researchers will be able to perform for managing their research projects, analysing big datasets of clinical and population data and searching for Internet sources that accompany their main research tasks.
- Finally, Section 5 provides concluding remarks for the work presented in this deliverable and how this work relates to future activities in WP5 and the project as a whole.

2 USABILITY IN MOCK-UP DEVELOPMENT

Following the introduction of the BD2Decide User Centric Design process that we presented in the BD2Decide Deliverable D2.2, in this section, we focus on the implementation of the usability design concepts in the mock-up version of the BD2Decide visualisations. Specifically, this section makes an overview of the BD2Decide platform and how this relates to the scope and the contents of this deliverable. It, then, presents the roles of the end users in the clinical domain, with particular tasks in the interaction with the platform user interfaces. Finally, this section summarises the objectives and the drivers for the development of the conceptual visualisations for the relevant BD2Decide tools, which are analysed in the next sections of this document.

2.1 Overview of the BD2Decide platform

As reported in Deliverable D2.2, the BD2Decide platform integrates various components, which are brought together to facilitate functionalities for the clinicians, the physicians, and other doctor specialties. The primary scope of the platform is to provide these stakeholders with the means to come up with informed decisions along the three phases of the Head and Neck Cancer (HNC) treatment process: i.e. diagnosis, treatment, post-treatment / follow-up. In order to achieve this goal, the platform implements functionalities for the management of the patients' data record, as this has been defined in the BD2Decide project.

More specifically, the BD2Decide platform integrates multisource data, which can be either provided by the hospital information systems (HIS) or they are derivatives of the analysis performed in the BD2Decide big data infrastructure and the processes to be supported within the BD2Decide environment. Depending on the data that the platform needs to process, the input method and the supporting technology may vary, as it will be explained later. In D2.2, we named the data being collected from the HIS as the electronic health record. In this Deliverable, in order to avoid any terminology conflicts and be specific on the type of data that the BD2Decide platform handles, we will follow the term, BD2Decide patients electronic Clinical Record Format (or e-CRF for short).

An overview of the BD2Decide platform is presented in Figure 1. As shown there, the core of the BD2Decide platform is the Clinical Decision Support System (CDSS). This tool implements the BD2Decide workflow for managing the collection, processing, storage and visualization of the patients' data and their assessment. Around CDSS, we build various components and tools, which offer additional functionalities and enable the integration of individual services and components, such as the prediction analysis and prognosis of the life expectancy rate for a patient.

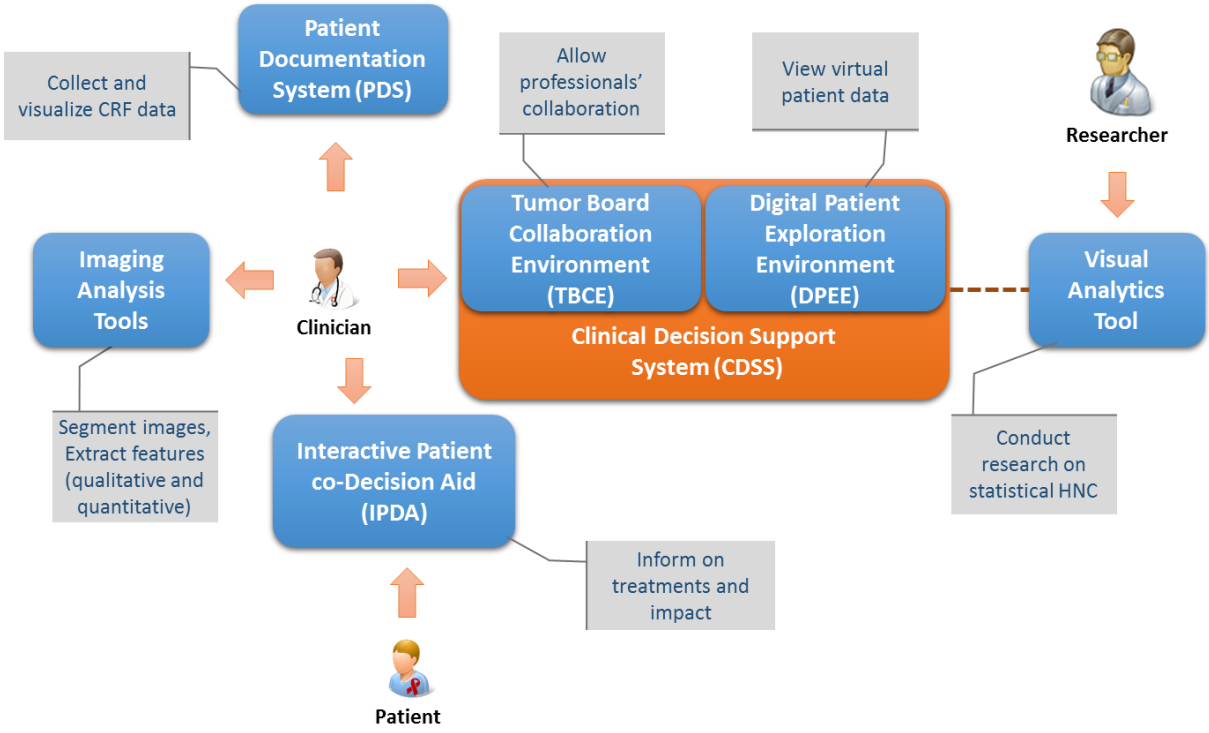


Figure 1: The BD2Decide platform overview.

The CDSS consists of the following main components:

- The Patient Documentation System (PDS) is responsible for maintaining the records of the patients' data. This tool implements the functionalities for importing patients' data into the Integrated Patients' Records Repository (IPRR) and retrieving them to visualise either the complete eCRF record as row information, through the PDS User Interface (UI), or feed the other tools of the BD2Decide platform.
- The Digital Patient Exploration Environment (DPEE) provides an enhanced view of the patients' profile, as it is defined in the BD2Decide project. The tool implements the digital patient concept to provide focused analysis and presentation of the patient's information and assist clinicians in a better interpretation of the patient's status, through connections to the results of the predictive models, the patient's prognostic factors and the radiomic and genomic features. The DPEE is essentially a presentation layer tool, which visualises the patient personalised risk scoring, the comparison of the patient's prognosis to similar cases and through different prediction models and the assessment of qualitative factors, such as the collective responses and relevant scores from the Quality of Life questionnaires.
- The Tumor Board Collaboration Environment (TBCE) facilitates the diagnosis phases of the HNC treatment process and allows clinicians to collaborate with each other in the context of the tumor board organization.

Based on the implementation plan of the BD2Decide project and the results of Deliverable D7.1, the CDSS tool hosts patients' data from retrospective and prospective studies. The input method of

this data varies, according to the study under examination and the type of data, since CDSS does not collect and maintain any imaging and radiomic and genomic features data, which are stored directly into the big data infrastructure of the BD2Decide platform.

Along the CDSS, the BD2Decide environment offers the patients an enhanced experience for making them aware of the implications of their HNC case to their health and analysing the effects from the adoption of a specific treatment in their life. Through the Interactive Patients co-Decision Aid (IPDA) tool, physicians and patients can be guided in making informed decisions on which is the treatment that best suits to a diagnosed HNC case. The implementation of IPDA is part of Deliverable D5.4, which is due M18 (June 2017) and, thus, it is left out of this deliverable.

Finally, the BD2Decide platform offers a dedicated tool for the clinical researchers to harvest the collective knowledge from different clinical centres and enhance their accessibility to valuable information sources, required for the assessment of HNC cases. In that respect, the Visual Analytics Tool provides the environment to perform complex data queries on multiple datasets and assist researchers in exploring the disperse and unstructured (even hidden in some cases) knowledge extracted from both patients and population data, as well as past studies and research activities.

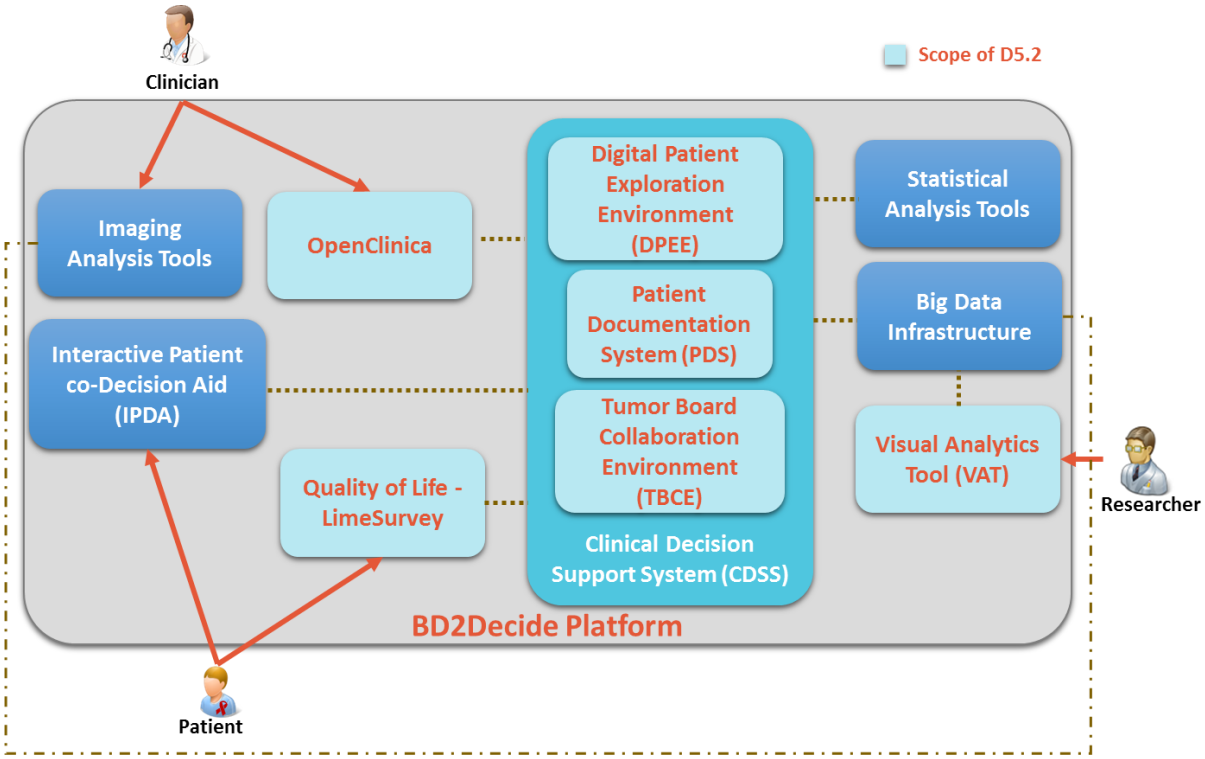


Figure 2: The User Interface components of the BD2Decide platform environment.

Figure 2 summarises the components of the BD2Decide environment, which expose a user interface for the end user stakeholders of the platform environment. In this figure, we have highlighted the user interfaces that are examined in this Deliverable D5.2, through the relevant visualisation mock-ups presented in the following sections.

2.2 Target roles of the platform and processes to address

The BD2Decide platform targets health professionals, being physicians in an HNC case or undertaking a specific role in the HNC treatment process, like a surgeon, a medical oncologist, pathologist, a radiologist or a radiation oncologist. These end users, being the BD2Decide clinicians, constitute the primary target user group of the BD2Decide platform and they access the platform to perform the following functionalities:

- Manage the information to the BD2Decide platform, through the PDS and the CDSS;
- Browse anonymised data for the clinical status of their patients;
- Get assistance for making informed decisions on the selection of the appropriate treatment for a specific patient;
- Request the patient life expectancy rate, according to different prediction models;
- Enhance prognosis by selecting to integrate big data from public sources in the prediction analysis;
- Aggregate views for making assessments on the patient status and disease evolution, compared to similar cases;

Along with the Health Professionals, the BD2Decide platform is used by clinical researchers. This group of stakeholders can access any clinical data stored into the CDSS for research purposes only and combine them with population data, which are collected from Internet sources. Through the Visual Analytics Tool, the clinical researchers can:

- Build synthesised queries on big data, combining clinical information, statistical and studies from public libraries and the Internet.
- Explore different visualisations on multisource complex data structures.

The platform also supports the personalization of the IPDA tool to enhance the informed co-decision making process on the appropriate treatment between the physicians and their patients. However, this functionality is not part of this Deliverable.

2.3 High level conceptual architecture design

In this section, we present the interaction of the target users with the BD2Decide tools from a conceptual perspective. For each interaction, we identify the main function that connects a user with the related tool. The detailed analysis of the BD2Decide architecture is presented in Deliverable D2.3, which is due M12 (December 2016).

The CDSS tool is exploited by the clinicians and other health professionals to support in making decisions across the HNC treatment process. The objectives of the BD2Decide project for the conduction of clinical studies, based on big datasets of population data and past patient HNC data, require the collection of patient data from retrospective studies, which, in turn, will be combined

and aggregated to provide assessment for the clinical status of patients being involved in prospective studies.

As shown in Figure 3, the clinicians (and, subsequently, authorised health professionals) will interact with CDSS and, specifically, with: i) the PDS component for managing the data of their patients in the prospective studies, and ii) the DPEE component for assessing the effect of the treatment process in the prognosis of the patient survival rate, according to various prediction models. Furthermore, the clinicians will use another part of the PDS component to introduce data from patients selected for the retrospective studies.

As part of the treatment process, the health professionals, of different specialties, collaborate to assess the status of an HNC patient and gather into a tumor board to decide on the proper treatment actions to be proposed to the patients. Figure 4 presents the main functions for the interaction of the clinicians and other health professionals for their collaboration in the context of the tumor boards, through the TBCE component of CDSS.

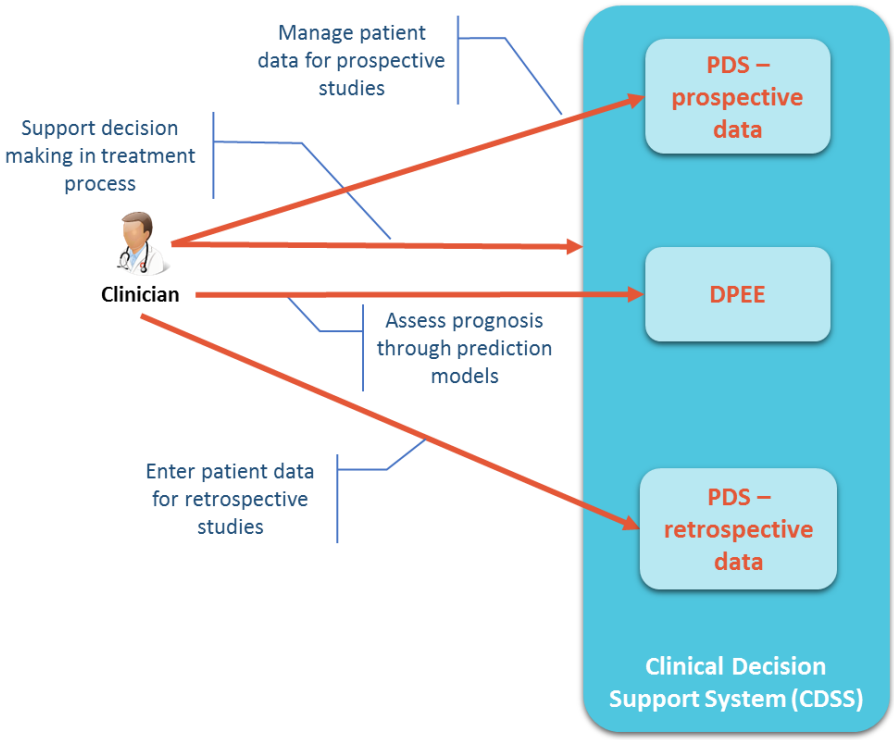


Figure 3: Main functions for supporting decision making in the treatment process.

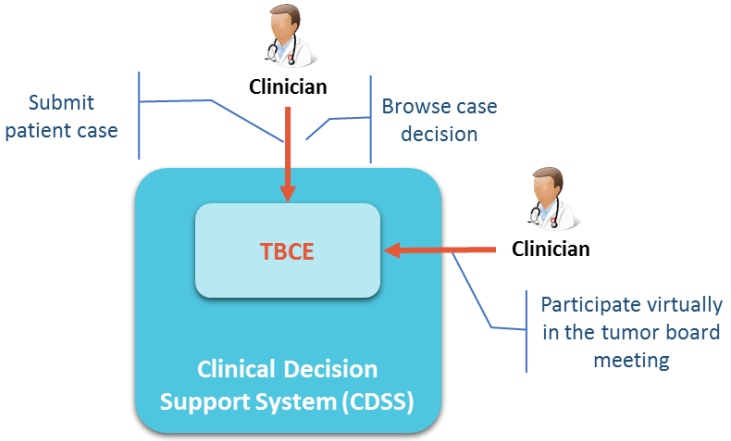


Figure 4: Main functions for enabling the clinicians' collaboration in the form of tumor board.

An integral part of the decision making mechanisms across the treatment process is the quality of life of the HNC patients at the diagnosis, the treatment and the follow-up phases. This quality of life is expressed by the patients themselves in the form of surveys conducted by the clinicians. The structure of the surveys has been standardised from international bodies in the HNC field. In BD2Decide, we implement three of the surveys proposed in these bodies, which are used as instruments from the clinicians to assess the perceived quality of life from the patients. Figure 5 summarises the main interactions of the stakeholders with the BD2Decide tools.

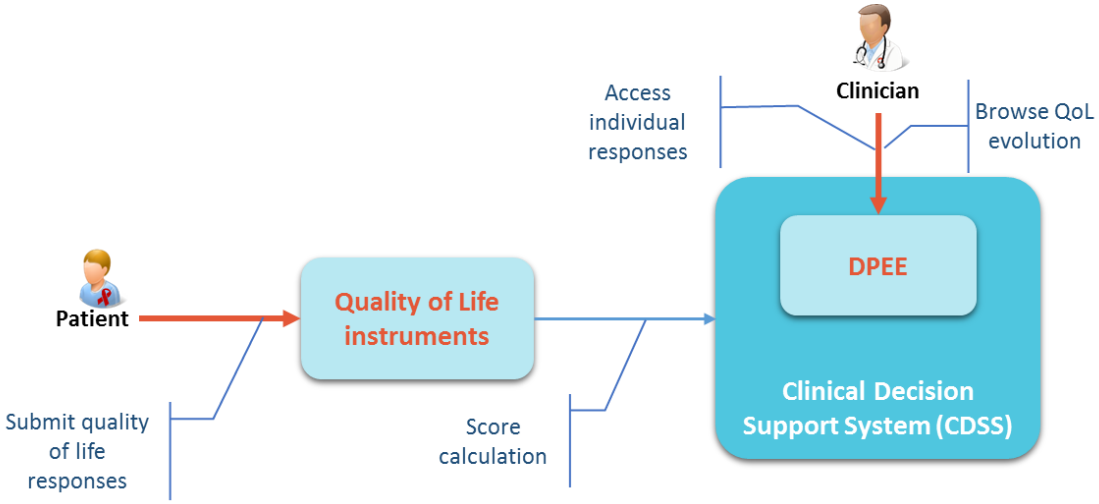


Figure 5: Main functions for assessing the quality of life in the BD2Decide platform environment.

Finally, in Figure 6, we present the functions implementing the interactions between the health professionals and the clinical researchers for querying in a big clinical datasets and population databases. CDSS integrates the patients' data records from both the retrospective and prospective studies and processes them to be discoverable for the functions required by the researchers.

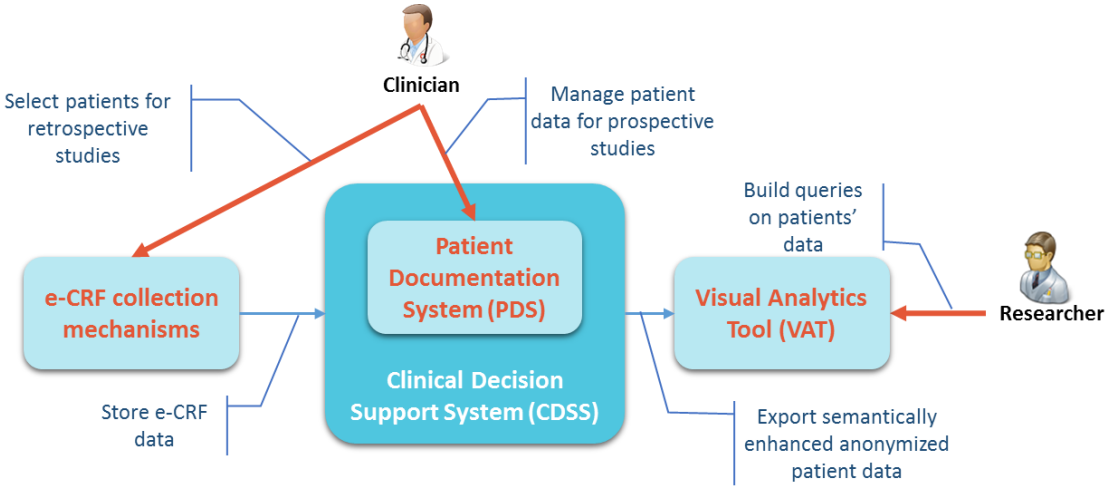


Figure 6: Main functions for enabling researchers in visualising big data for clinical research.

The functions implementing the purpose of the interactions presented in this section will be placed in the respective user interfaces of the components and tools comprising the BD2Decide platform environment. Sections 3 and 4 elaborate on the conceptual visualisations of these tools.

2.4 Implementation of the user centric design approach

As reported in D2.2, the project employs a user centric design approach to develop the BD2Decide platform. In this Deliverable, we emphasise on the steps undertaken to finalise the first iteration of usability design concepts of the BD2Decide platform via functional mock-ups and design walkthroughs, which are made available to the clinical partners to assess a number of factors, such as the effectiveness of the mock-ups to address the user requirements and use cases listed in D2.1 and their usefulness to implement the perceived benefits of the BD2Decide project.

The main design principles for the BD2Decide visualisations have already been introduced in D2.2. In this deliverable, we build on top of them to move from the interaction wireframes presented in D2.2 to mock-up visualisations for the CDSS and VAT tools of the BD2Decide platform environment. These principles have driven the specification of the objectives for the conceptualisation of the BD2Decide visualisation mock-ups. These objectives, together with the challenges foreseen in the future, are summarised on Table 1.

Table 1: Visualisation design principles, objectives and challenges.

Design principle	Objective	Challenge
Suitability The suitability of the interfaces to enable the interaction of the target user groups with	The tools that we have designed within the BD2Decide environment should fully cover the main functions foreseen in the user requirements and the relevant use cases presented in D2.1.	The mock-ups should be able to accommodate any further requirements coming up in the course of the development phase, or be extended to

Design principle	Objective	Challenge
BD2Decide	For each end user group, namely physicians, clinicians and other health professionals, and researchers, a clear view of what the tools provide for them should be presented.	address new use cases in a seamless way.
Familiarity Learn from best practices in the look and feel of tools in the field	The BD2Decide platform should loosely integrate various tools, which do not deviate from the current realisation and knowledge of the clinical stakeholders on how the functionalities and the information are presented to them.	Some features are firstly introduced from the project, especially in the VAT part, thus they should be smoothly integrated with existing look and feel styles.
Simplicity Interactions in an almost autonomous way, through self-explained ways	The visualisations should minimise the need for guidance by hiding the complexity of the functionalities offered by the tools on the user interface level.	Some of the BD2Decide use cases and the involved datasets are very specific to particular specialties of the health professionals, so the visualisations must emphasise on the proper role for the consumption of a certain mock-up
Flexibility Have the control of the workflow execution, through comprehensive navigation	Emphasise on the use of navigation bars and control panels that allow the end users to easily browse from one task to another, without too many back and forth activities.	The CDSS tool integrates different functionalities and components, so that users must always be able to realise which function is being used in a certain task in a tool transparent way.
Awareness Realise the status of the workflow and the consistency of the information	The mock-ups must allow the clinicians, the researchers and the other professionals to realise on the status of the workflow they execute along the treatment process.	Although the timeline view for the treatment process is well defined in the clinical domain, for the researchers' tasks this is user specific.
Efficiency Clarity on the primary action and expected outcome	The screens of the conceptual visualisations should highlight the main interaction activities and specify the expected results of these	In order to achieve this, we may spread the BD2Decide functionalities in too many screens, which raise risks on

Design principle	Objective	Challenge
	interactions.	the ease of navigation through them.
Presentation Visually pleasant and attractive interfaces	The look and feel of the visualisations should be based on modern techniques for Web-based applications, while maintaining a conceptual link to existing tools used in the clinical domain	The clinical domain is still using old technologies and tools, which may disrupt the engagement of the end users with modern visualisations.
Accessibility Based on international standards and for specific access channels	The development of the BD2Decide platform must consider international accessibility practices, emphasising on the end device channels.	The working paradigms of health professionals (i.e. accessing the BD2Decide platform from hospital networks) may raise restrictions in the use of some resources.

Towards this move, in the previous months, we engaged the clinical partners with the wireframes presented in D2.2 to get their feedback on how they realise the implementation of the BD2Decide front end components. Of the main points arisen from these discussions, we summarise the following:

- The use of timeline views for assessing the current status of the patient in the HNC treatment process is required.
- Although the visualisations should provide the minimum required information, it might be necessary for the clinicians to be able to get the whole set of data for online or offline use.
- The development of predefined queries will help the health professionals in better accessing the VAT tool.
- The collaboration among the clinicians might be extended beyond the organisation of the tumor board meetings.
- The 3D visualisation of the virtual patient is of less importance.

In the following sections, we present the conceptual mock-ups of the visualisations expected in the BD2Decide project for the components of the CDSS tool and the VAT tool.

3 CONCEPTUAL VISUALISATIONS OF THE CLINICAL DECISION SUPPORT SYSTEM

3.1 Introducing retrospective data

As it has been reported in D2.2 and D5.1, the CDSS tool manages patient data for prospective studies. In order to facilitate these studies, CDSS requires retrospective patients' data, which should be collected from the various clinical centres and be inserted into the BD2Decide environment. This is enabled through the use of the PDS module. This module has been developed with the use of the OpenClinica tool, an open source software[2] that has been customised to the structure of the eCRF decided with the BD2Decide project. As the BD2Decide eCRF integrates the knowledge of five different clinical centres, from different countries, for four different cancer cases and from various health specialties from these centres, a lot of revisions have been made in the initial eCRF presented in D2.1. The final one has been implemented into the OpenClinica tool and for the five clinical centres.

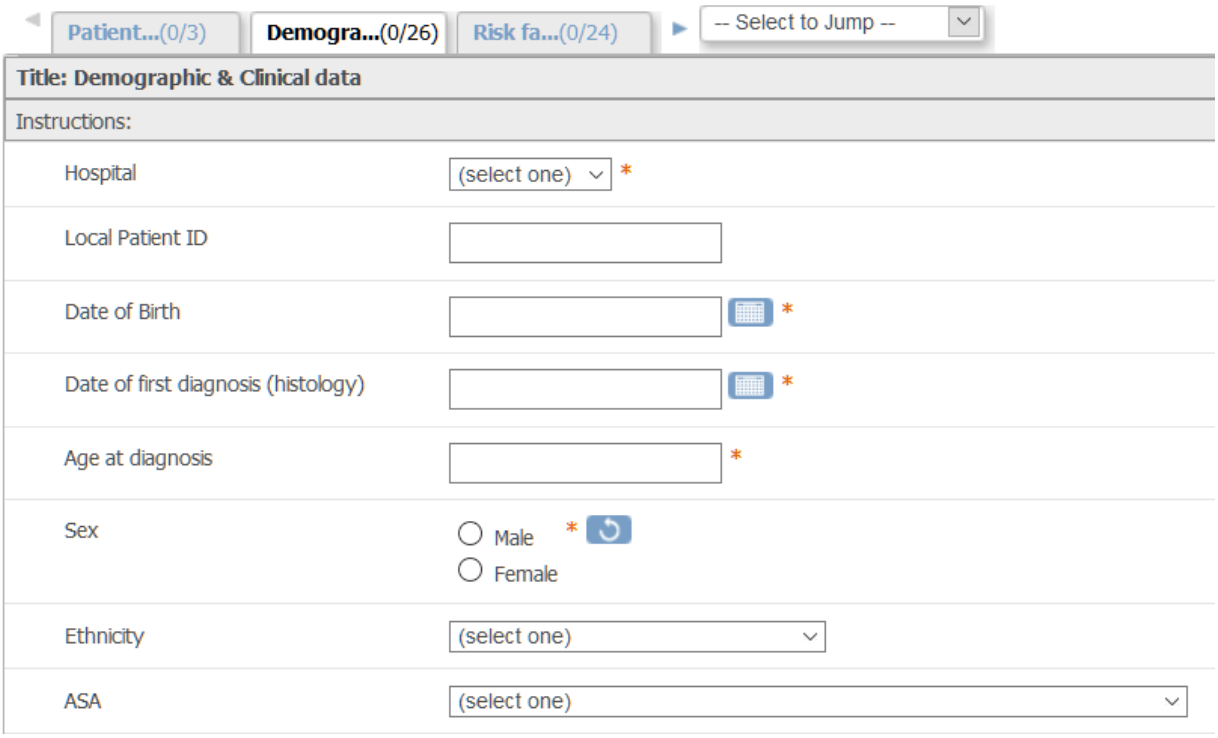


Figure 7: PDS – The structure of the clinical data in OpenClinica, based on the e-CRF format.

In this section, we present the main visualisations of the OpenClinica tool for the clinicians. Once the user decides to enter a new patient into the OpenClinica tool, the tool automatically assigns an ID for this patient. The entry form is logically split into the different sections of the eCRF, as shown in Figure 7. The navigation to the different sections can be done either with the left and right arrows

[2] https://www.openclinica.com/

or directly by selecting the relevant section from the dropdown list. This implementation of the PDS supports the following:

- Highlight of mandatory fields, so that no critical information is missing in the patient's CRF record.
- Selection of the field values from dropdown lists.
- Multiple selection of values as response to specific fields.
- Automatic calculation of field values, based on the responses given in previous fields (see Figure 8).
- Guidance on the proper format of the field values, by providing notes or links to external pages.
- Visual explanation of the candidate responses, so that the clinician provides a self-assessment of the best possible value. This is for example implemented in oral hygiene field of the risk factors sections of the eCRF, as shown in Figure 9.

On top of these functions, the current prototype implements a set of rules that control the navigation of the clinician to the different fields in the e-CRF. Depending on the selected values, additional fields may be displayed or hidden from the data entry process.

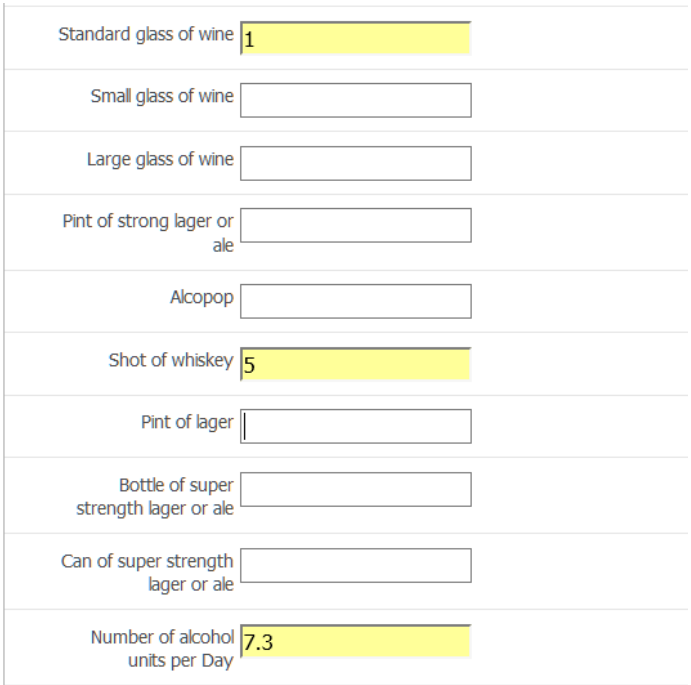


Figure 8: PDS – Example for the automatic calculation of field values in the risk factors section of OpenClinica.

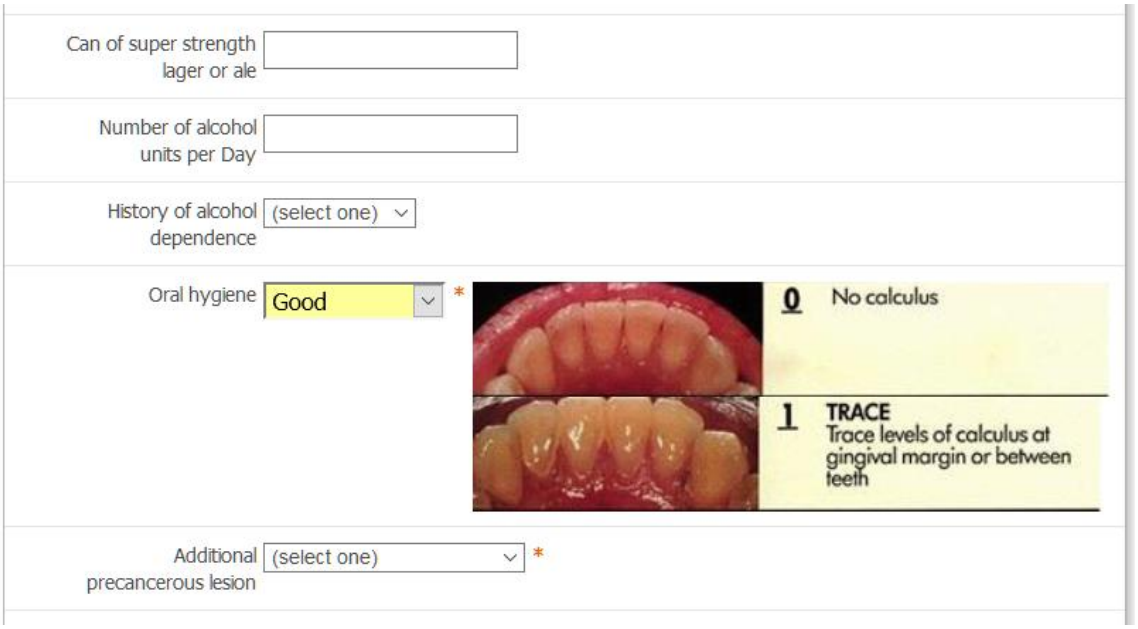


Figure 9: PDS – Example of visual explanation of the field values in OpenClinica.

Apart from these visualisations, an administration view is also available, which is used to:

- Set up the structure of the eCRF for the current study;
- Configure the list of active studies. For the purposes of the BD2Decide project, each clinical partner has their own study.
- Manage the users and their roles in each study. In the current development, each clinical partner has appointed users for two roles, namely data entry, and data manager (the one being responsible for the finalisation of an individual's eCRF record).

3.2 Exploring patients' data

The CDSS tool allows the health professionals to exploit the collected clinical data and run prognostic models to assess the long term status of their HNC patients to facilitate decisions that need to be taken across the treatment process. The CDSS tool acts as the user interface container of all the BD2Decide tools, thus it offers access to any of them through a single interface. The home page of the Web-based CDSS tool is presented in Figure 10.

As shown in Figure 10, the CDSS front end has a menu bar with the options to: i) browse through the HNC patients (the "My Patients" button), and ii) connect to the TBCE, the VAT tool and the imaging tools (this option is available if the user specialty is radiologist).

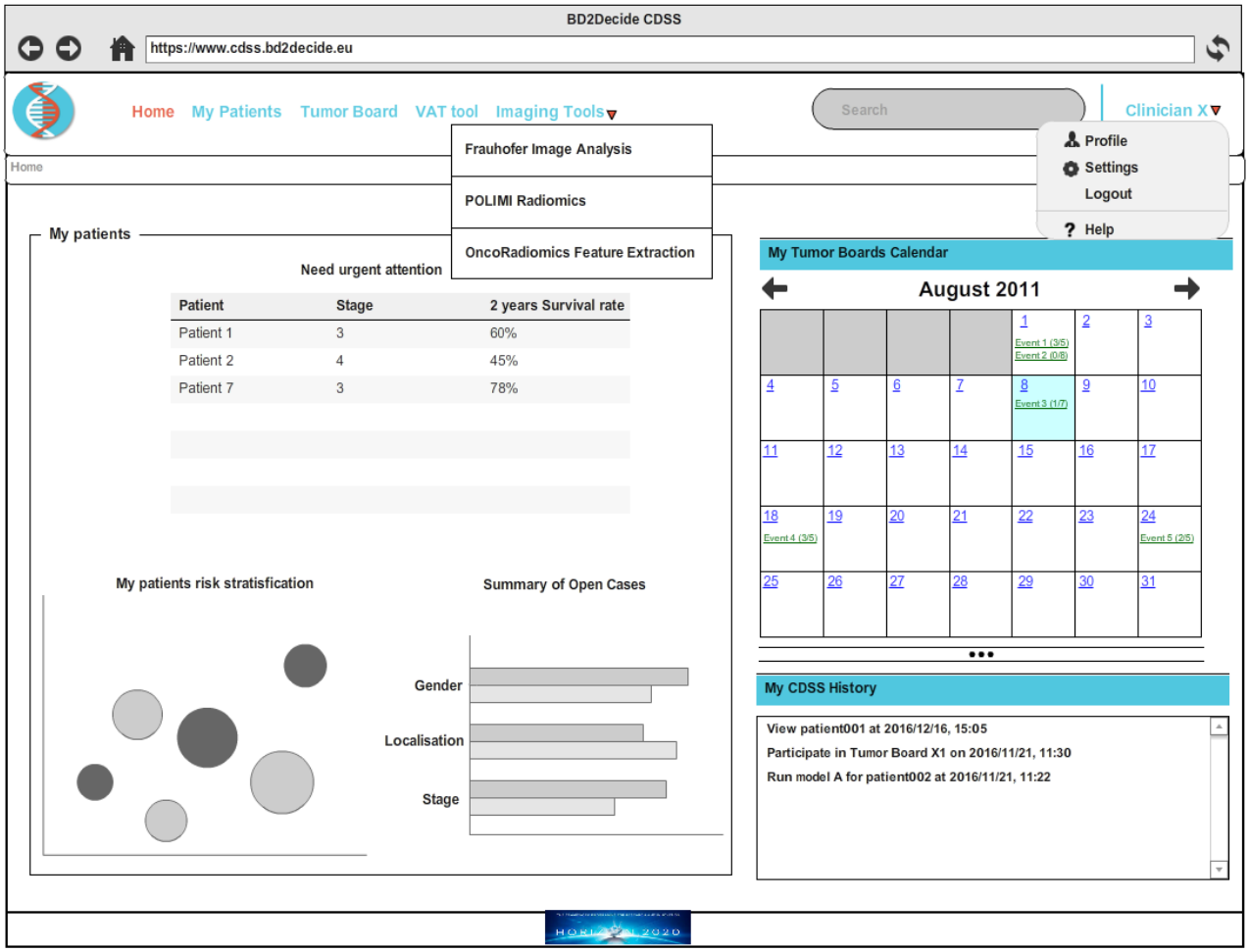


Figure 10: CDSS - The home page.

The main part of the home page is split between the patients' view and the tumor board meetings schedule. In the patients' view, the user can view a list of patients assigned to this user, the risk stratification for these patients and a summary of which of the assigned patients' cases are still open and need the user attention. The tumor board meeting view is a calendar of the meetings with the involvement of this user and it directs to the TBCE tool. Along to these two views, the home page displays the list of latest actions performed by this user in the CDSS history box.

Finally, through the home page, the registered users can manage their profile or the settings of the CDSS tool.

By clicking the "My patients" menu option, the user gets the list of patients (see Figure 11). This list can be sorted by date of visit, while a left side panel allows the health professionals to filter between the patients assigned to them or the whole list of HNC patients registered in the respective clinical centre. The main functionality of this screen is the "View Patient" button next to each patient ID, which loads the DPEE for the selected patient.

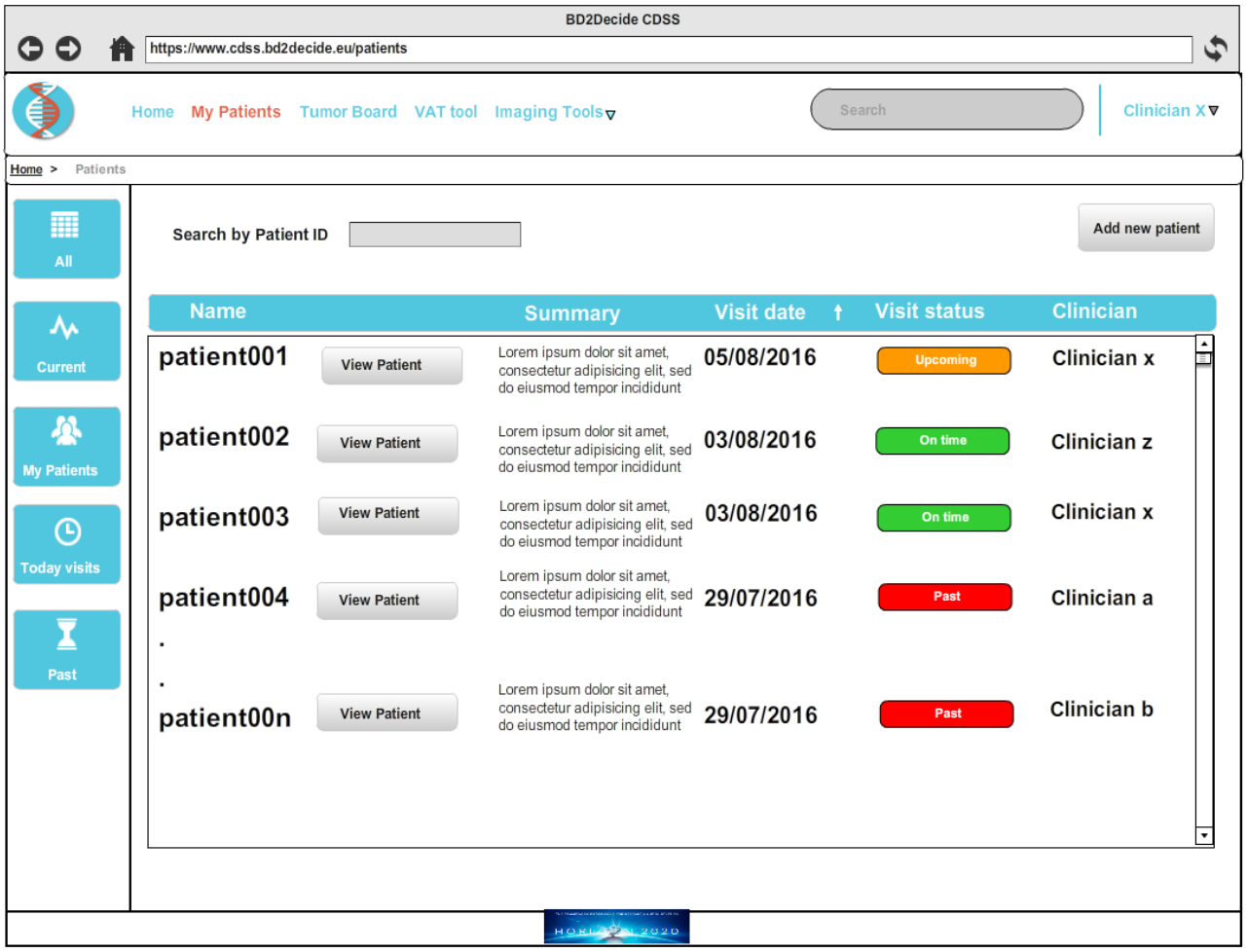


Figure 11: CDSS – The list of patients.

As it will be shown in the next paragraphs, the DPEE tool offers a specific visualisation template for each patient, which is presented in Figure 12. As shown there, the DPEE is split into four main parts:

i. The top patient quick overview bar, which is a static window that displays the patient name (i.e. ID), some basic demographic (gender and age) and risk factor (whether the patient is s smoker or consumes alcohol) data, an overview of the tumor localisation and the clinical staging, and three coloured areas summarising key assessment factors (in this view we configure the DPEE tool to present the survival rate in 2 and 5 years' time and the possibility rate for metastasis.

ii. On the left hand side part of the template, the registered health professional has a set of quick access functionalities. Currently, these functionalities allow quick access to: a) the patient clinical and pathology data, which are recorded during the treatment process, b) the radiomic features and the respective segmented radiological images, produced by the BD2Decide imaging tools, c) the genomic feature data, d) the prognostic models and the prediction analysis offered by the BD2Decide environment, and e) the collection of recorded

responses to the quality of life questionnaires. Depending on the phase of the treatment process, additional buttons may be added, like in the case of the diagnosis phase, in which this panel hosts the quick access button to the sketch module.

iii. On the right hand side part of the template, the timeline of the treatment process is presented. This timeline is designed with the aim to provide the health professionals with an assessment of the current status of the treatment process for the selected patient, a history of the main steps followed so far and link to the data referring to each phase. The timeline is vertical having on the top of the line the date of diagnosis and running to the bottom by appending the steps that the HNC patient has gone through till the current date, the date that each step was accomplished and a small textual description of the step outcome. The design of the timeline tries to clearly spot the dates for the main phases of the treatment process, as well as to include in the timeline view the key steps of the treatment process that assist the professionals in making assessments of the current patient case.

iv. The central part of the DPEE user interface displays the data for the treatment phase and functionality, based on the selections made on the left and right hand side panels.

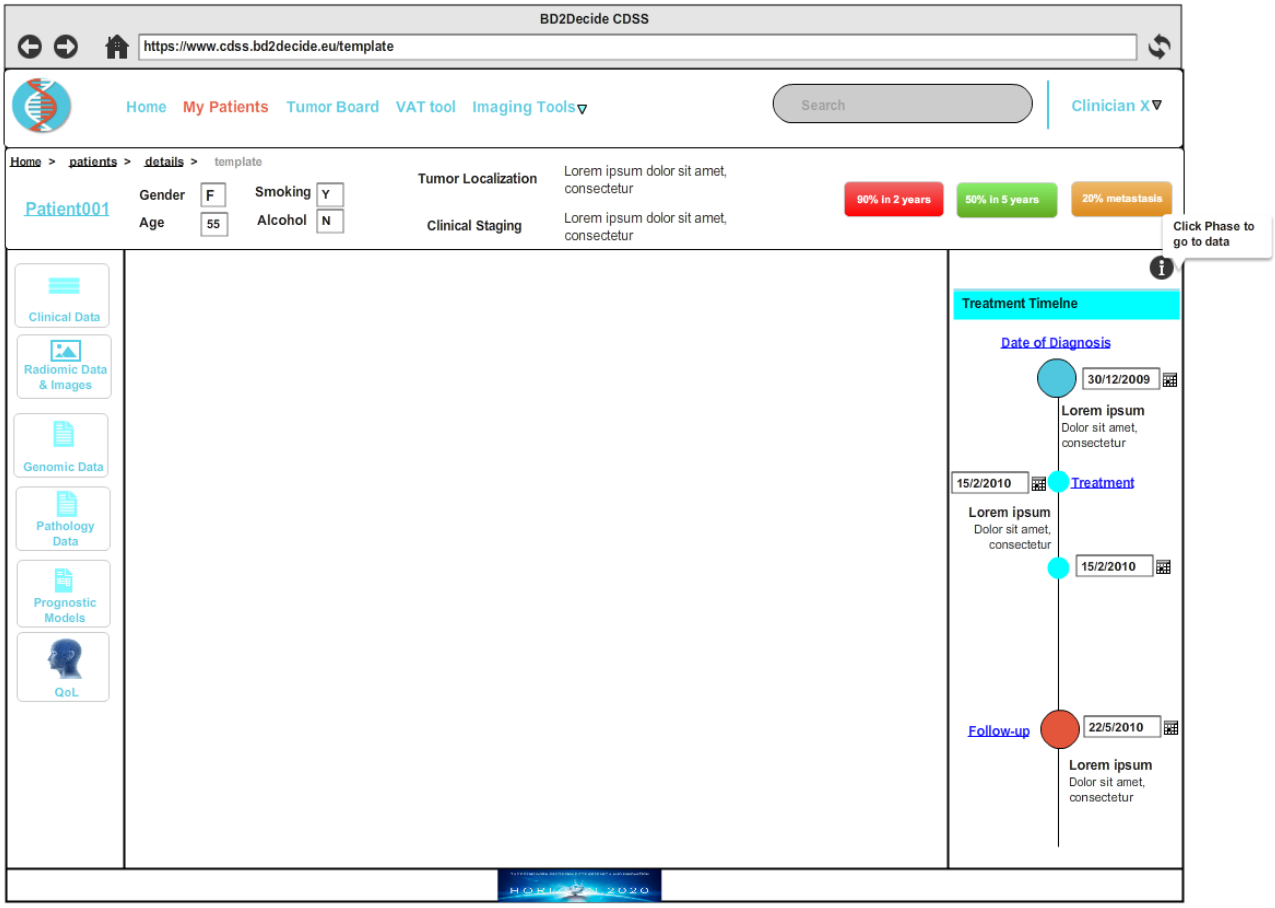


Figure 12: CDSS – The template view of the DPEE.

This template is customised in the following paragraphs.

3.2.1 Supporting the treatment decision

In the diagnosis phase, the health professionals require from CDSS to assist them in recording and effectively browsing the clinical data that are collected from various sources, like clinical studies and radiological analysis, to constitute the electronic CRF.

The central part of the DPEE template provides the details of this dataset through a CRF based categorization. A header horizontal button group allows navigating to the CRF categories for the data collected and processed in the diagnosis phase of the treatment process. This is shown in Figure 13. This view is the default one, when the use selects the diagnosis phase from the timeline view on the right, as well.

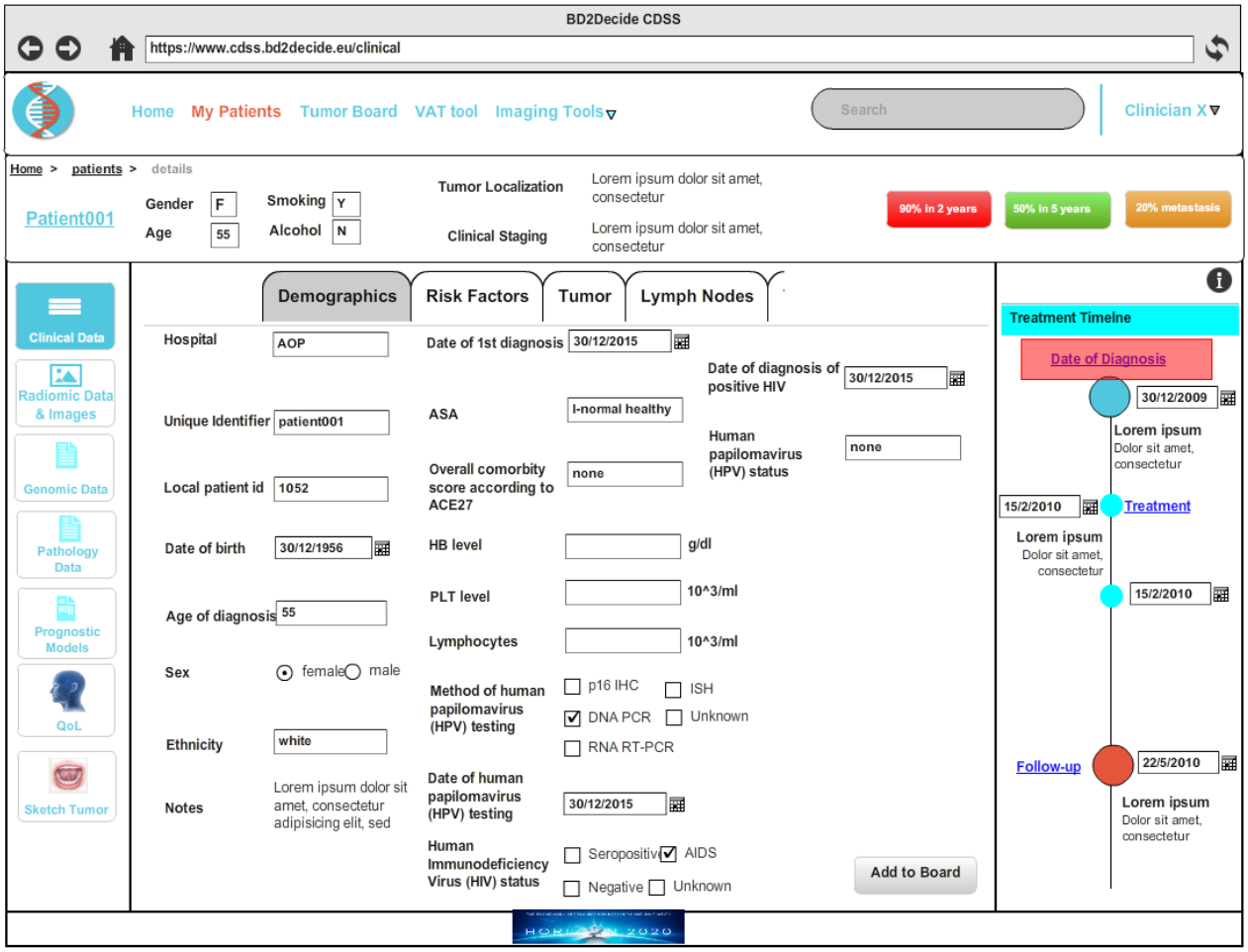


Figure 13: CDSS – The clinical data view at the diagnosis phase.

In the view of the clinical data, we have added a button that enables the physician to propose this patient to be examined in the next tumor board meeting. This button should trigger a functionality that adds this patient ID (shown on the top panel of the DPEE visualisation) to the potential agenda

items of a regular or urgent tumor board meeting. The functionalities of the tumor board meetings are implemented through the TBCE tool and the respective screens are presented in section 3.4.

Furthermore, the DPEE template is customized for this phase by adding an additional button in the left hand side panel that allows the health professionals in sketching the tumor localization, depending on the tumor case. This is depicted in Figure 14. The aim of this screen is to allow the physician for an early assessment of the tumor localisation, which may also be used by the radiologists when analysing the CT or MRI scans with the BD2Decide imaging tools.

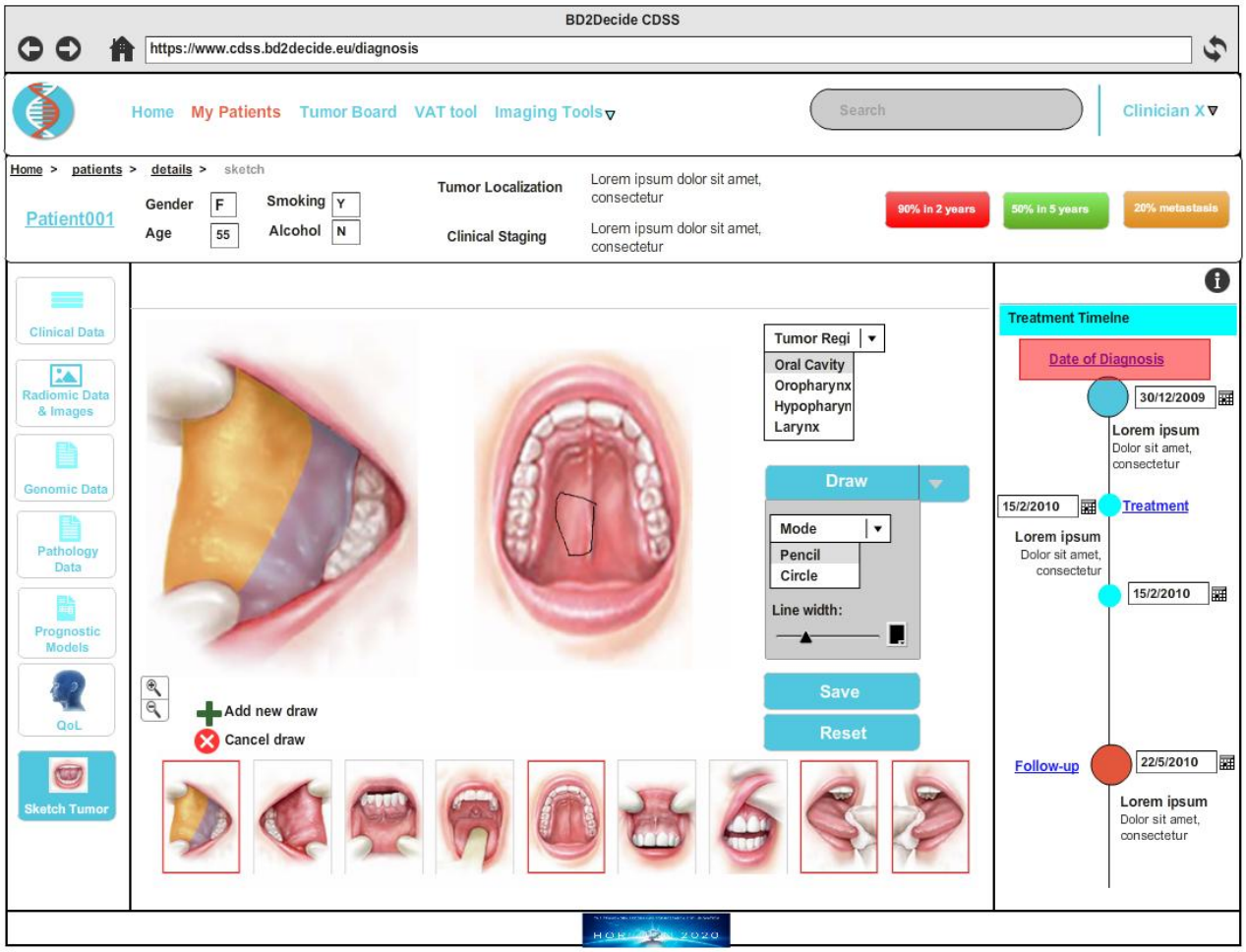


Figure 14: CDSS – Allowing users to skecth the tumor localisation at the diagnosis phase.

Through the use of the imaging tools, the radiologists can analyse and segment CT and MRI scans to extract the respective radiomic features. This process is performed outside the CDSS tool. The outcome of the imaging tools is made available to CDSS for visualisation. The relevant screen is presented in Figure 15. In this figure, the central part of the DPEE template is filled in with both the segmented images and the radiomic features, while a tumor summary panel is pinned next to the images for quick assessment.

Currently, the radiomic features are presented in a tabular form for those features that are considered as more important for the clinicians. A more efficient visualisation way will be sought for the next version of this screen. For a complete inspection of the radiomic features, a download link allows the location storage of the whole set of the radiomic features for offline use by the authorised specialties.

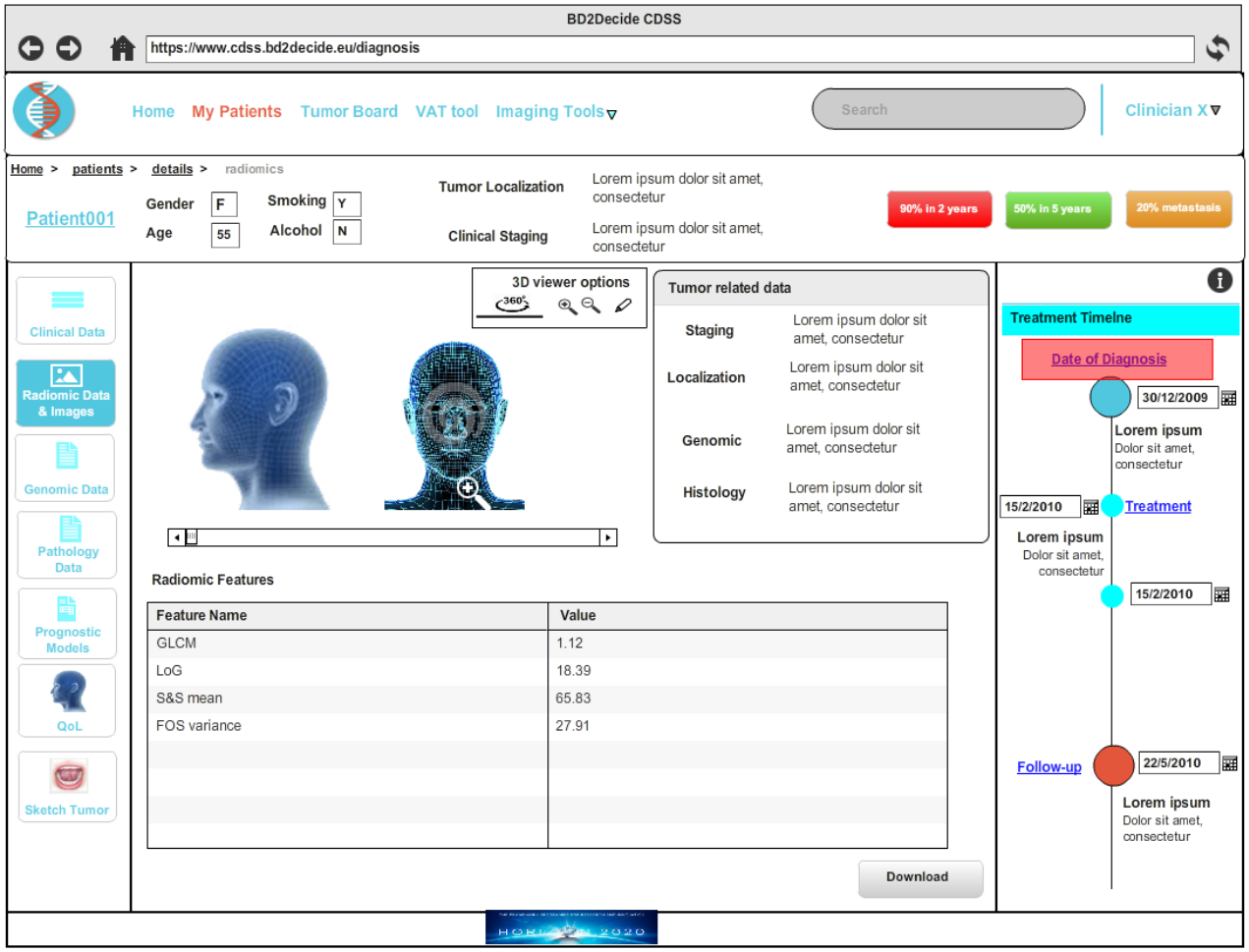


Figure 15: CDSS – Browsing the radiological and radiomic data.

In a similar way, Figure 16 presents the visualisation of the genomic features. A selection of genes is made to be presented to the authorised users. This selection is predefined and is currently performed outside the CDSS environment. Again, a download link is provided to the authorised users that allows them to perform a complete offline inspection and process of the genomic features.

The currently provided tabular representation of this dataset will be further evaluated by the clinical partners to come up with a more intuitive visualisation of the most relevant and important genes.

As said above, the timeline view on the right panel of the DPEE is used to browse through the different phases of the treatment process. For example, when selecting the treatment phase (see Figure 17), the respective data for the selected treatment option is presented.

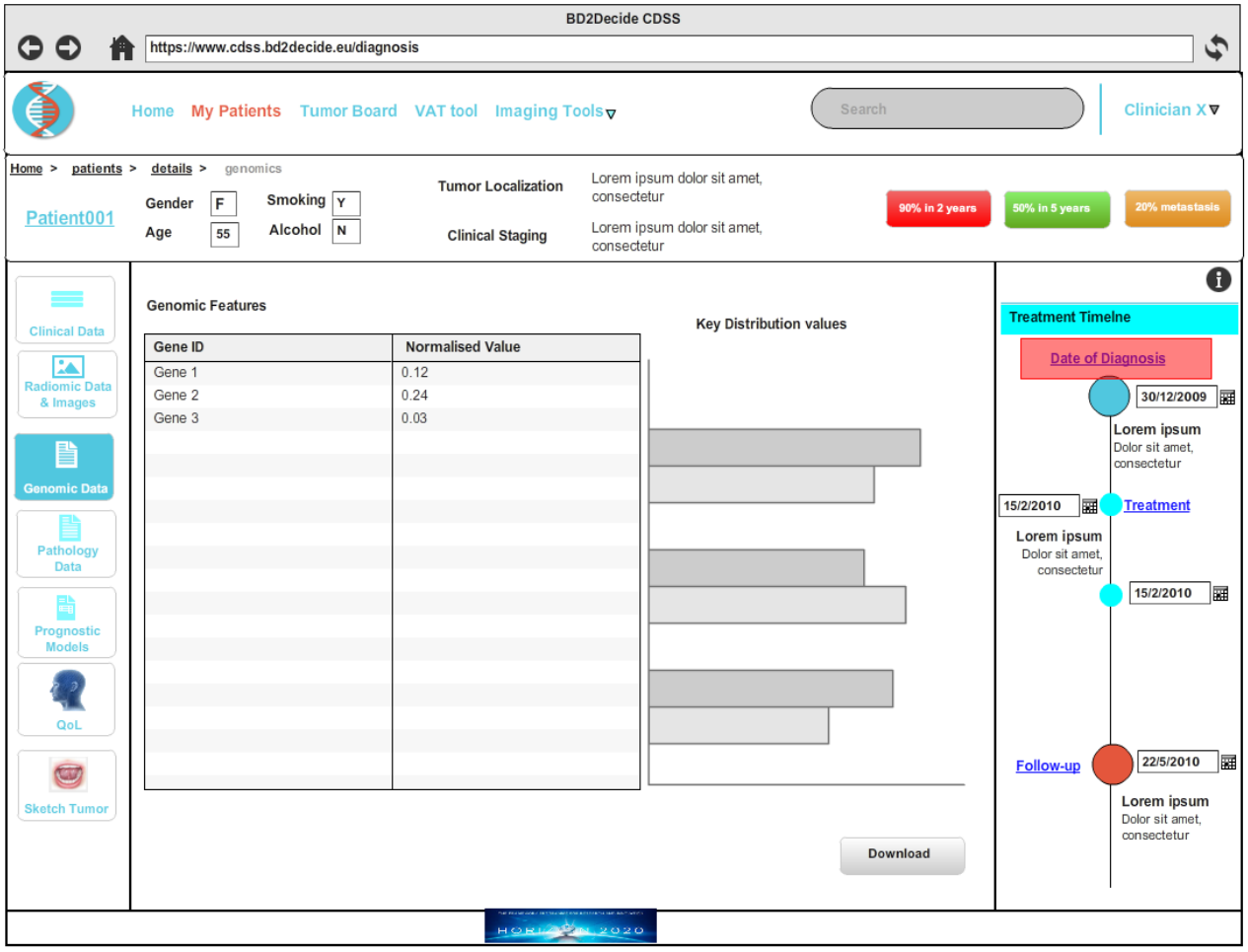


Figure 16: CDSS – Browsing the genomic data.

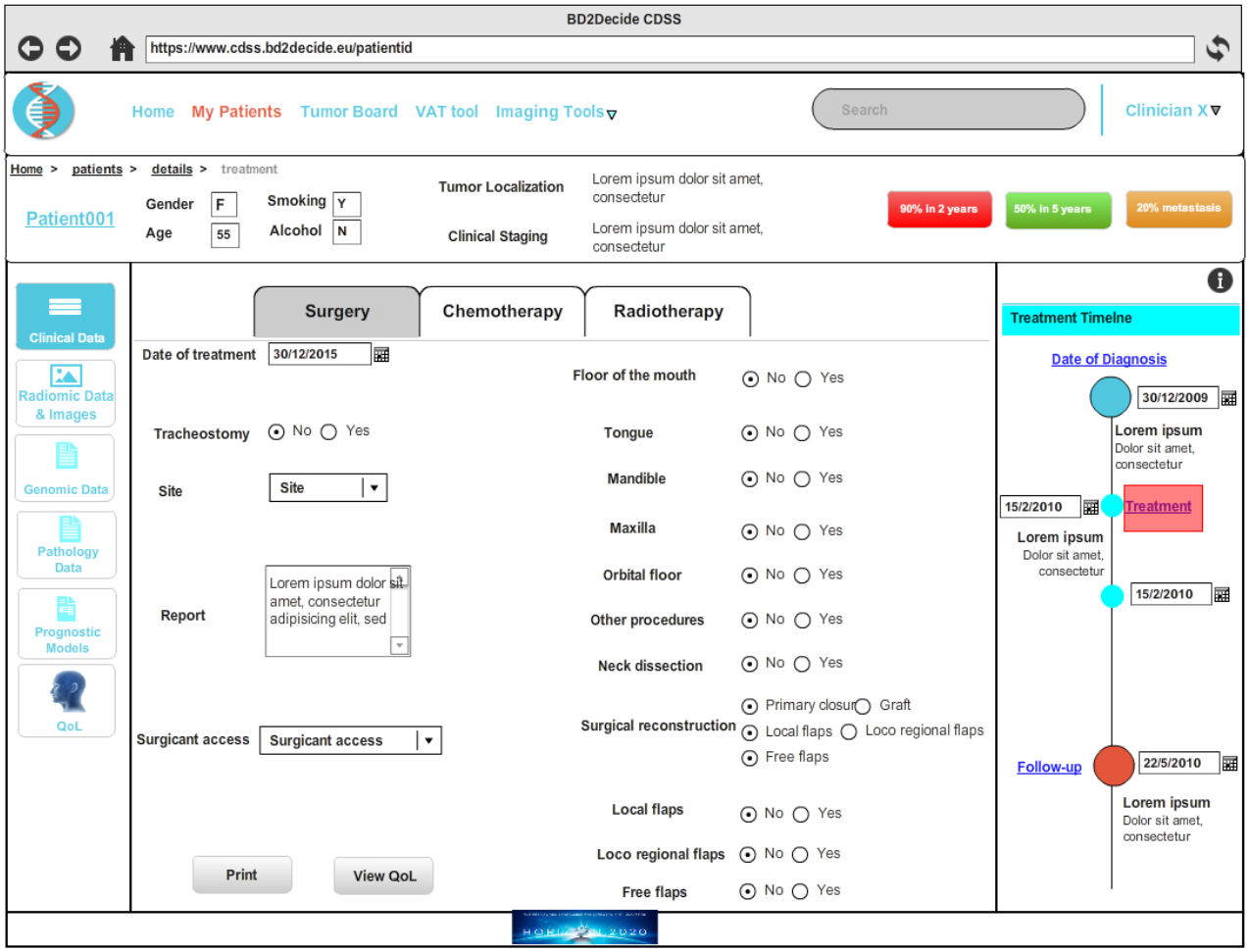


Figure 17: CDSS – Recording the clinical data in the treatment phase.

3.2.2 Predicting the patient's risk score

As already explained in Deliverable D2.2, an important part of the CDSS visualisation is the process for supporting the health professionals in making predictions on the effect of a treatment process in the survival rate of their patients, based on the current clinical status. The access to the prognostic models is offered from the left hand side panel of the CDSS interface. The view, which is loaded (see Figure 18), enables the physician to switch between the prognosis window, the function for comparing the prognosis through the application of different prediction models, the function for comparing the prognosis of the selected patient with patients with similar cases in the BD2Decide environment, the view for the risk stratification of the patient to cluster this patient into groups with other similar cases, and the simulation window, which simulates the current study of the patient with similar cases for the reoccurrence factor, using population-based data.

The default page of the prognostic models functionalities of the CDSS tool is the one for the individual prognostic analysis. As shown in Figure 18, the physician can select the prediction model to run and get the prognosis for the survival rate of the patient in various visualisations, according to

the model. For each model selected a separate pop up window may be loaded by clicking the "configure" button. This button is used by the clinicians to modify the default configuration of the selected model.

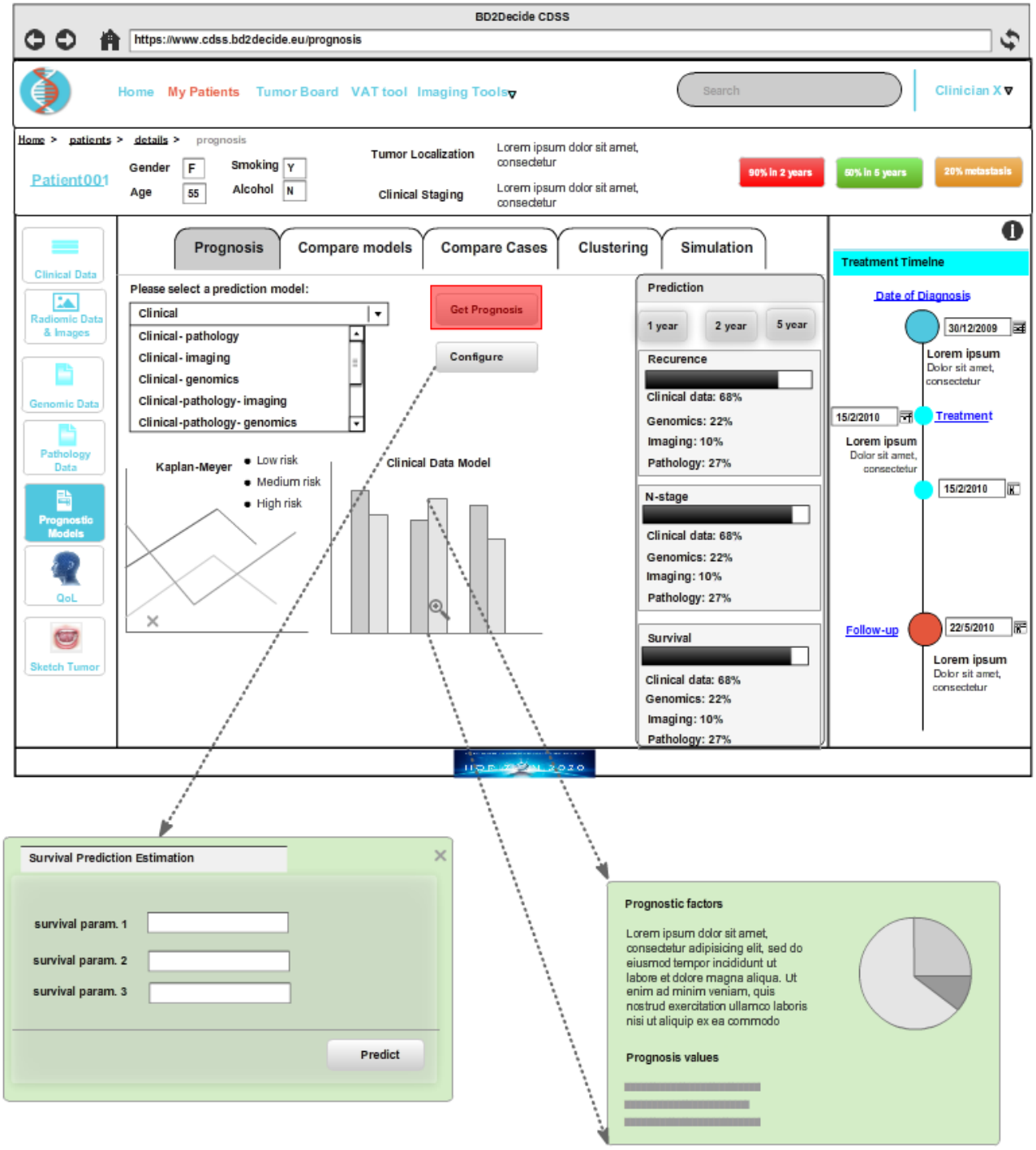


Figure 18: CDSS – Getting the patient prognosis on selected prediction models.

When a model configuration is completed, the user clicks the "get prognosis" button, which gives back the survival rate visualisations. The professional may decide to emphasise on a visualisation mode by zooming into the details of the graphs.

Furthermore, on the right side of the central panel of the window, the CDSS UI loads the prediction box, in which the physician can select the time window of the prediction and receive assistance on which factors affect the prognosis for specific prediction cases, like the reoccurrence probability, the survival probability, etc.

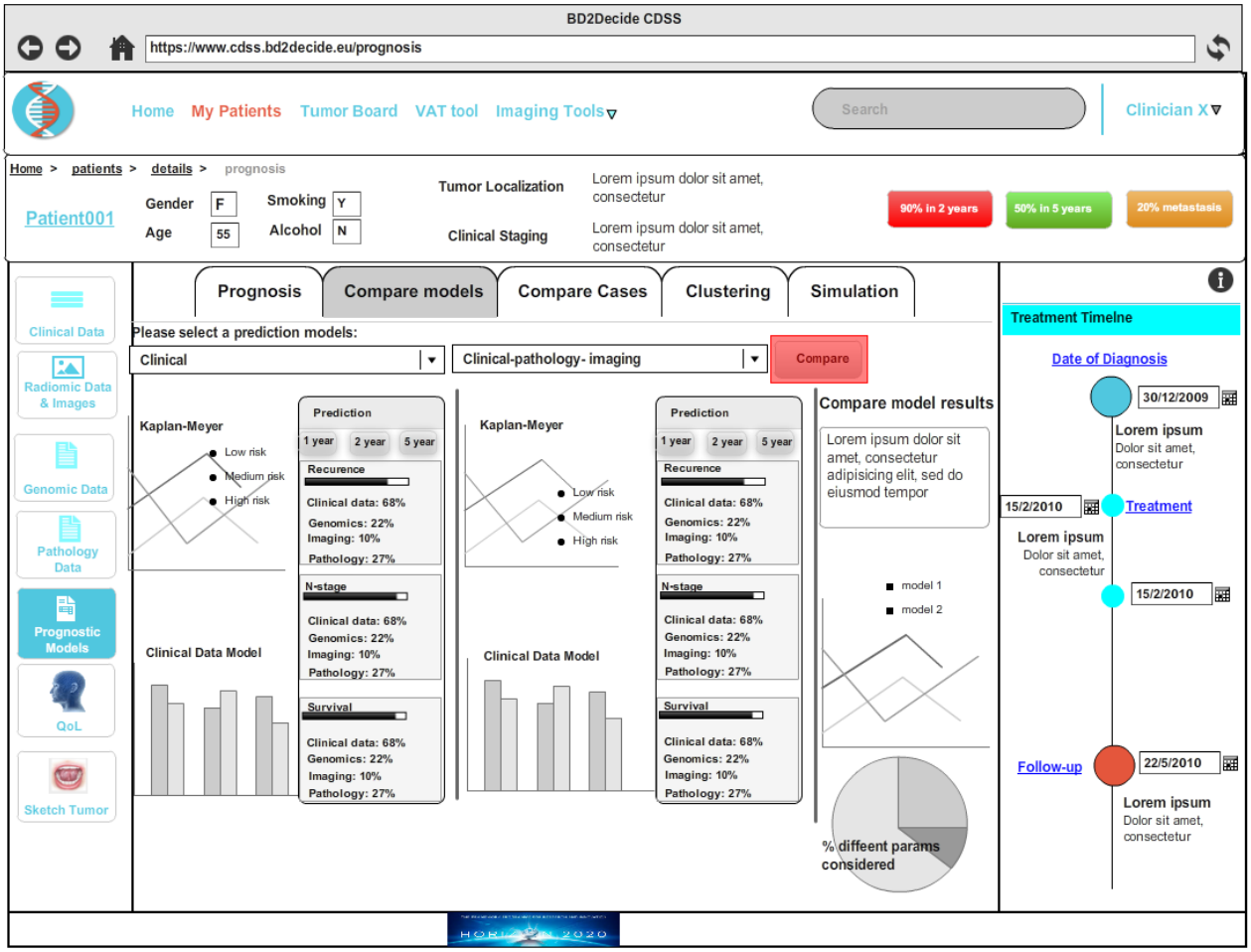


Figure 19: CDSS – Comparing two models for a patient case.

The prognostic analysis can be extended in the "compare models" window, which is used for a side-by-side comparison of the prognosis results using different prediction models. As shown in Figure 19, the physician selects to compare the prognostic prediction cases for two or more prediction models and gets back the models prognosis both in separate and combined graphs.

Apart from individual prognosis, the CDSS tool supports the health professionals in making comparisons between the patient's clinical case and other similar cases. This is shown in Figure 20. The comparison views follow the ones presented for the individual prognosis. In a later stage of the

project development, we will examine the possibility with the clinical partners (as evaluators of these sketches) to be able to select specific population criteria (demographic and other criteria) to make comparisons.

Finally, the user may select to get a cluster view of the patient compared to other cases for the risks associated with the case under study. In Figure 21, we present the respective screen of the CDSS visualisation that allows the physician to perform risk stratification of the patients. The clustering approach aggregates the prediction factors for groups of the population and presents them to the physician to visually assess the patient's case, compared to the rest of the population.

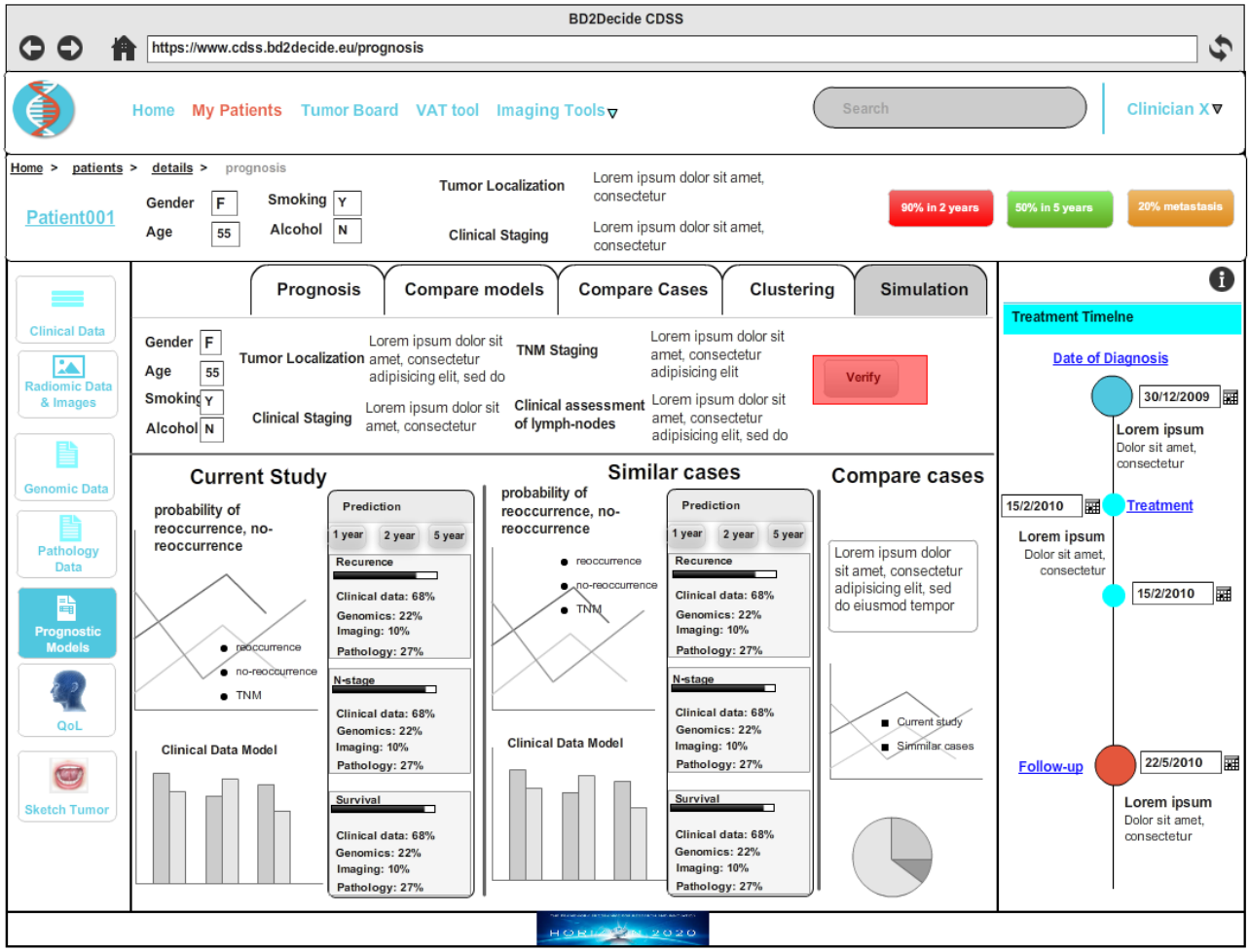


Figure 20: CDSS – Running a simulation model for a patient case.

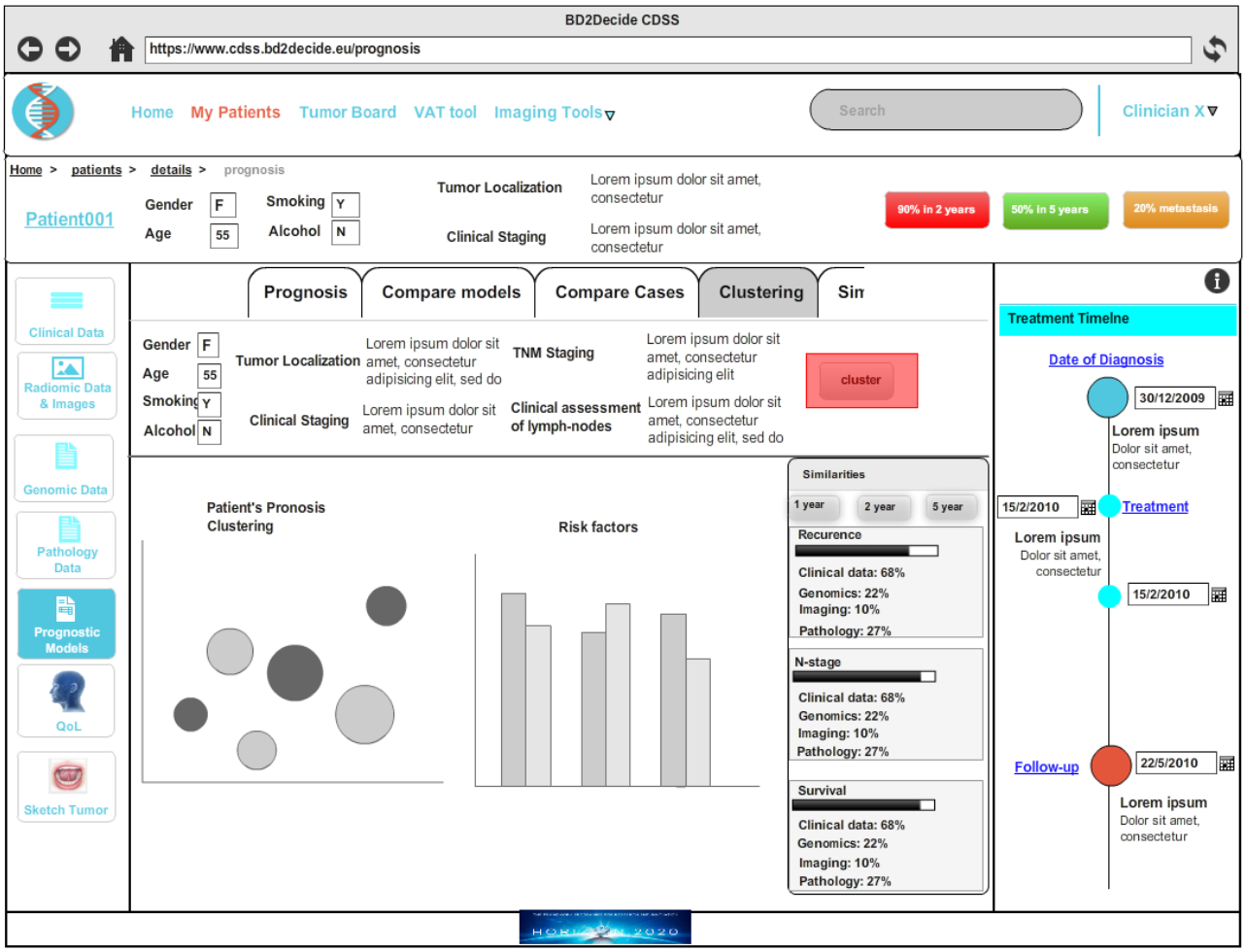


Figure 21: CDSS – Visualising the risk cluster of the patient case.

3.2.3 Supporting follow-up planning

The use of the CDSS tool is extended in the follow up phase of the treatment process, as well, through the visualisation implemented in DPEE. In this phase, the tool aims to support the physicians in managing the follow-up tasks for their patients and making decisions on the medium term clinical status of their patients after following a specific treatment process. The follow-up visualisations are accessible from the timeline view of the CDSS interface. The relevant screen of the DPEE is presented in Figure 22.

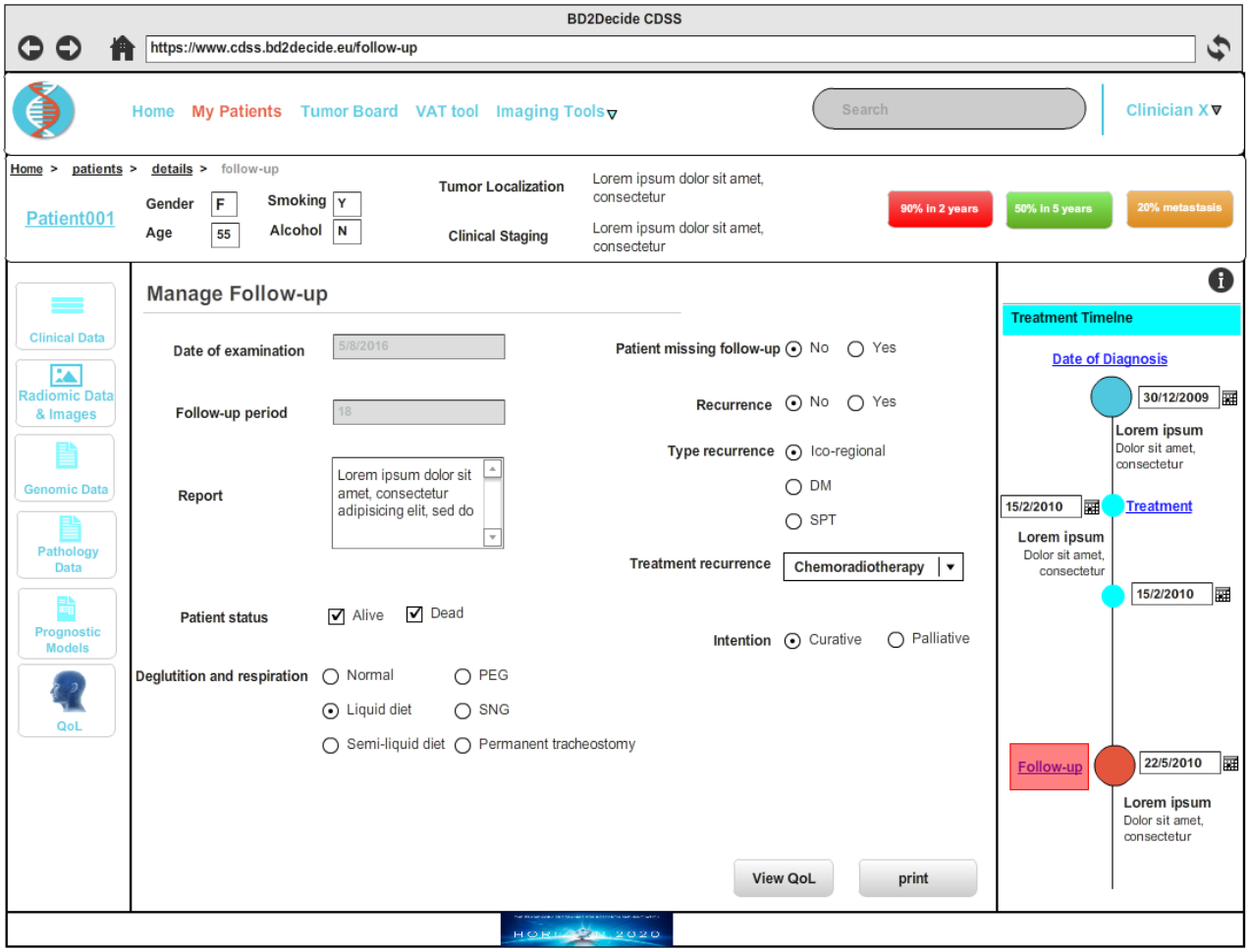


Figure 22: CDSS – The follow up screen of the DPEE.

3.3 Quality of Life assessment

Within the BD2Decide project, the health professionals in the HNC domain use three instruments to assess the quality of life of their patients. As introduced in Deliverable D2.2, these instruments are namely the following questionnaires promoted by the international standards:

- The EQ-5D-5L questionnaire developed by the EuroQol Group[3] for the measurement of health outcome;
- The QLQ-C30 from EORTC[4], which is a questionnaire developed to assess the quality of life of cancer patients;
- The QLQ - H&N35 from EORTC, which is a questionnaire developed to assess the symptoms or problems arisen from a treatment followed by cancer patients.

[3] http://www.euroqol.org/eq-5d-products.html

[4] http://groups.eortc.be/qol/

As an external part of the CDSS environment, the BD2Decide project has followed the guidelines of the respective bodies and has implemented a draft version of these questionnaires to facilitate the collection of data from the patients. The development of the questionnaires has considered the use of personal mobile devices (and especially tablet devices of 10 inches' screen, as reported in the guidelines) through Web browsers. The technology behind this implementation is the open source software LimeSurvey[5], which has been extended with custom implementation for the development of specific parts of these questionnaires, such as the visual analogue scale used in the EQ-5D-5L product (see Figure 23).

Figure 23: Quality of Life assessment – screenshot from the implementation of the visual analogue scale in the EQ-5D-5L product, with Limesurvey.

It must be noted that, since the three questionnaire instruments refer to the patients of the clinical centres in three different countries, they have been developed in four different languages (based on the official translation provided by the responsible bodies, where this was available).

On the CDSS side, the health professionals are interested in browsing the list of questionnaires completed by their patients and the scores coming from these responses, given in various phases of

[5] https://www.limesurvey.org/

the treatment process. In this respect, the evolution of the quality of life scoring is of interest to be visualised in the relevant screens of the CDSS interface. This is enabled by clicking the qol functionality on the left hand side panel (see Figure 24). The first screen that the user sees when clicking this button is the list of the completed questionnaires for the selected patient. By selecting one questionnaire from the list, the quick overview window displays the score calculated from the responses given by the patient in this questionnaire, the relevant date and phase of the treatment process, as well as the score of the other two questionnaires for the same phase. By clicking on the "view patients' results" option, the user can directly access the data, which the patient filled in the respective questionnaire and through which the score has been calculated.

Figure 25 presents an elaborated analysis of the instruments used by the professionals for assessing the quality of life of their HNC patients. In this screen, the user can monitor the evolution of the QoL scores in time for the specific patient. The user may select for which instruments to display the score evolution.

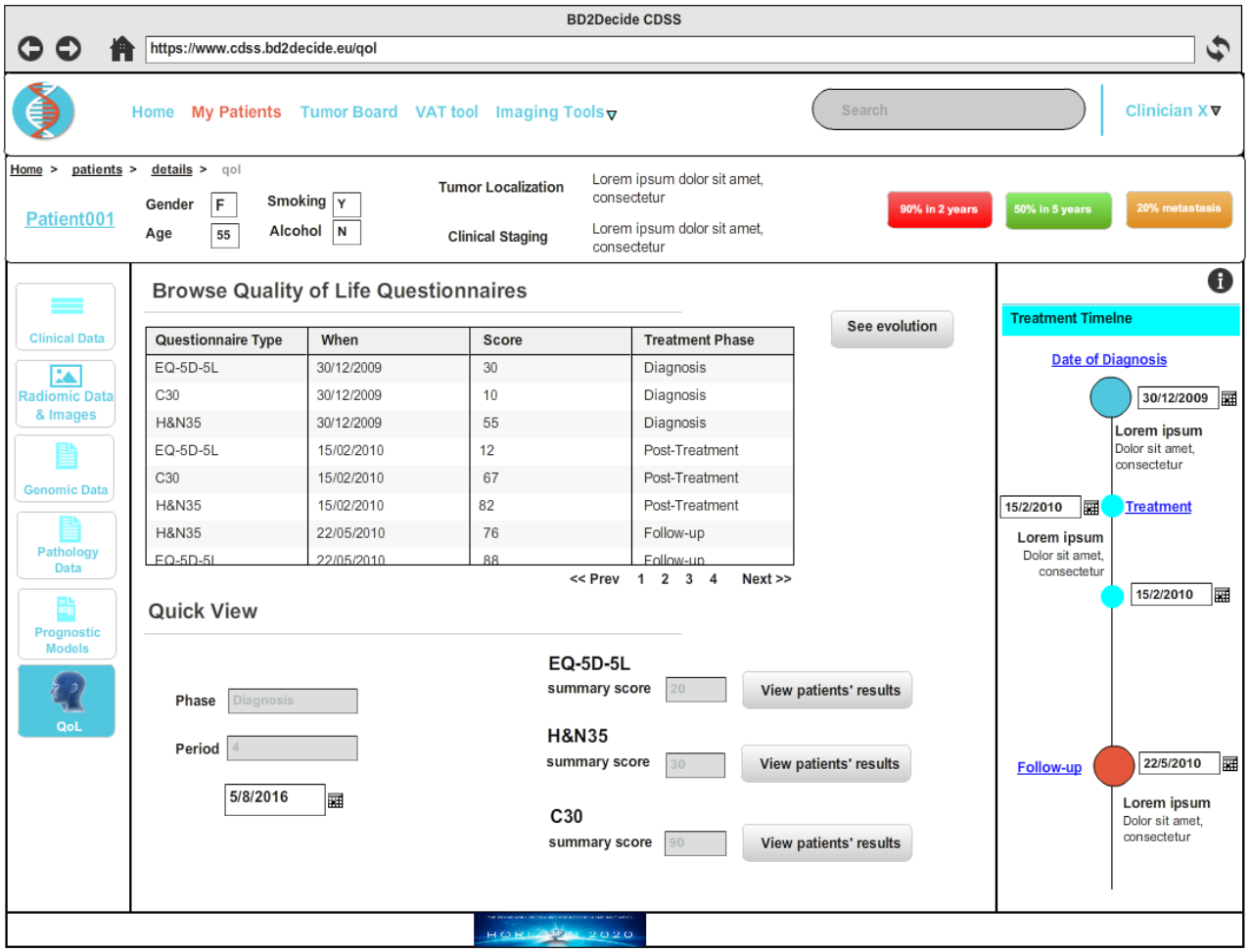


Figure 24: CDSS – Browsing the quality of life questionnaires scoring.

Figure 25: CDSS – Viewing the quality of life scoring evolution

3.4 Specialists' collaboration environment

The collaboration environment for the health professionals is implemented through the TBCE module of the CDSS. In the respective screens, the health professionals can organise and run a tumor board, which is called with the aim to allow these professionals discuss the diagnosis data of HNC patients, follow the primary assessment of the assigned physician and consult on the proper treatment method to be employed.

From the main screen of CDSS, a health professional can navigate to the TBCE module by clicking on the "Tumor Board" menu button. The visualisation of this tool is presented in this section.

TBCE is a Web-based tool, which has a static menu bar on the top to navigate to the different options made available in the TBCE environment. The main actions that TBCE has to undertake are:

i. To manage the organisation and running of tumor boards decided and handled by the authorised health professionals.

ii. To allow the health professionals involved in a tumor board to collaborate and make up decisions on the status and the necessary treatment process of an HNC patients.

iii. To facilitate the discussions in a tumor board by enabling the professionals to browse to the clinical status of the patient and the prediction of the survival rate in an easy way.

iv. To support the professionals in processing, storing and managing the decisions of a tumor board for effective retrieval.

To implement this set of functionalities, the visualisation of the TBCE tool offers this static menu bar with the options to switch between two main views, apart from a home page view. The first view is the "My meetings" view, which is used to manage the tumor boards, while the second view allows the professionals to search the results of the boards on a patients' level, through the "browse cases" option.

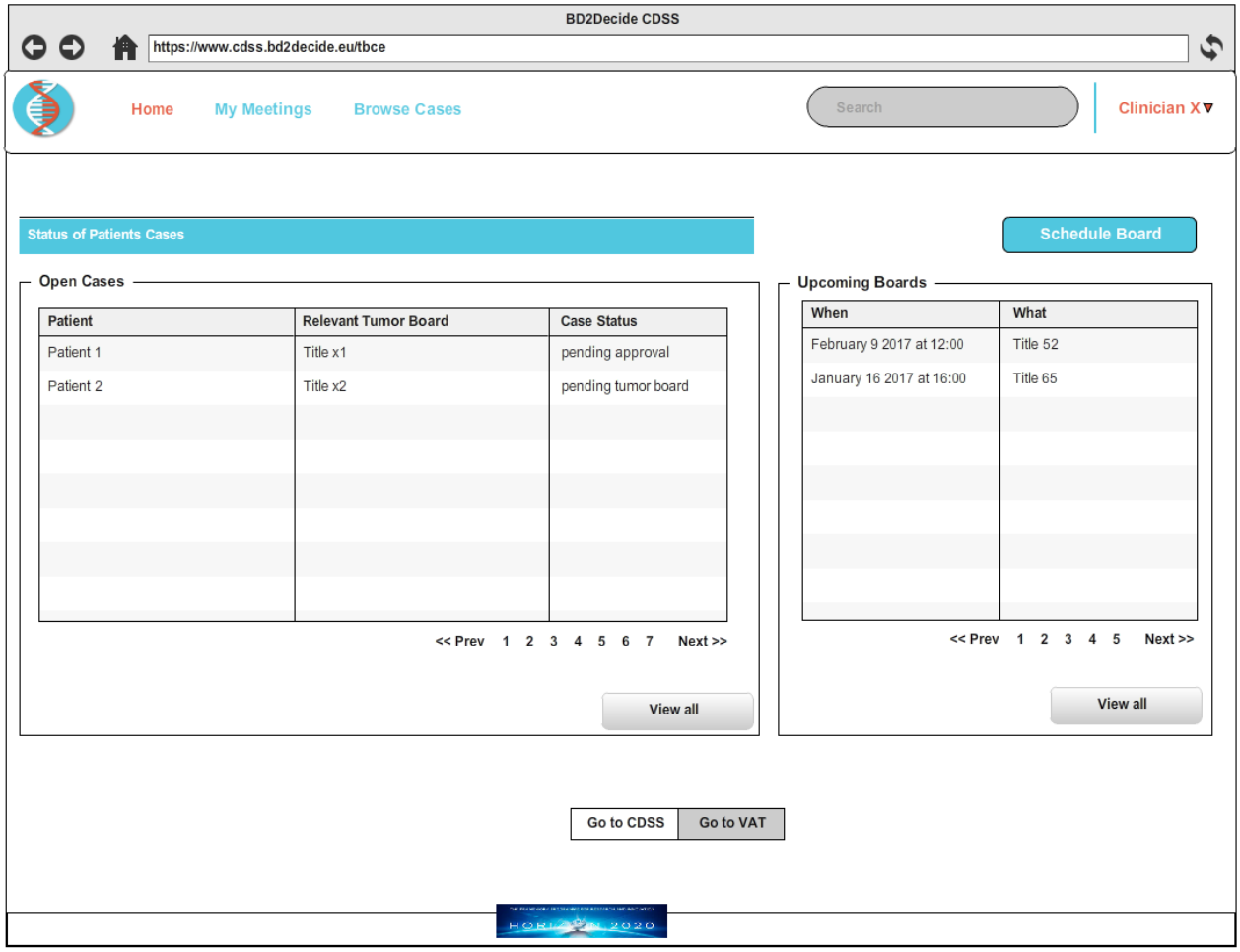


Figure 26: TBCE – Home page.

The home page of the TBCE tool is shown in Figure 26. This page allows the registered health professionals with a role in the organisation and running of a tumor board to do the following actions:

- View the list of open cases for the patients that the registered clinician is responsible. An open case is realised as the case, in which the tumor board or the decision of the tumor board for the patient is pending. The "view all" button navigates the user to the "browse cases" page.
- View the list of upcoming tumor boards that the registered clinician is invited to participate. The "view all" button navigates the user to the "my meetings" page.
- Schedule a new tumor board by pressing the respective button on the top right corner.
- Switch between the other BD2Decide tools, namely to CDSS and VAT.

When pressing the "my meetings" menu, the clinician can manage the tumor boards, as shown in Figure 27. Through this page, the user can select to view the whole list of tumor board meetings (ordered by date), or to select to see only the upcoming or the past boards. Again, the user can press the button on the top right corner to schedule a new tumor board meeting.

In the list of meetings, a set of actions is available. Thus, for the upcoming tumor boards, the user may select to start or cancel a tumor board, or to edit the details of this board. The latter refer to the agenda of the board, as well as the items required to organise a virtual tumor board, like the list of invited participants, etc. The detailed view of a tumor board agenda is shown in Figure 28. This view is logically split into the following parts:

- A representative title of the meeting, which is configurable as text by the one responsible to organise the tumor board meeting.
- The items that must be configured by the organiser to schedule the meeting. These items include the date and time of the meeting organisation, the type and the frequency of the meeting, as well as an optional field to set a password in order to access the virtual meeting. By default, we assume that the virtual meeting is configured to be executed only via the audio-visual equipment of the used computer of the clinician (so, no phone access is made available).
- The participants of the meeting. In this field, we have two major roles, the board organiser, which can be the registered user opened the agenda session or an appointed delegate, and the board participants. The agenda view offers a view with the list of available clinicians and the user has to select which of them to invite in the scheduled board and with which means (SMS or email).
- The agenda of the tumor board meeting. In this field, we offer some basic fields like a textual description of the meeting purpose and the ability to add or remove cases in the agenda of the meeting. The list of candidate patients to be discussed is automatically completed by the proposal made by the physicians at the diagnosis phase of the CDSS tool. In order to offer flexibility in the organisation of the board meeting, in this screen, we allow the organiser(s) of the board to quickly assess the case of the proposed patient through the overview window, or to browse to the patient's electronic record by pressing the relevant button in this window.

Once the details of the meeting have been configured, the user clicks the "schedule" button to register this meeting in the list of upcoming board meetings. An automatic invitation to the participants is sent via the selected way (SMS and/or email).

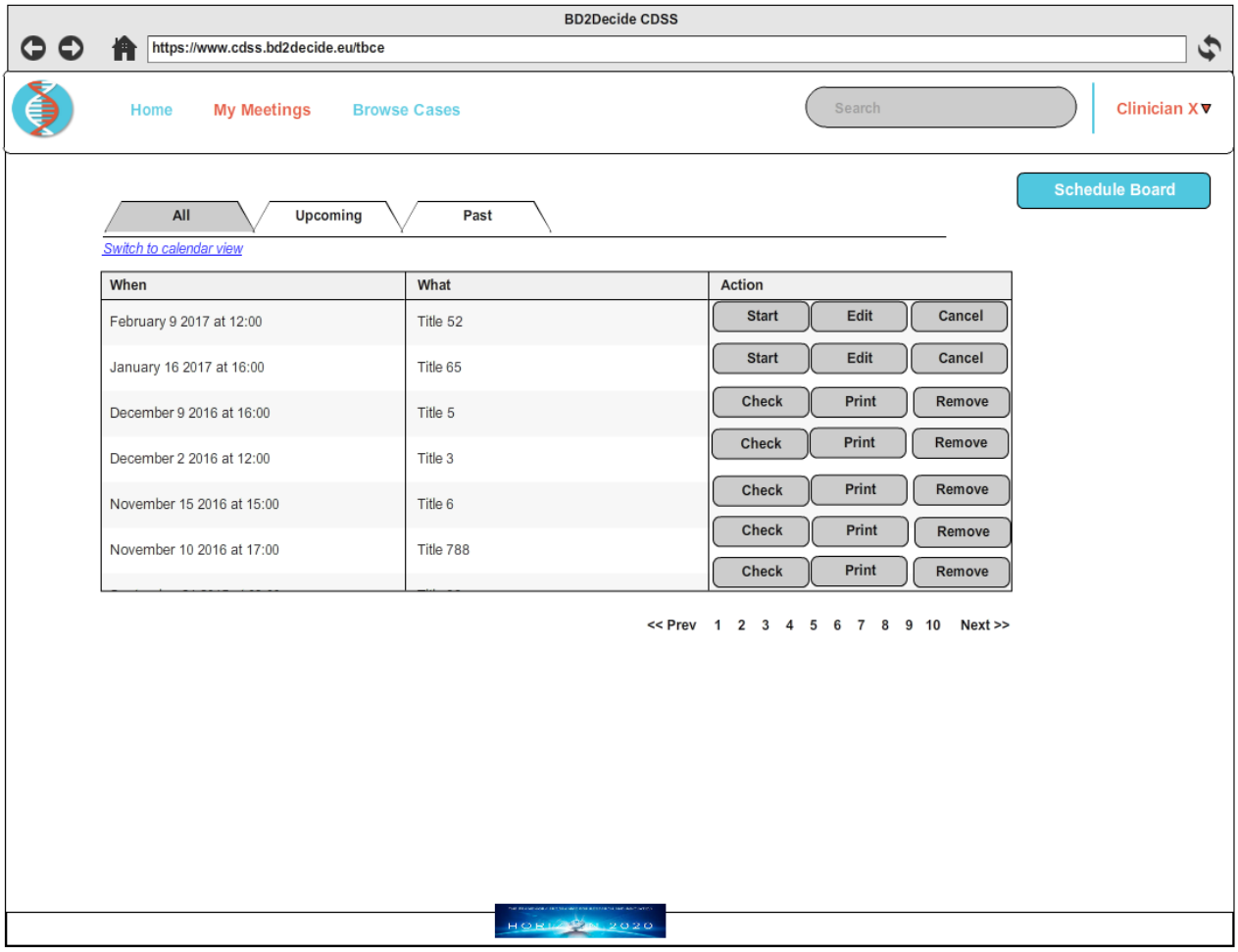


Figure 27: TBCE – My Meetings view.

By clicking the start button (see Figure 27) in a record, the relevant meeting starts. This loads the virtual space view of the tumor board meeting, which is shown in Figure 29. This view consists of the following main parts:

1. The agenda on the left part of the screen, summarising the patients under examination in the current board meeting. This window actually provides the agenda details, allowing the participants to select a patient to quickly view through the patient status by clicking on the patientID in the list.
2. The participants view on the right side of the screen. This view lists the participants and allows the organiser to manage the audio visual details for each of them (e.g. mute all, etc.). It, also, offers a chat room to facilitate written discussions and communication among of the participants of the tumor board.

By clicking the view patient button in the patient overview panel on the left, the current patient panel is activated. This screen provides the details of the patient case under discussion, including the prediction of the survival rate through various models, access to the CRF data of the patient or even the option to load the complete patient view in the CDSS tool, by clicking the "browse more" button. This window also provides a control panel for sharing the screen of the organiser, performing actions, like changing the presenter and managing the recording of the meeting.

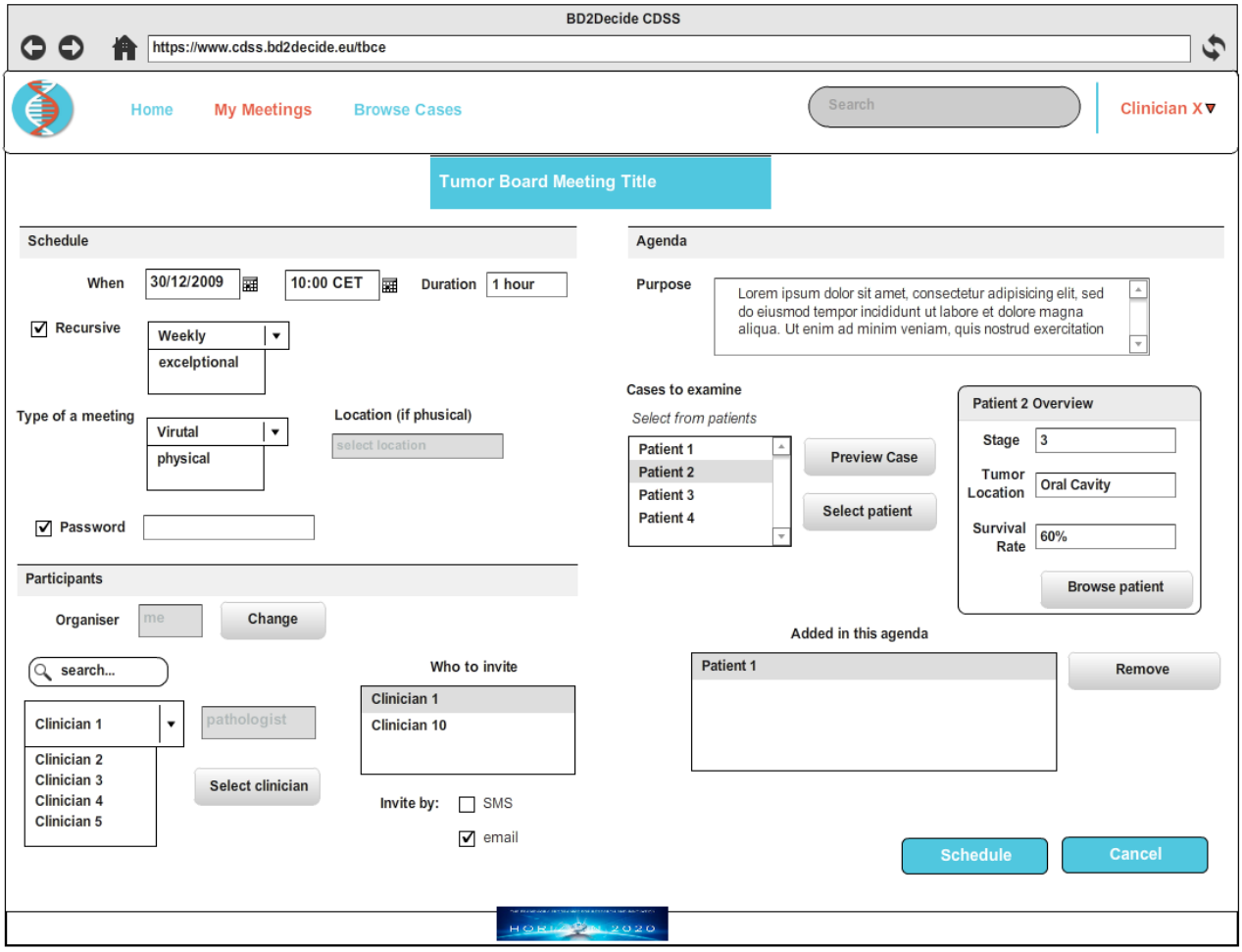


Figure 28: TBCE – The agenda view of a tumor board.

3. The proposed action window on the bottom of the virtual space. This is per active case and allows the organiser to compose the proposed tumor board decision in a textual form. Each participant can provide their written comment to the decision and attach it to their vote, which is logged when the user presses either the "I approve" or the "I object" button. This view dynamically displays the evolution of the voting process, so that each participant knows the tense of the board against the proposed decision. A printing option of the decision, votes and comments is, also, made available.

Finally, by selecting the "browse cases" option in the menu of the TBCE tool, the registered professionals can browse through all the cases that have gone through a tumor board with the participation of this user either as a physician of the case or watcher. This is shown in Figure 30.

The respective window provides the clinicians with a search functionality to find the respective patient case from a list, as shown on the left part of the screen in Figure 30. The quick overview of each case includes the status of the decision (whether a decision has been made or not), a link to the corresponding meeting (so that the clinician can recall the assigned tumor board members and when this meeting was organised, etc.) and an "open case" button. The latter loads the view on the right part of the screen in Figure 30.

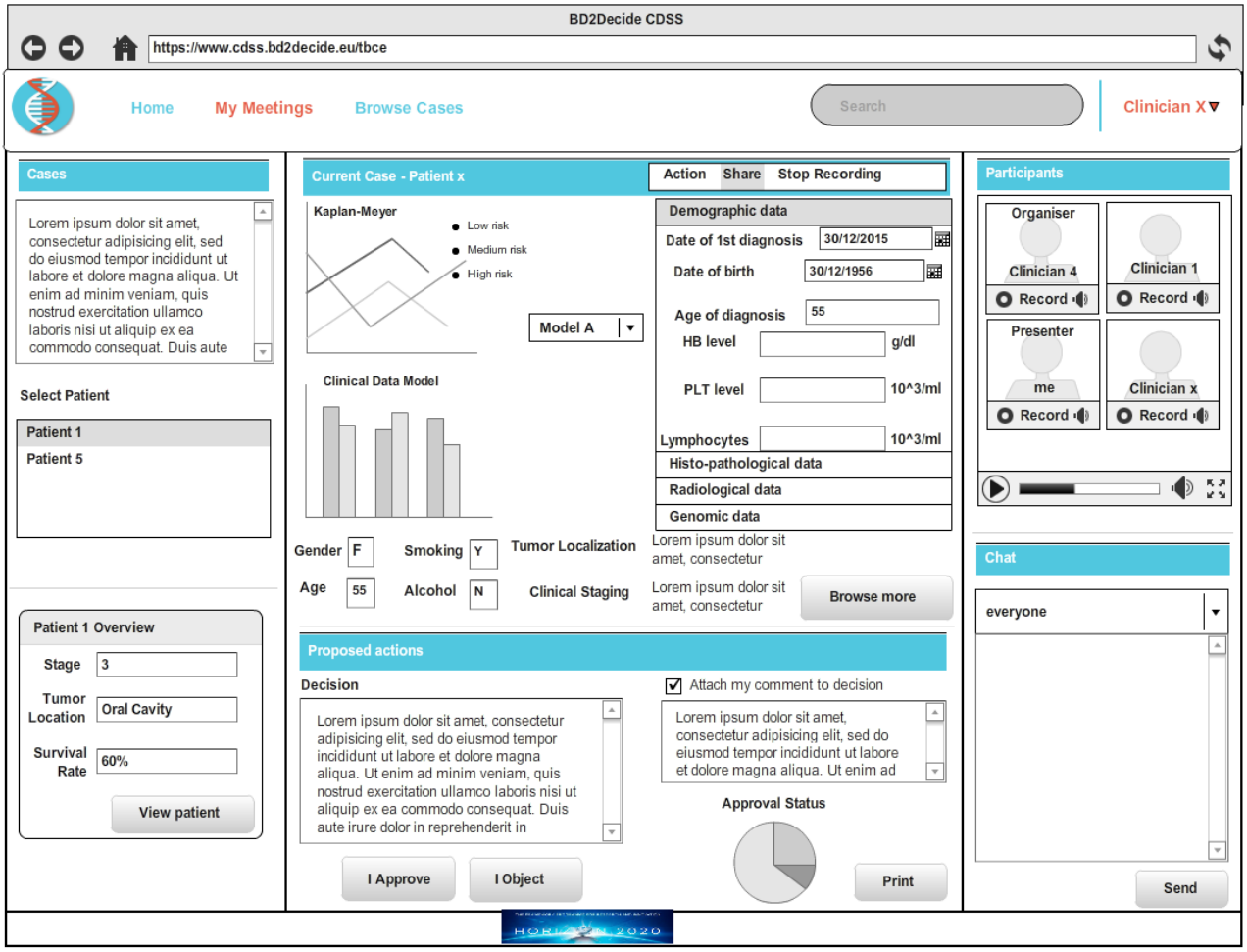


Figure 29: TBCE – The virtual space of the tumor board meeting.

For each patient case, the outcome of the board meeting is presented, along with the ability for the clinician to browse through potential discussion points attached to this decision with the option to add their own comment in each discussion thread. The screen also presents the risk stratification for the selected patient and an option to print the board decision for offline use.

In the same part of the screen, the user can browse the other cases that had been examined in the same tumor board meeting. Again, the patient overview panel is available for quick inspection, together with the "open case" button to load the details of board meeting outcome for this case.

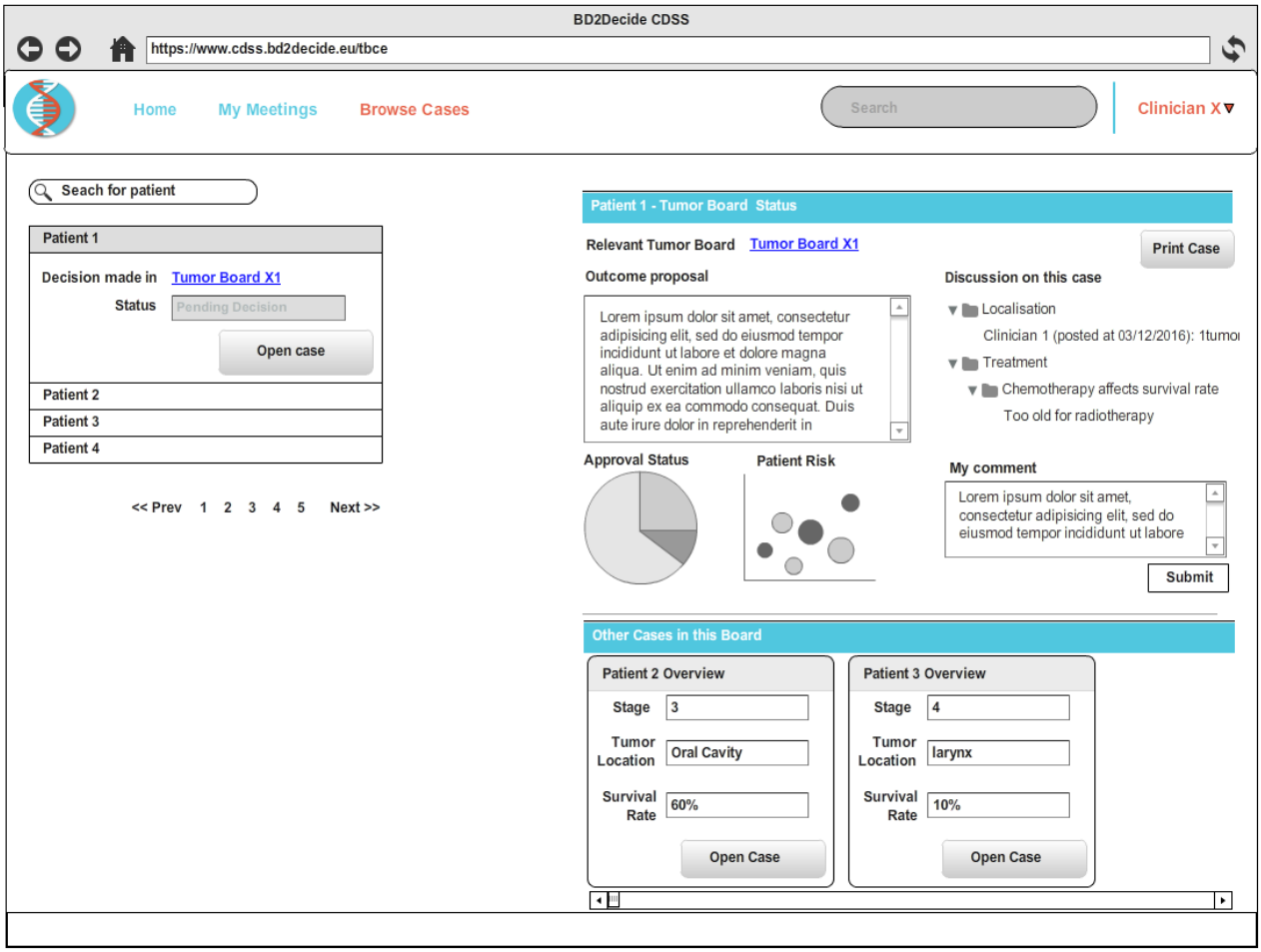


Figure 30: TBCE – The view for browsing the patient cases.

The screens presented in this section are part of the prototype that will be further evaluated by the clinical partners of the BD2Decide project to provide the best possible alignment with the process followed in a physical tumor board meeting in the course of the project.

4 CONCEPTUAL VISUALISATIONS OF THE VISUAL ANALYTICS TOOL

The Visual Analytics Tool (VAT) supports the work of the researcher, facilitating the representation, interpretation and sharing of H&NC data. Within the BD2Decide project, a big variety of clinical data is collected. Such data is generated from different sources and processed to support to the researcher. This support allows the user to make easy to be up to date in the H&NC status and to perform the analysis needed in the researches. Clinical and other data inputs such as population data are visualized in the VAT in a user-friendly way, after applying data analysis techniques such as statistical models or big data analysis. In this section, a first mock-up concept of this researcher tool is described.

Different from the CDSS, the VAT aim to exploit the BD2Decide data and represent it by offering decision support to the user. To achieve that, the VAT includes specific features, such as a powerful and dynamic visualization of patients' data, a set of research queries, correlation finding and innovative visualization techniques.

The researcher suite includes diverse functionalities designed as independent modules. The next sections describe each module with the corresponding mock-up representation and functionality.

The definition and the design of the VAT tool follows the User Centred Design (UCD) methodology, described in *About Face* book by Cooper. UCD focuses on the end users of a product, in which all user needs are kept in mind at all stages within the design, development and evaluation lifecycle. The UCD approach is divided in two main stages: conceptualization and development (see Figure 31).

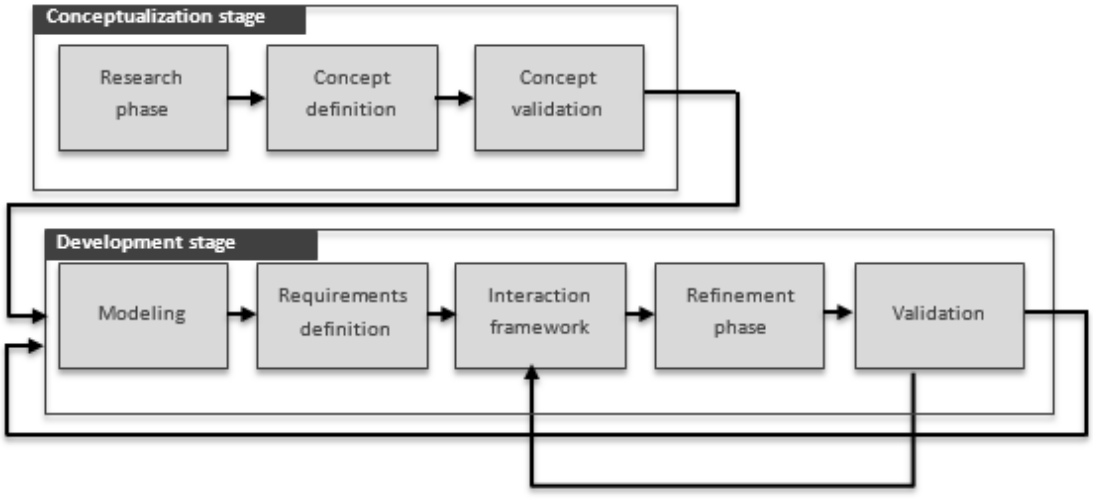


Figure 31: User centered design schema

At this point of the BD2Decide project, the conceptualization stage and the first two phases of the development stage have been executed, while the last three phases are currently in process. A first concept definition of the VAT was presented in the deliverable "D2.1 - User needs and use cases", after performing the first research phase (including DoA requirements and state of the art study). A

new concept definition of the tool was successively defined on the user needs' results and the outcomes from a survey executed to a group of clinicians. The results of the last definition were presented in the deliverable "D2.2 - User interaction sketches". Finally, additional research work and evaluation techniques (such as *heuristic evaluation* and *focus group*) were carried out and, after the corresponding analysis results, a first definition of the VAT prototype was generated. This mock-up definition is constantly in evolution thus the interaction framework is changing and also the refinement phase is in progress.

4.1 Research project management

With the purpose of helping end-users to perform research activities in a structured way, the VAT is organized in 'projects': a project contains the whole analysis carried out during a specific research activity (e.g. all the queries, correlations and related bibliography). One or more active projects can be created and managed by the same user; the tool allows switching between projects in a user-friendly way, as is explain in this paragraph. Examples of these functionalities are shown in Figure 33, Figure 34 and Figure 35.

The first action the researcher has to take after login (Figure 32) is to select the project to work on (Figure 33). All the research activities executed within a project are stored by the system, in order to allow the researcher to exit the project whenever he/she want and look it up in another moment.

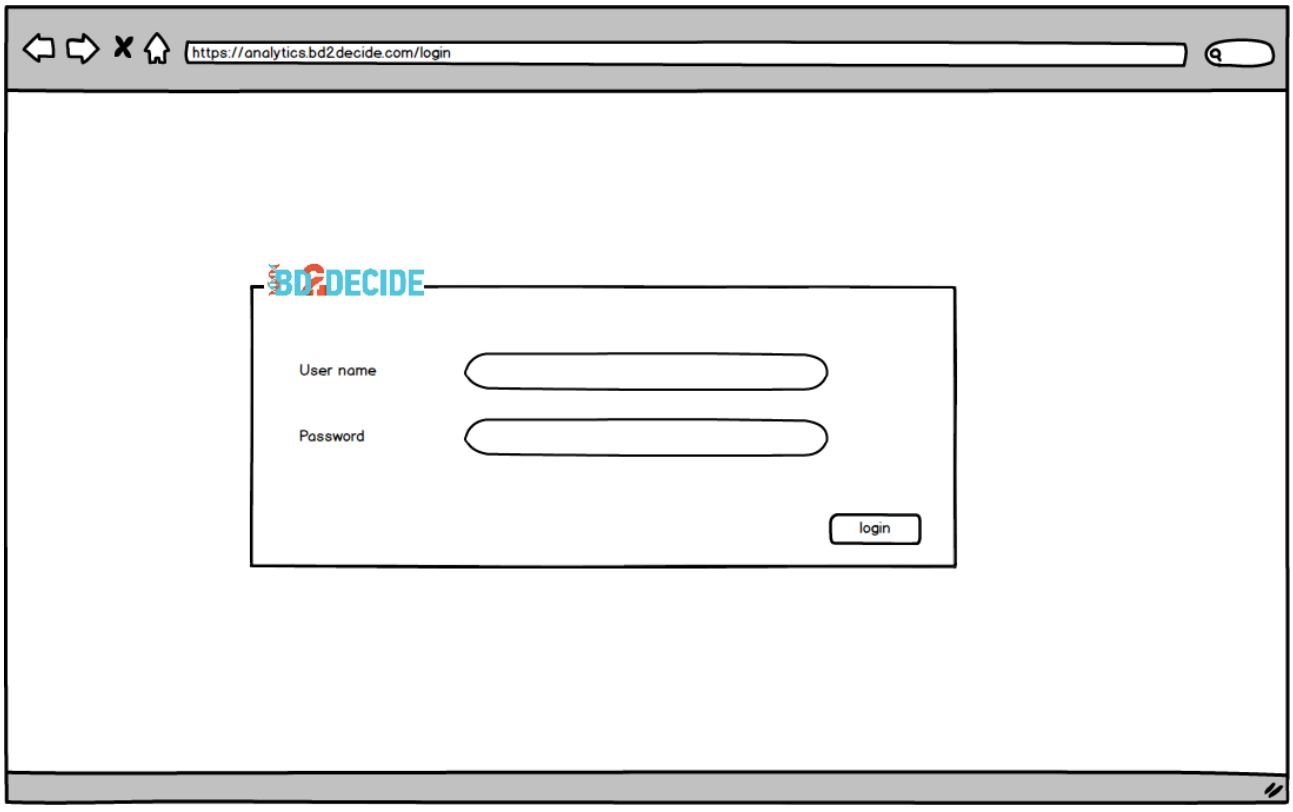


Figure 32: VAT login

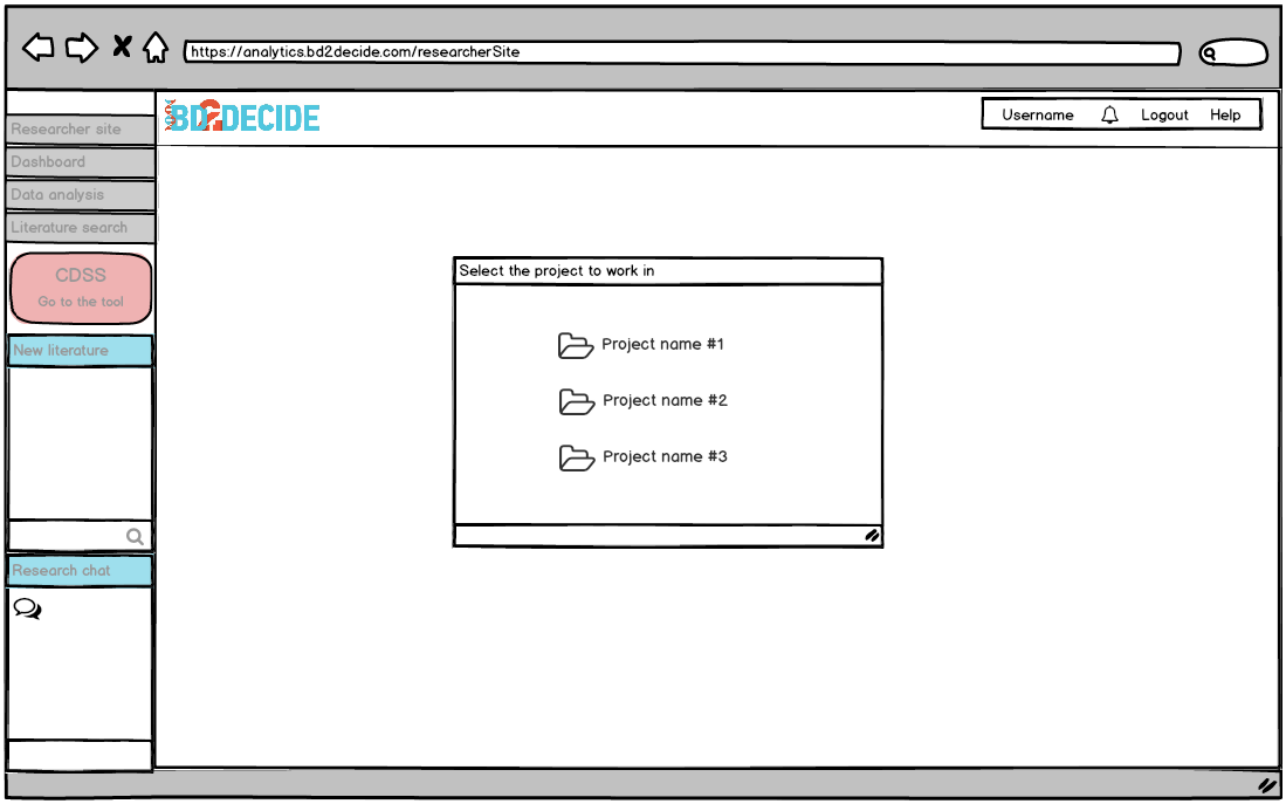


Figure 33: VAT project selection

Figure 34 shows a view of the main fields provided for each project. It is possible to visualize the specifications of the project that the researcher is currently working on (left side) and check the list of the created projects (open and closed ones). In this view, the researcher can edit and share with his/her research network specific data and information of the project (e.g. findings, outcomes…). In addition, it is possible to share the whole project or close it.

Additionally, it is possible to create a new project (Figure 35) or select another one. Once a project is selected, it is possible to start working in this one. There is a button named 'Work on this project' (bottom left corner in Figure 34) that allows this change of the project. It appears disabled when the project details correspond to the current project the researcher is working on, but appears enabled when the project view corresponds to other project the researcher is not currently working on.

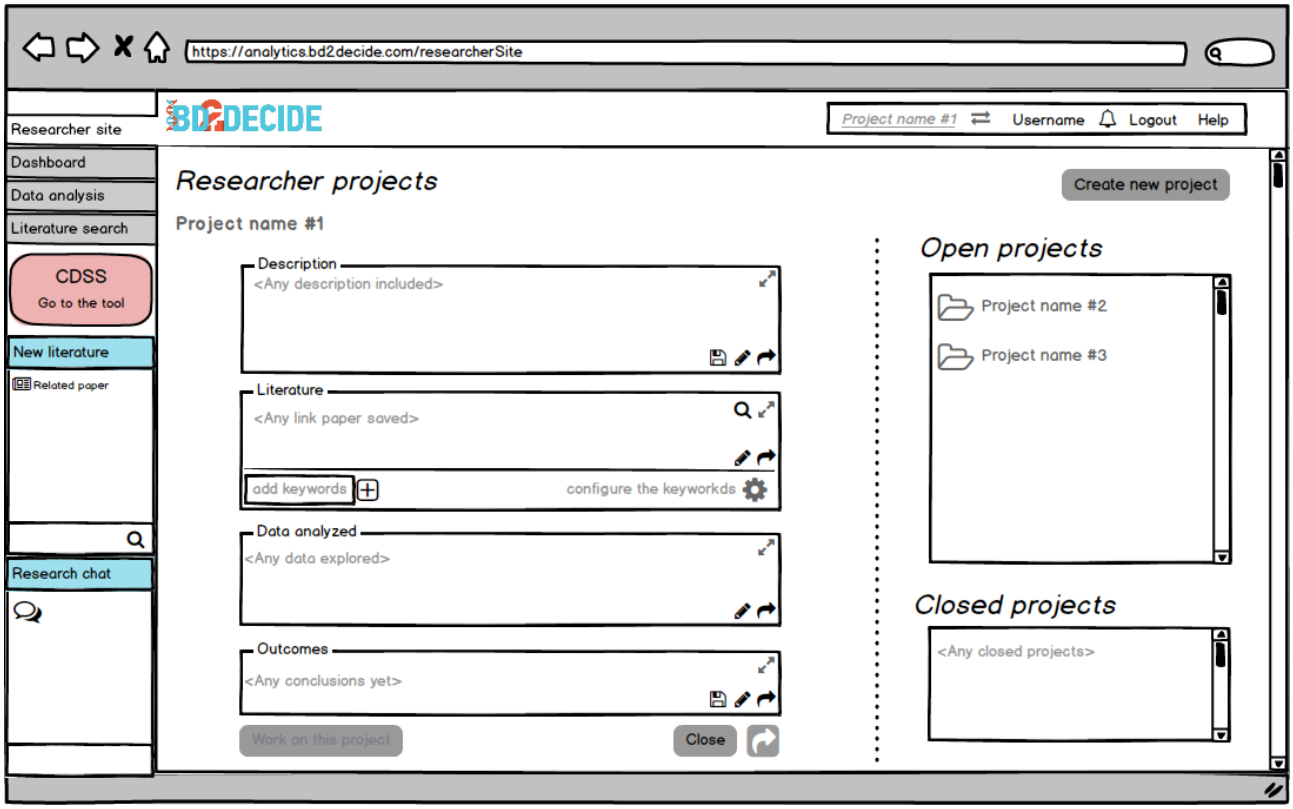


Figure 34: VAT projects

In the project details view, the literature documents stored are visible. It is also possible to share ( ) all of them or a desired one to the researcher network. The magnifying glass icon allows direct access to the literature search module (explained in the next sections).

Although the VAT makes use of a predefined keywords set with the aim of facilitating the literature search, the researcher can configure them by modifying the predefined set and adding new keywords.

In the 'Data analyzed' box, all the research queries of interest performed during the work are available. It is possible to share, edit and delete the queries.

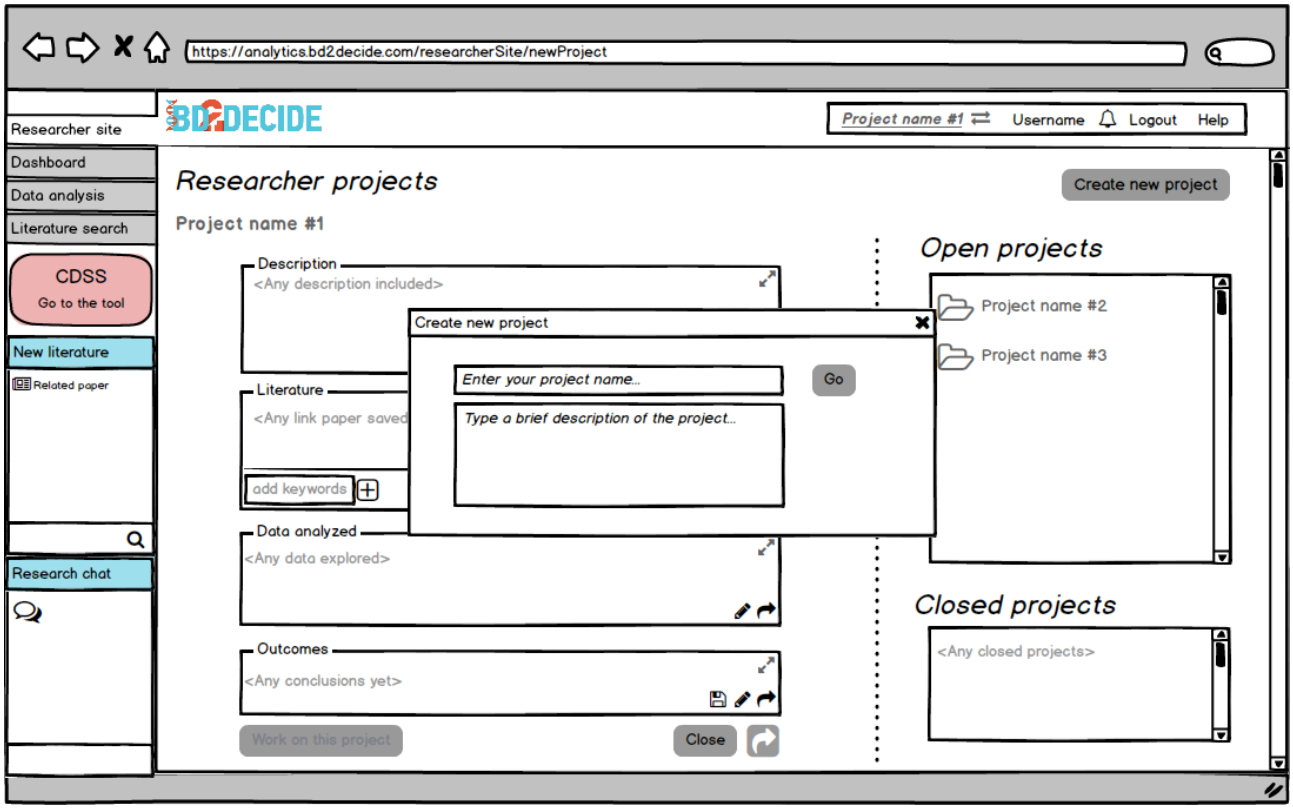


Figure 35: VAT create new project

4.2 Researcher network

The *Researcher network* module is designed with the purpose of allowing the researchers to share his/her work activities and be connected with other researchers. Among many advantages, the data sharing improves the common knowledge of the researcher network, by looking up other researchers' activities and publications, increasing the possibility of new scientific evidence.

Once the user selects a project she/he wants to work on, the researcher network main screen appears (Figure 36). The researcher can see the feedback, suggestions and comments from other researchers on her/his research publications and posts (comments, questions, etc.). Moreover, the user can visualize the work shared by other users. The network is customizable and the researcher can decide what to see and what to share.

In order to customize the preferences and the area of interest, the researcher can access the 'Edit my profile' tab (Figure 37). In this section, the researcher can specify the fields of interest, skills, paper links, a brief description of himself/herself and his/her current position. Additionally, she/he can include a profile picture and specify the network activity options.

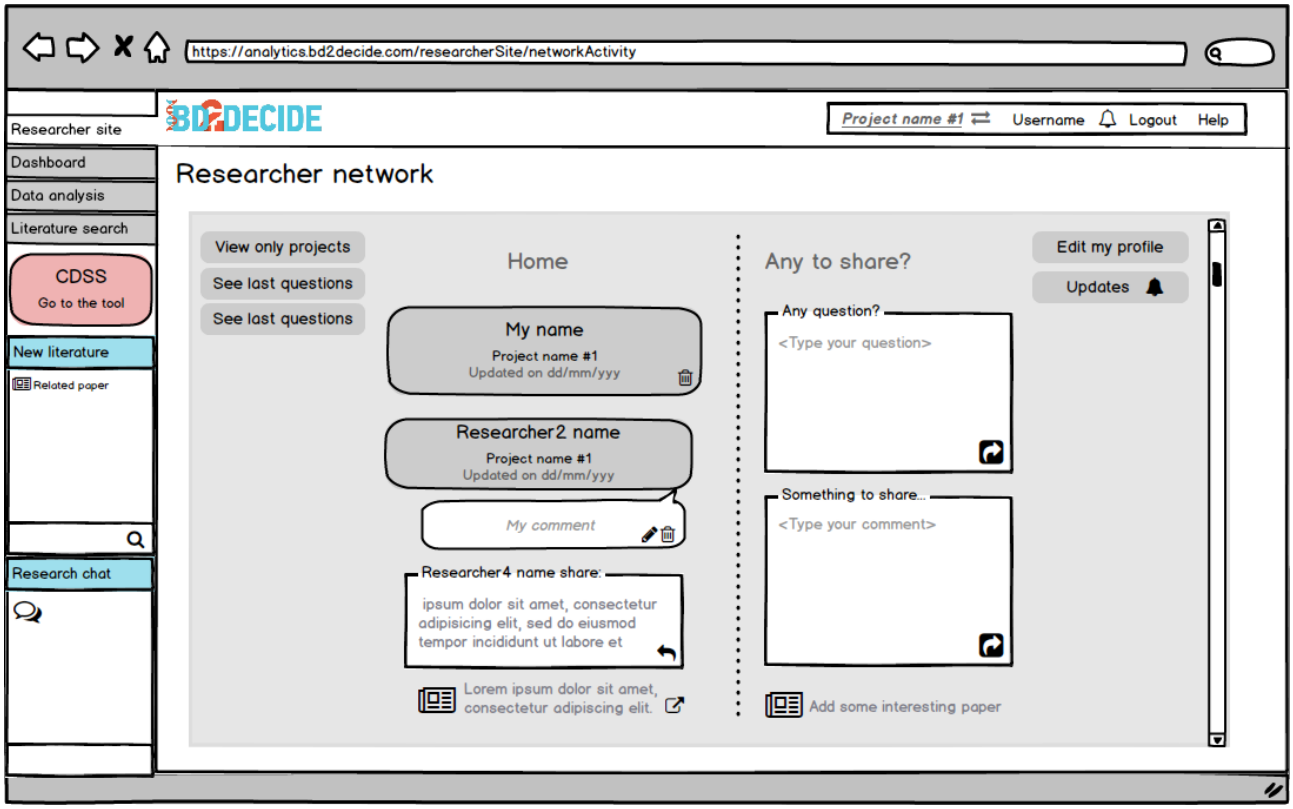


Figure 36: VAT researcher network

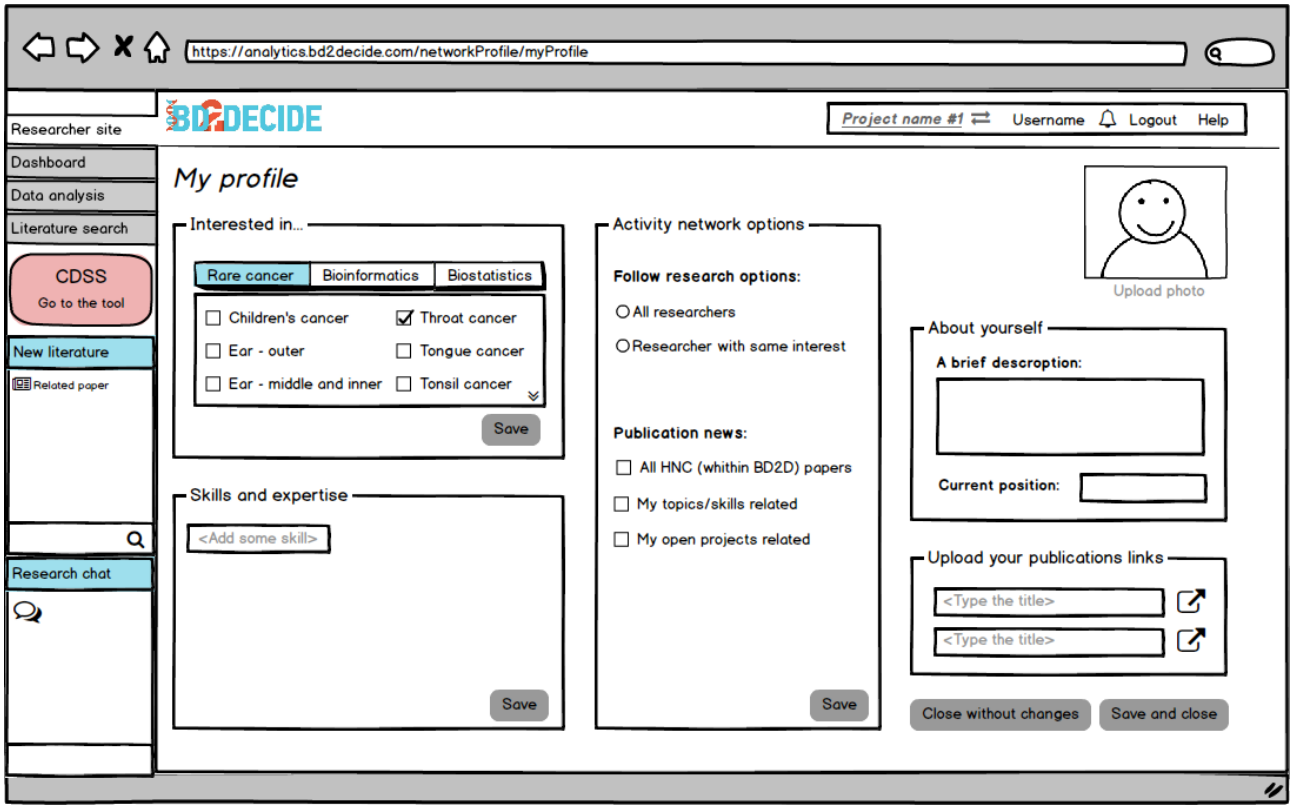


Figure 37: VAT researcher profile

4.3 Dashboard

This module has the purpose of providing a general overview of head and neck cancer research status within the BD2Decide context. By default, it is predefined but is possible to customize all the window items and adapt the visualization to the project or researcher's needs.

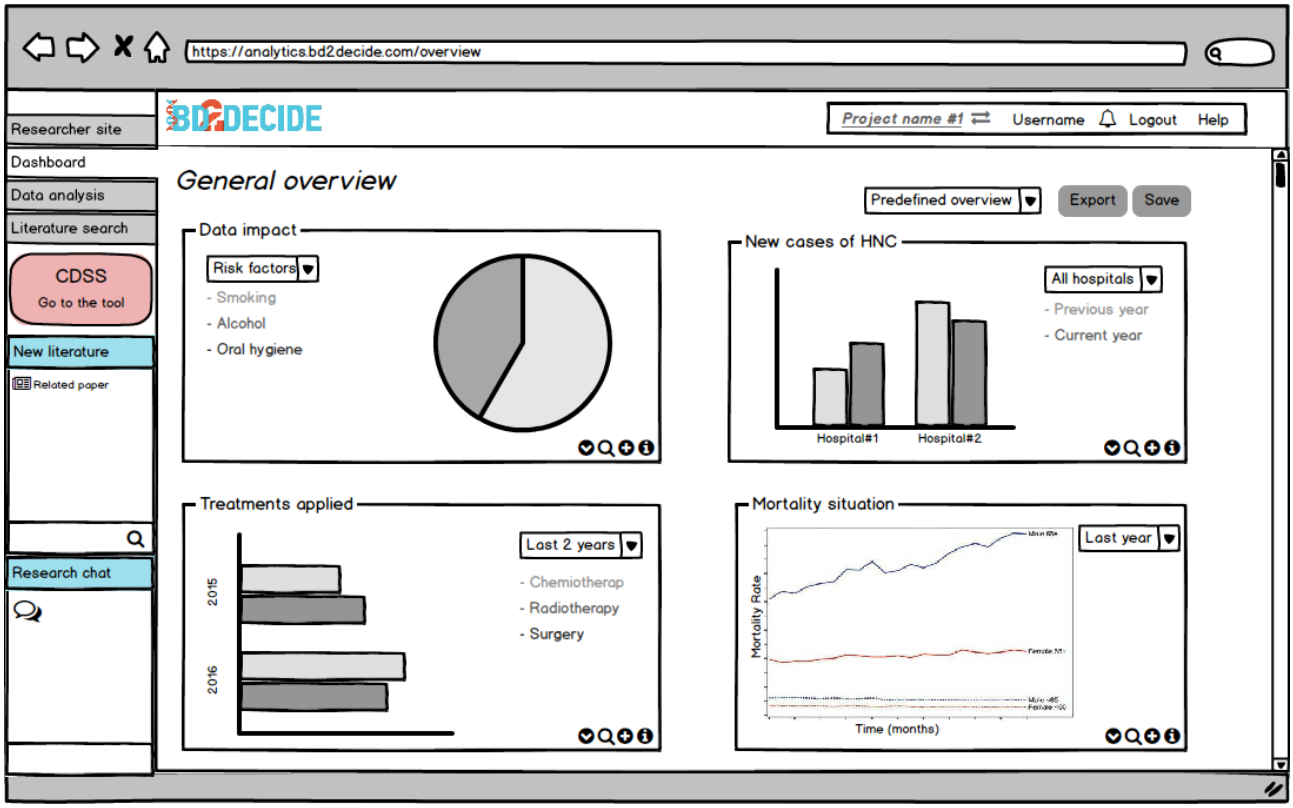


Figure 38: VAT Dashboard

As shown in the Dashboard mockup (Figure 38), the overview is configurable and exportable. In the table below, the drop-down menus options that allow changing the set of data to be represented are included.

Section	Data impact (pie chart)	New cases of HNC compared with the previous year (bar chart)	Treatments applied (column chart)	Mortality situation (Hazard ratio)
Dropdown section data	Risk factors	All hospitals	Last 10 years	Last 10 years
	TNM classification	Italy hospitals	Last 5 years	Last 5 years
	HPV status	Germany hospitals	Last 2 years	Last 3 years
	Tumor region	Netherland hospitals	Last 6 months	Last 2 years

Table 2: Dashboard customization options

A toolbar is included on each graph to give additional information on the chart. From left to right: export data, search related literature, data content and data info (description). An example of the individual graph toolbar is provided in Figure 39, where it is possible to see the information of clicking in the magnifying glass icon.

It is possible to export the whole dashboard and to save the configuration (if modified). All generated results can be exported in the most widely used formats (Figure 40 and Figure 41), allowing the research to use these outcomes on further analysis through external analysis tools.

Once saved, it is possible to come back again through a saved overview configuration, by selecting the 'Predefined overview' option in the drop-down menu.

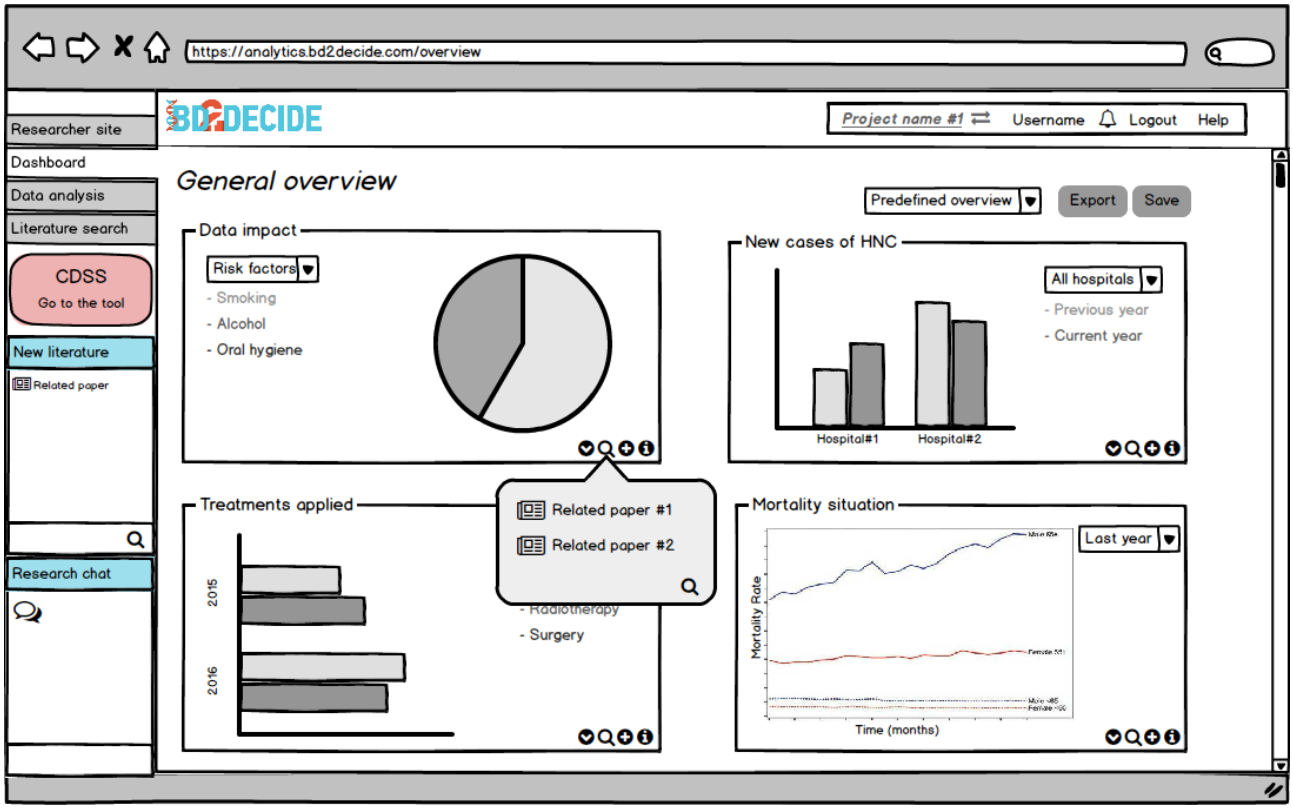


Figure 39: VAT dashboard literature search toolbar option

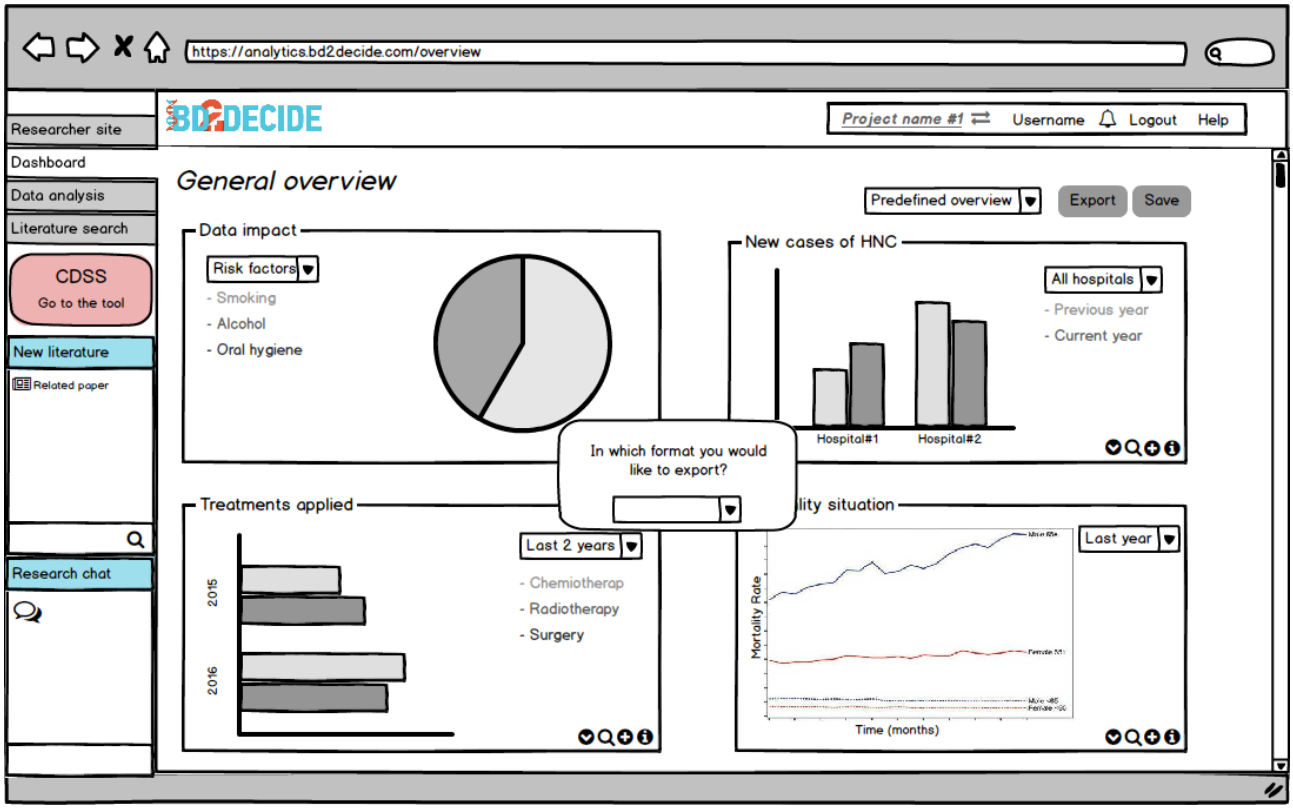


Figure 40: VAT dashboard export results (I)

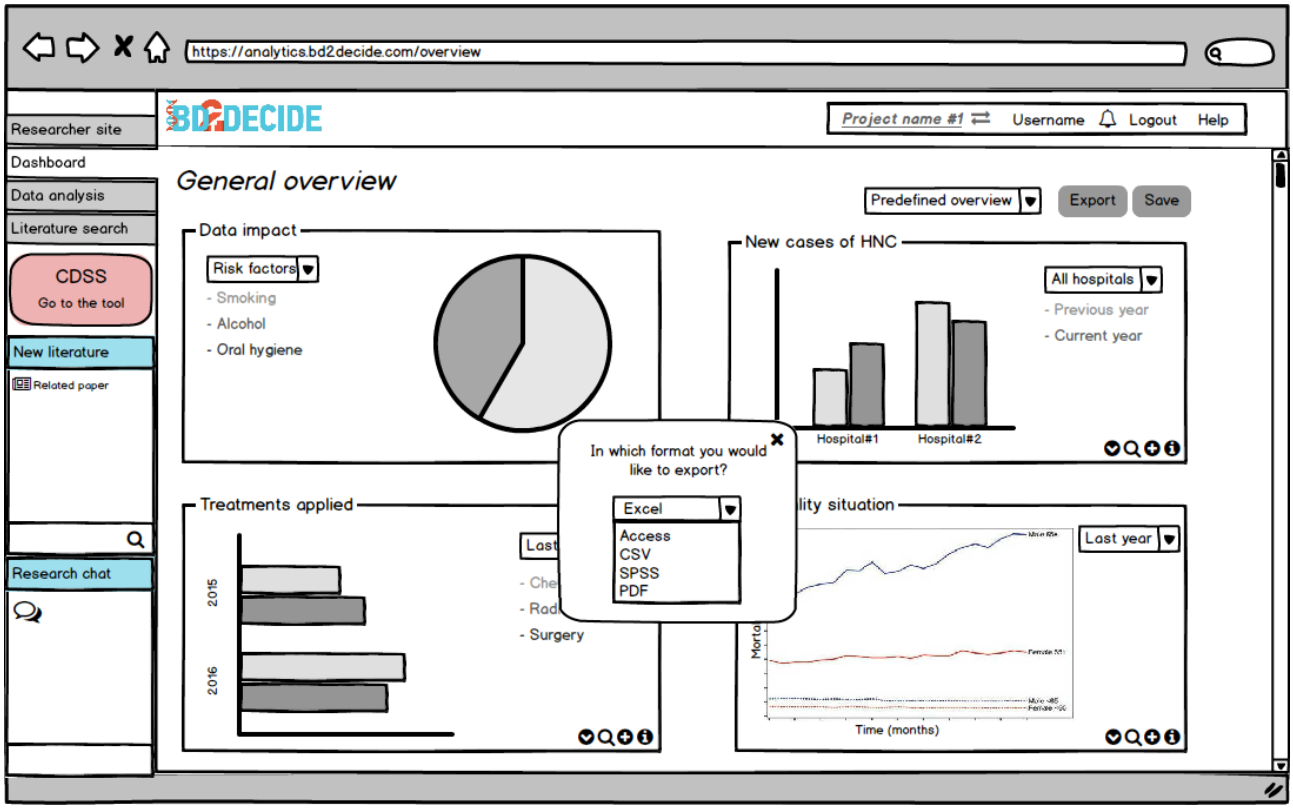


Figure 41: VAT dashboard export results (II)

4.4 Data analysis

The *Data analysis* module is divided in three main sections (as shown in Figure 42):

1) *BD2Decide queries*: it allows querying all BD2Decide datasets that are part of the BD2Decide system.
2) *Query external data sources*: it allows to perform queries to external databases, with the aim of retrieving more data to contrast with the BD2Decide queries and to complete the analysis.
3) *Select or simulate a patient*: it allows to select a specific patient or to simulate a patient with certain features of interest to compare (to look for correlations) or to run the decision maker module.

The *BD2Decide queries* module is the section that gives a direct support to the researcher for the data analysis. This module provides direct access to all the BD2Decide datasets and allows the user to specify which *outcomes* she/he is looking for, and under which *conditions* (Figure 43). It is possible to save the queries, which will also appear in the 'Data analyzed' section for the project.

By clicking the 'Show results' button (in Figure 43), the results of the queries appear (Figure 44). Each result of the data analysis contains a toolbar with *export data*, *search related literature*, *data content* and *data description* buttons. It is also possible to customize the visualization of the results (adding more graphs, moving them, etc.).

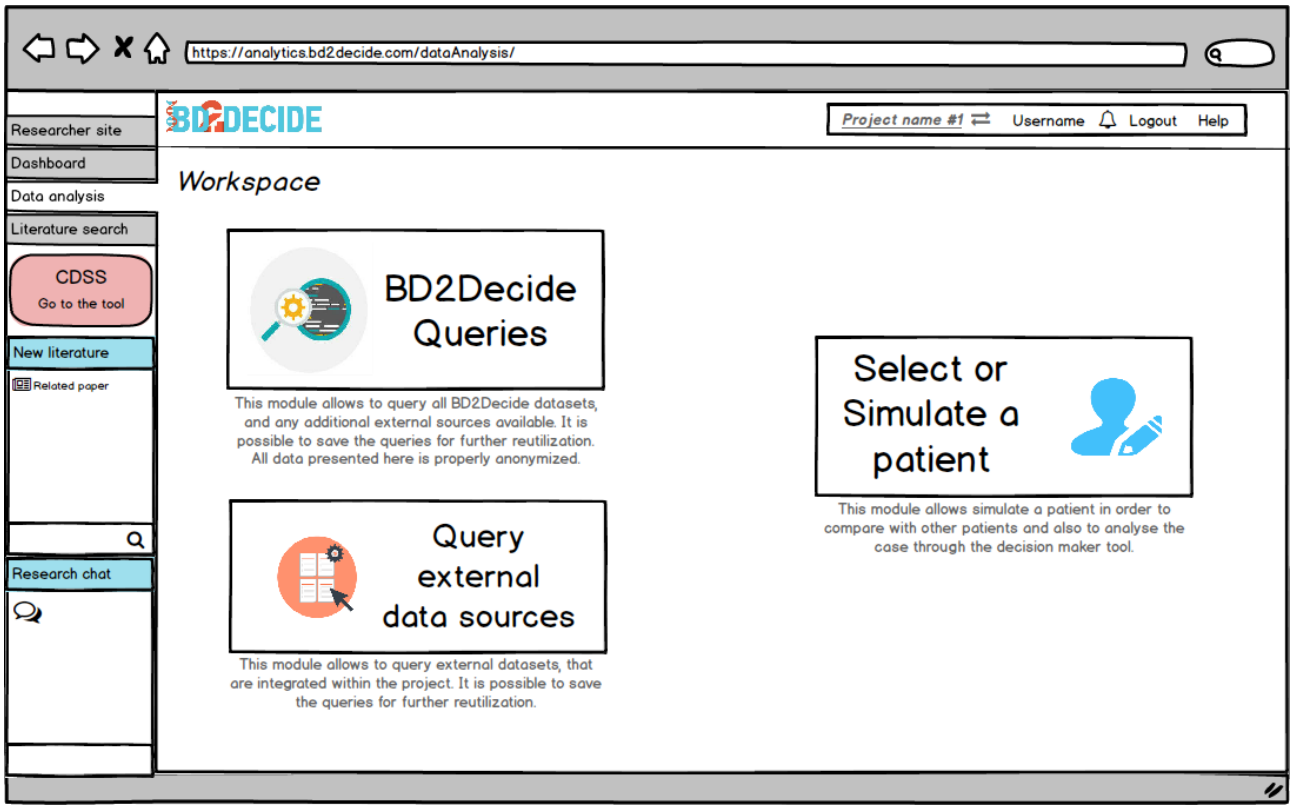


Figure 42: VAT data analysis workspace

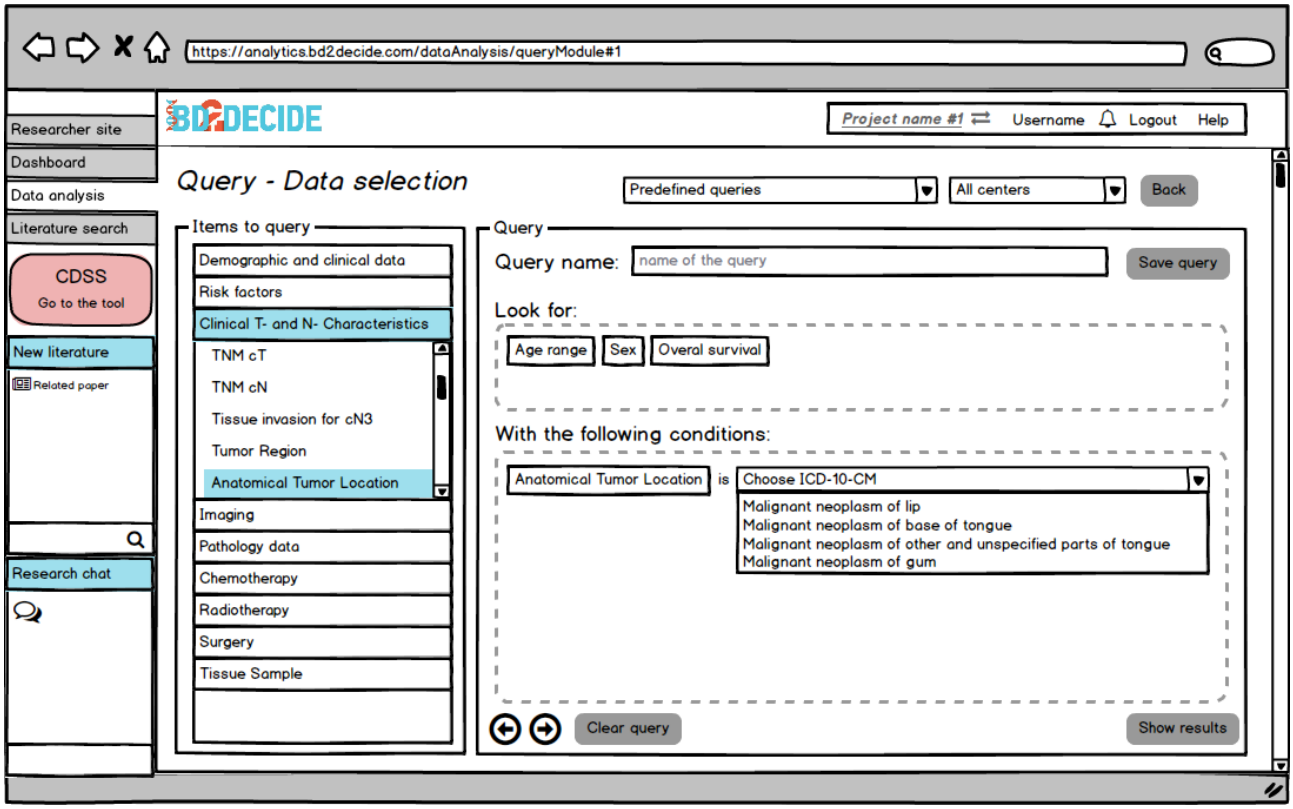


Figure 43: VAT BD2Decide queries - data selection

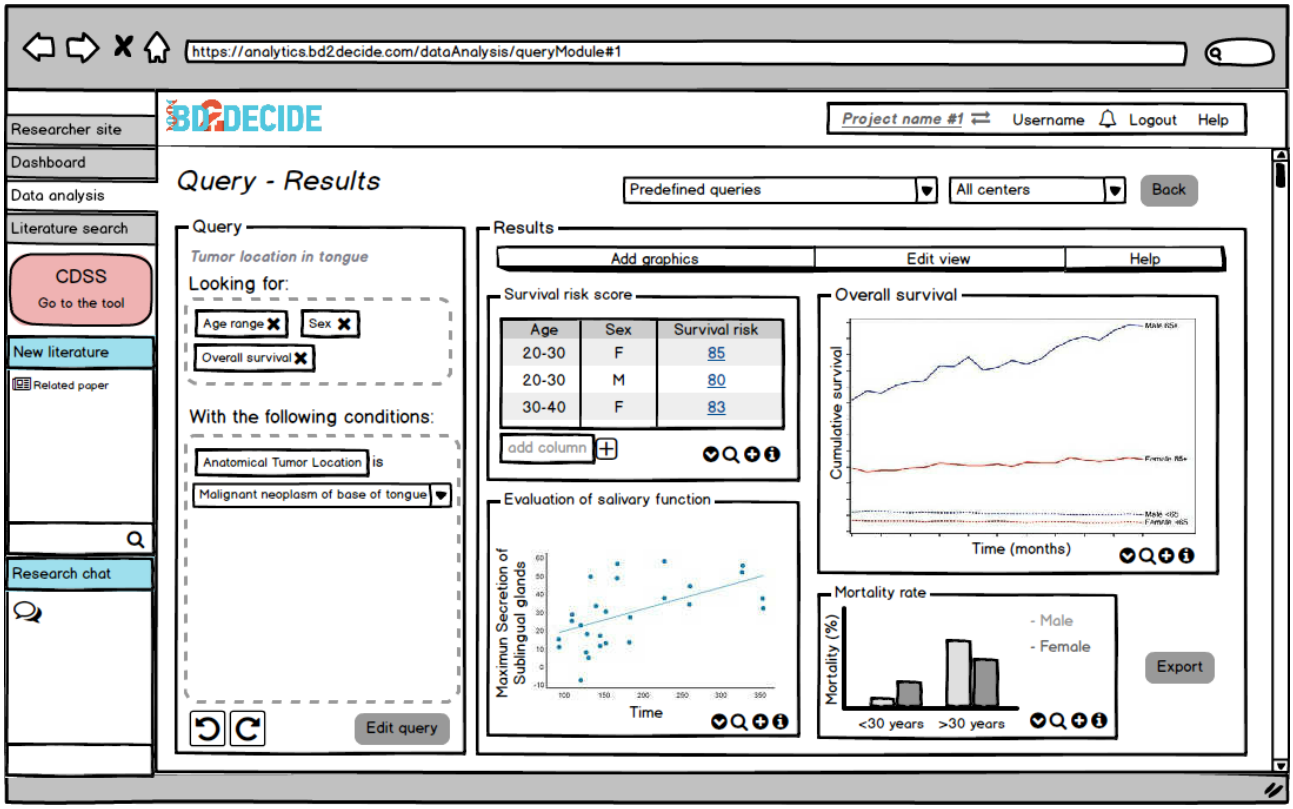


Figure 44: VAT BD2Decide queries - results

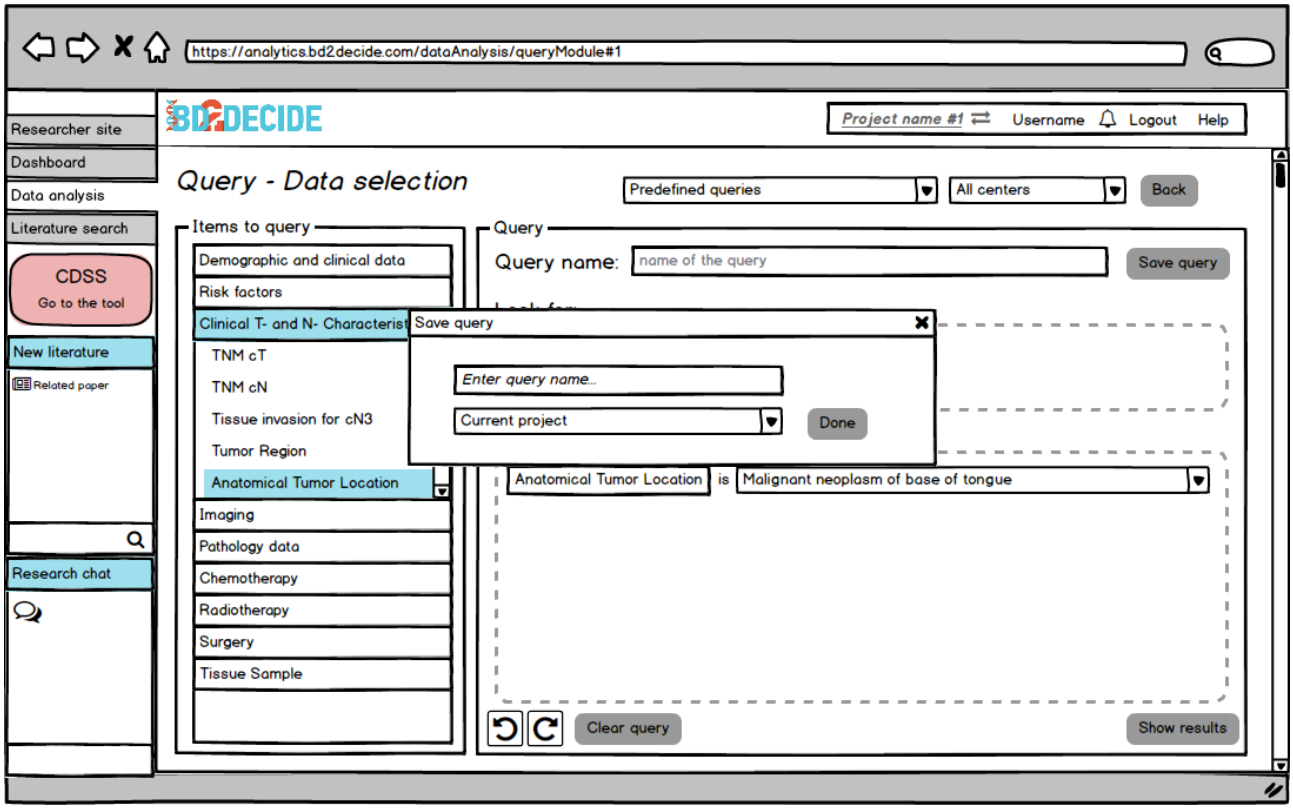


Figure 45: VAT BD2Decide queries - save query

Within the *Query external data sources*, it is possible to get access to external data sources (through a set of APIs specifically developed for this purpose, as defined in D2.3). Three main groups of datasets are defined (Figure 46, see D7.2 for more details).

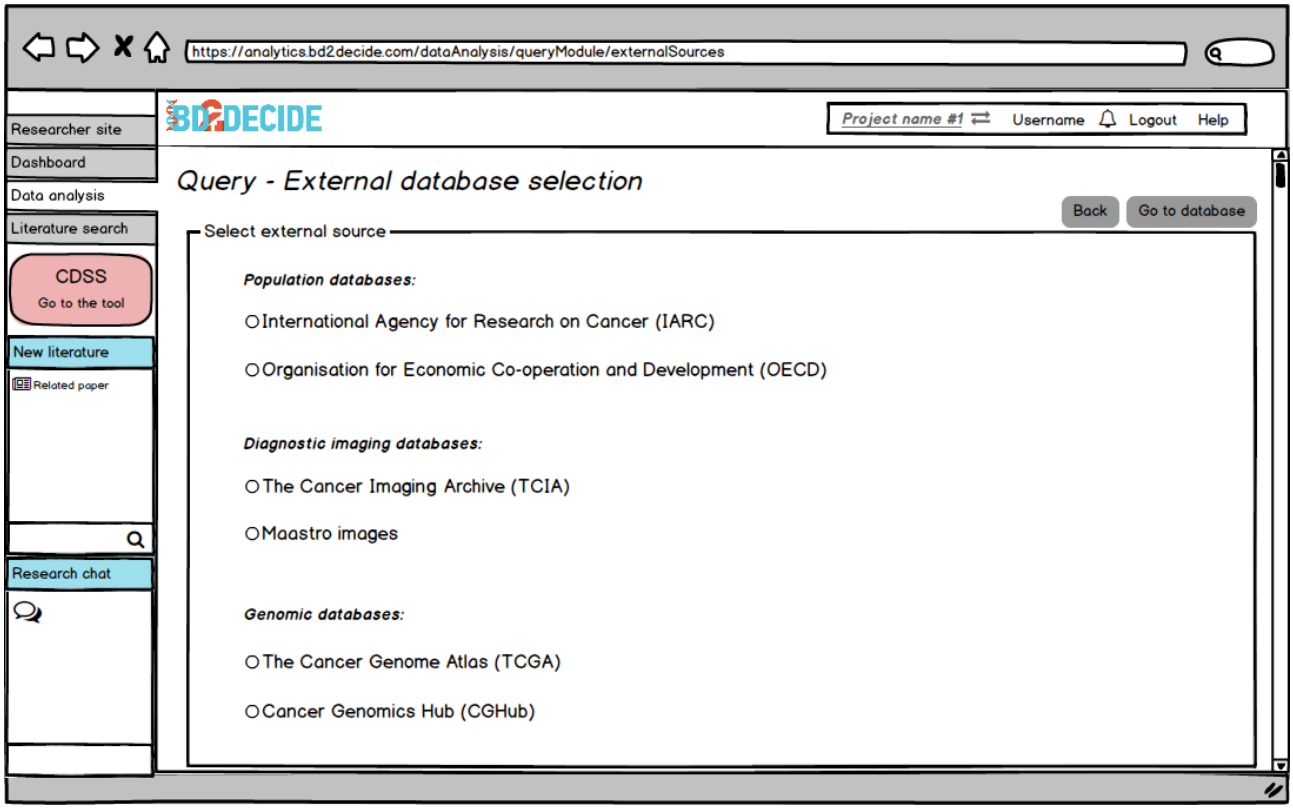


Figure 46: VAT query external datasets

By selecting a dataset, a brief description is shown (see Figure 47). By clicking on 'Go to database' button, the interface of the selected dataset is shown (Figure 48). These queries can also be saved and exported.

The *Select or simulate patient* section presents a view with two options: selecting a patient through the BD2Decide patient ID and modelling a patient through selecting specific features of interest (Figure 49). Once selected, the researcher clicks on 'Select current case' and choose the analysis to carry out (Figure 50): comparing with similar cases or running the decision maker suite.

By selecting 'Comparing similar cases', the tool represents the results, as shown in Figure 51. Among the results, visualization and correlation graphs are included for finding new evidence between different types of data. Other visualizations are included, such as similarity graphs and treatments evolution.

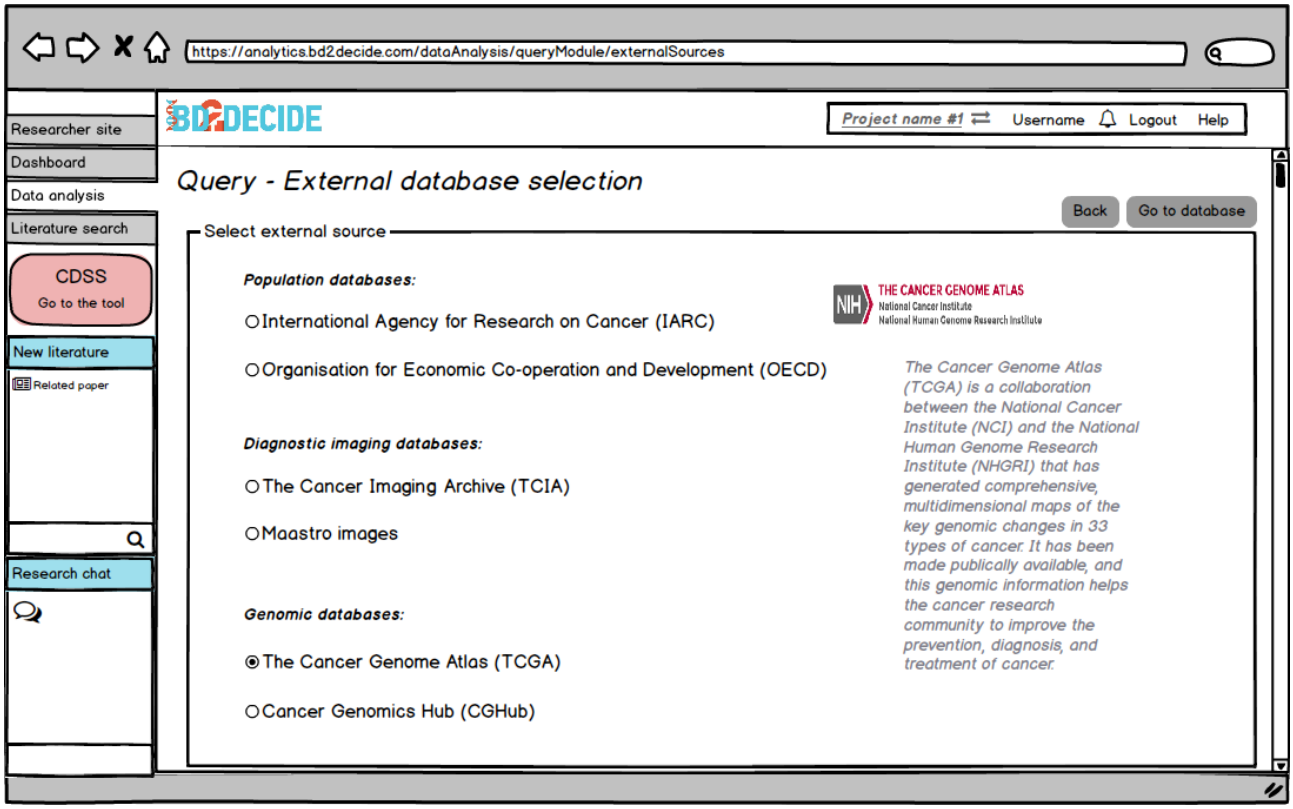


Figure 47: VAT Query TCGA external database selection

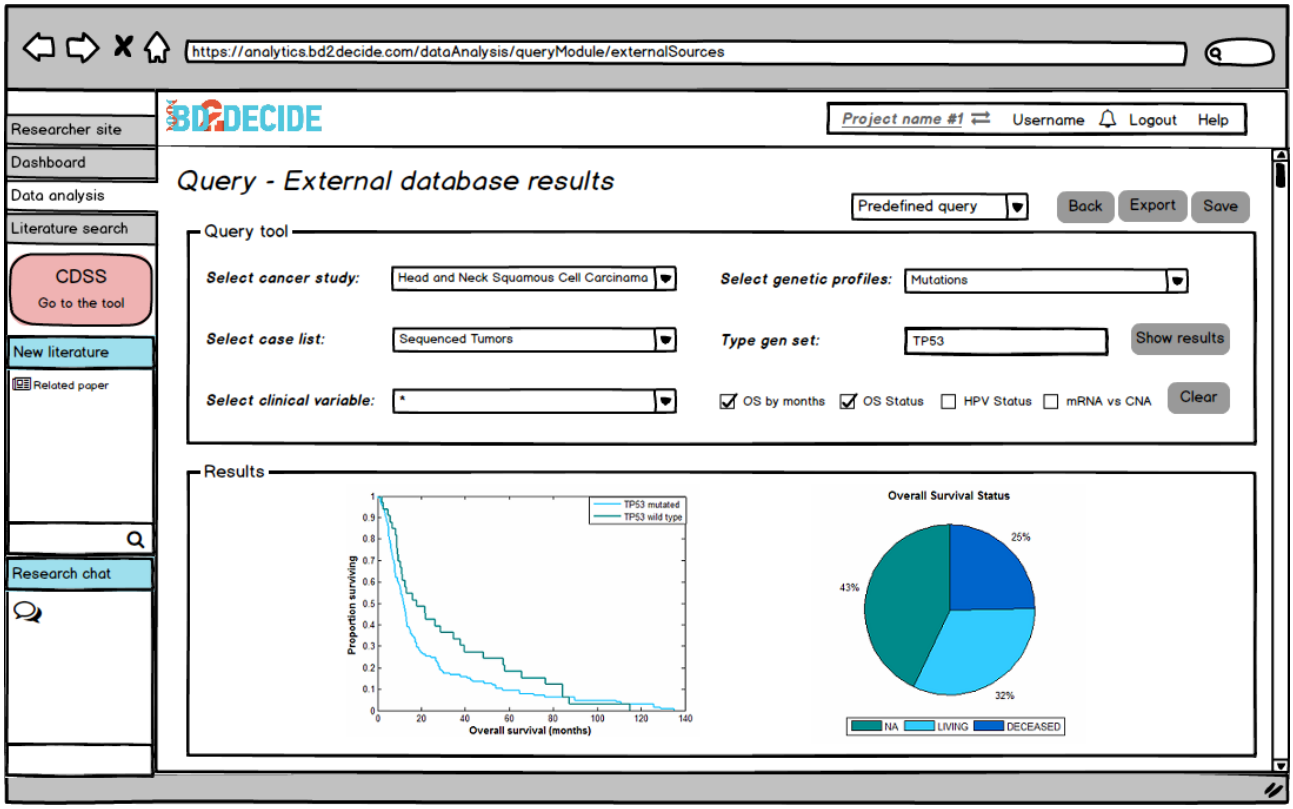


Figure 48: VAT Query TCGA external database API

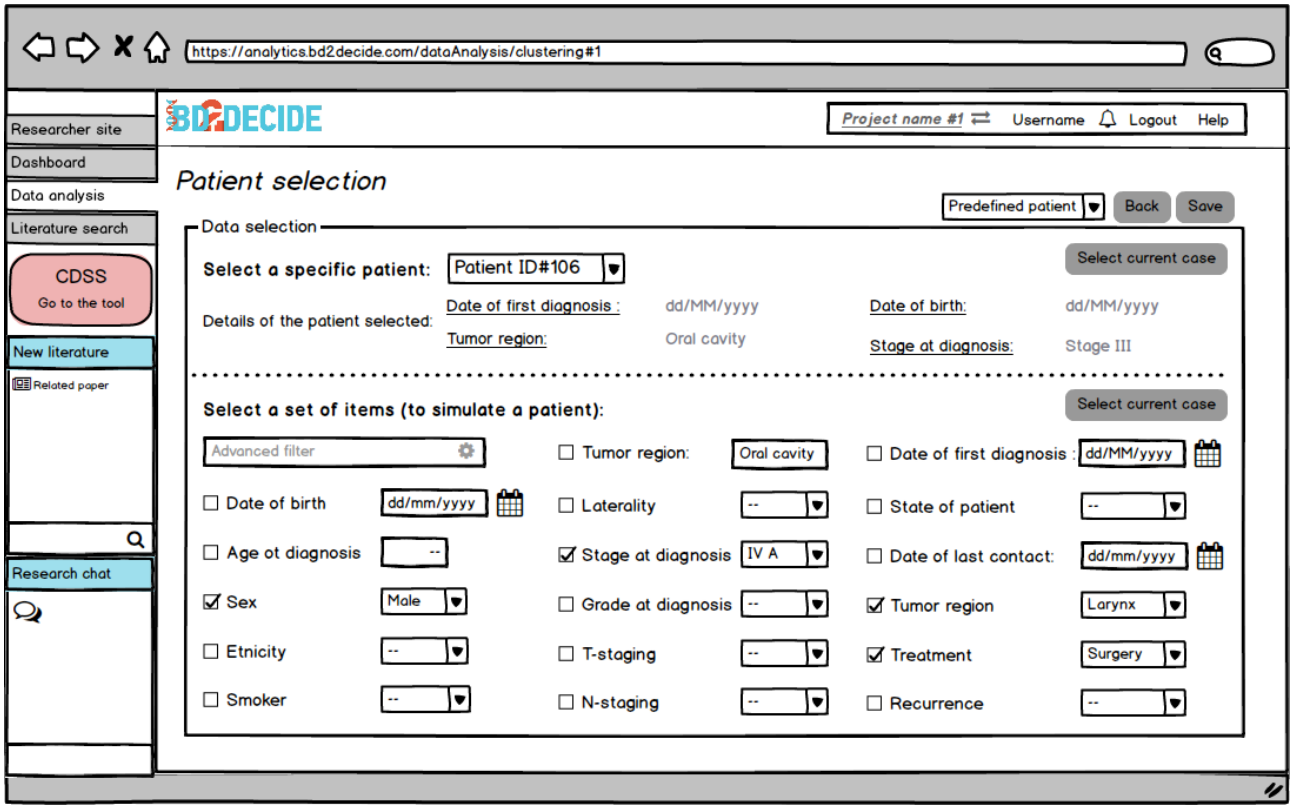


Figure 49: VAT patient selection

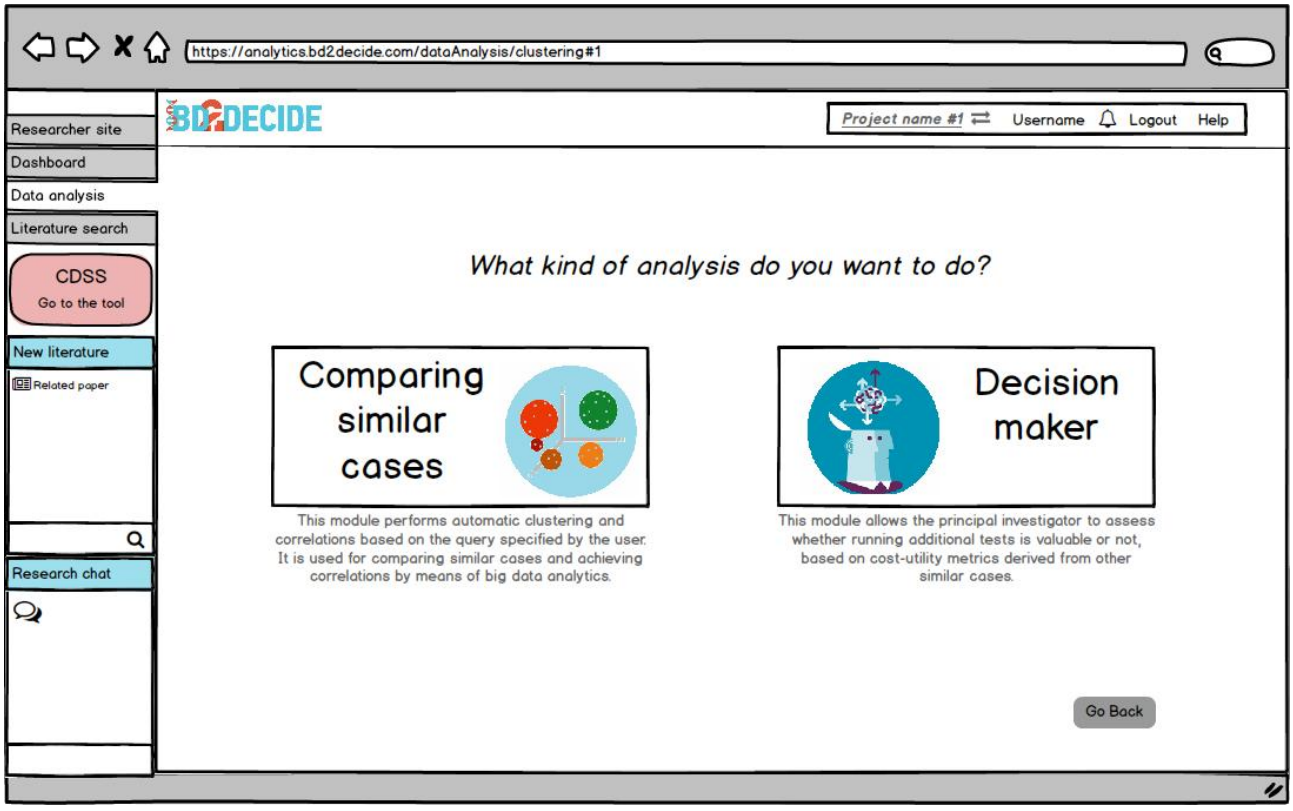


Figure 50: VAT options for patient data management

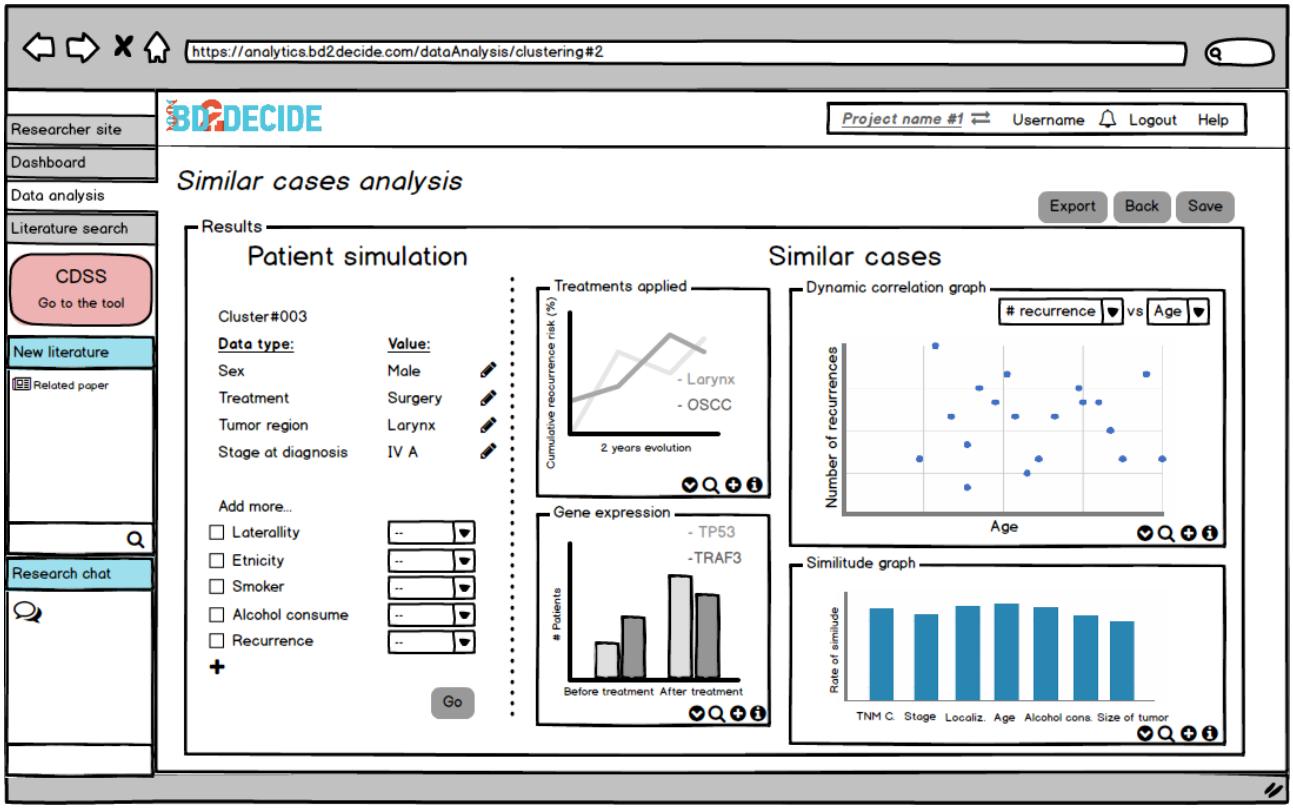


Figure 51: VAT similar cases analysis

By selecting the 'Decision maker', an analysis of the patient selected (real or virtual) on the left and the possible data to add on the right appear, as shown in Figure 52. The purpose of this module is to assess the cost and expected improvements (for instance, the expected survival rate) of applying a specific treatment (Figure 53).

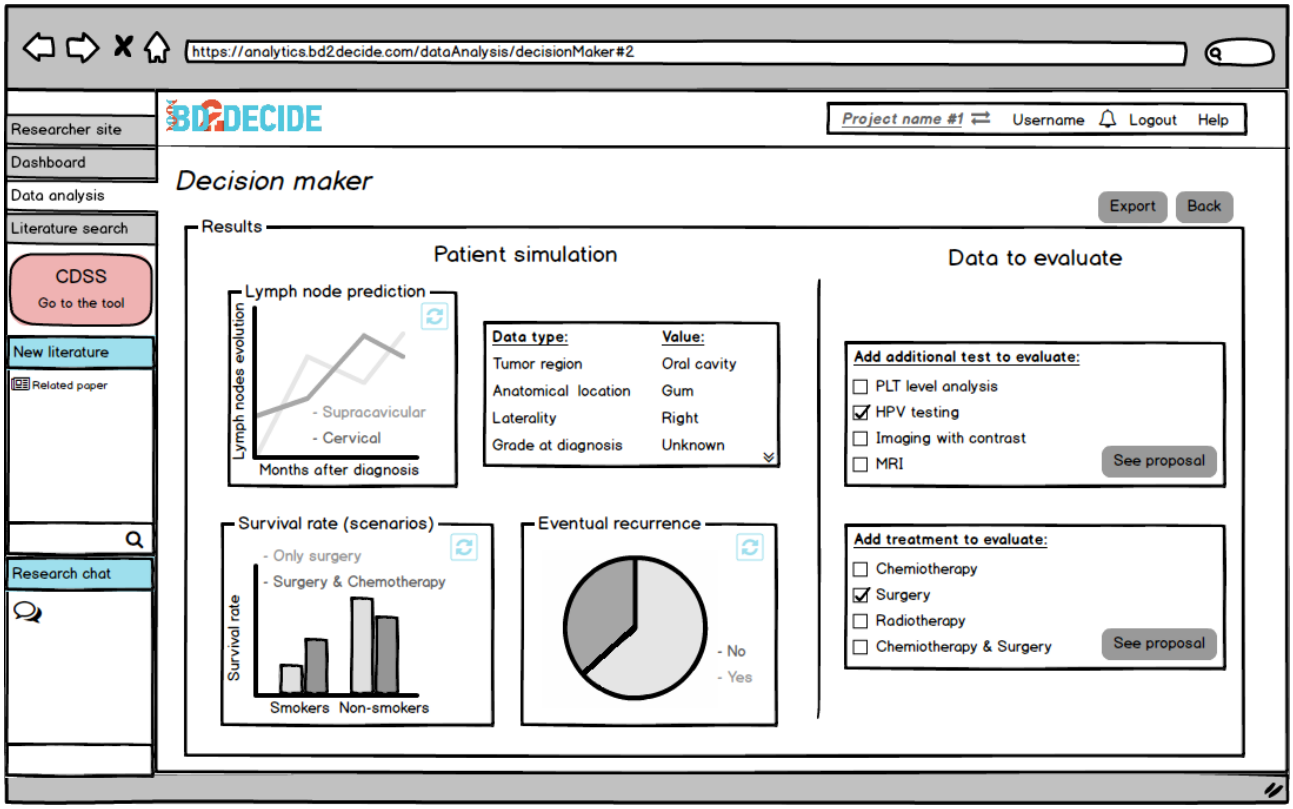


Figure 52: VAT decision maker after selecting the patient

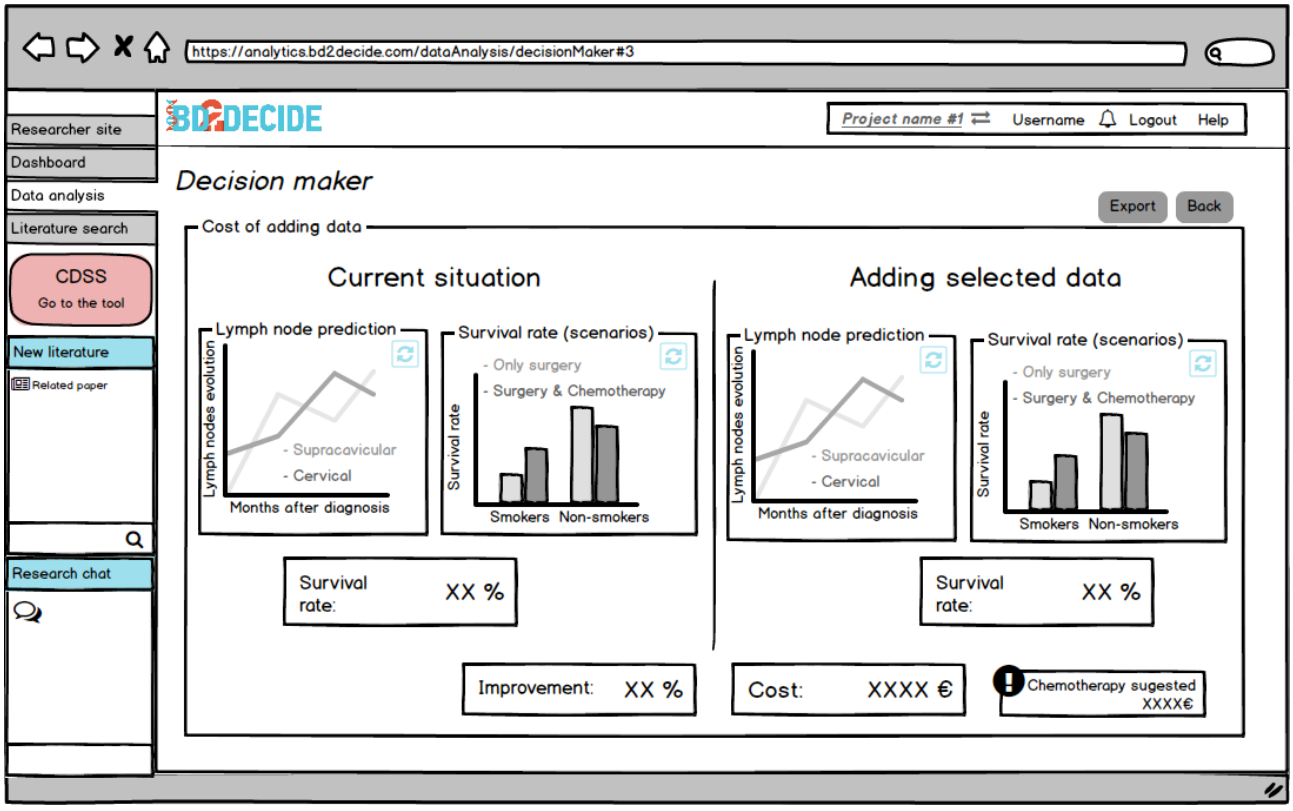


Figure 53: VAT decision maker results

4.5 Literature search

Literature search main page is shown in Figure 54.

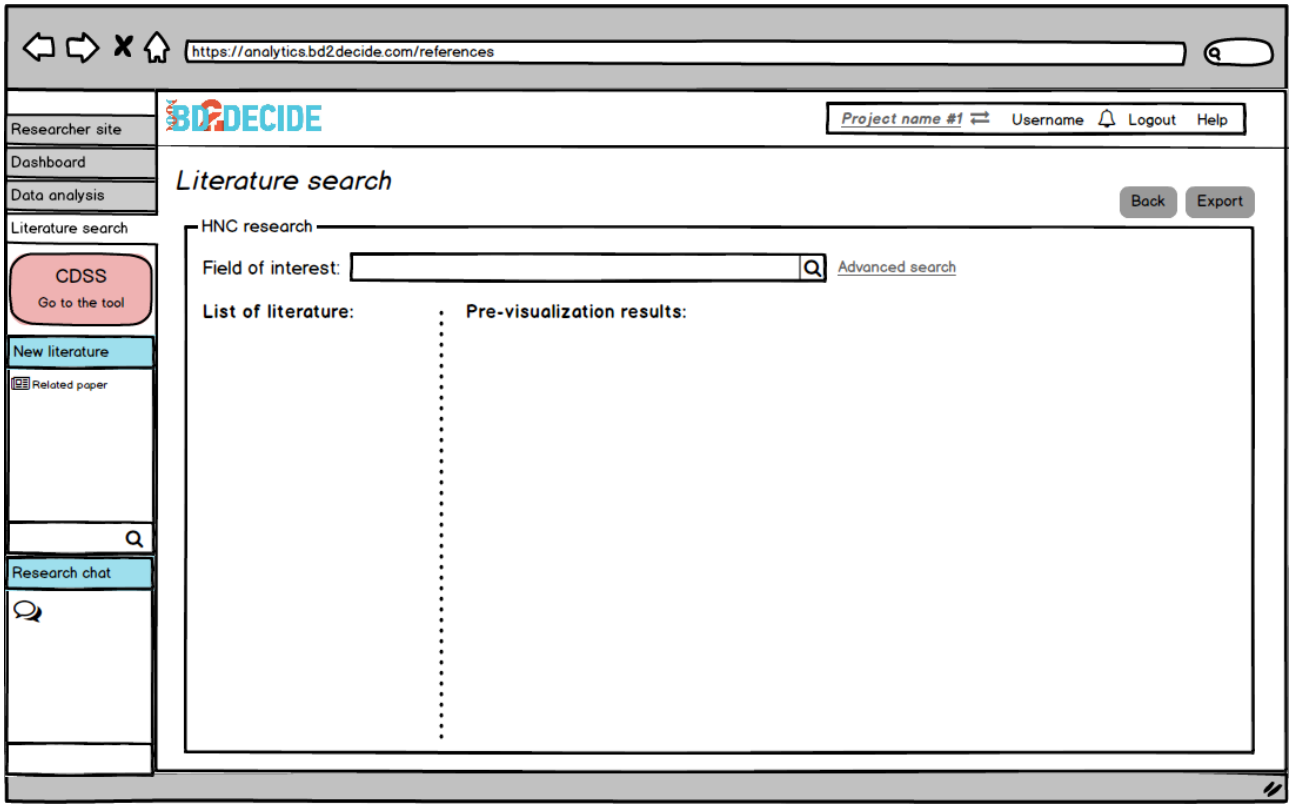


Figure 54: VAT literature search

The module allows to search for papers, journal articles, scientific publications, and more in an easy way, avoiding clinician researcher the need of access to external resources. When a field of interest is specified, a list of publications appears (left side in Figure 55).

The results show a list of selected papers (Figure 56) that can be visualized and downloaded (the papers reviewed and saved will be available within the project details section). This pre-visualization is a result of the big data analysis that make use of the list of papers resulted from the search, (e.g. stats about the papers published on a certain risk factor).

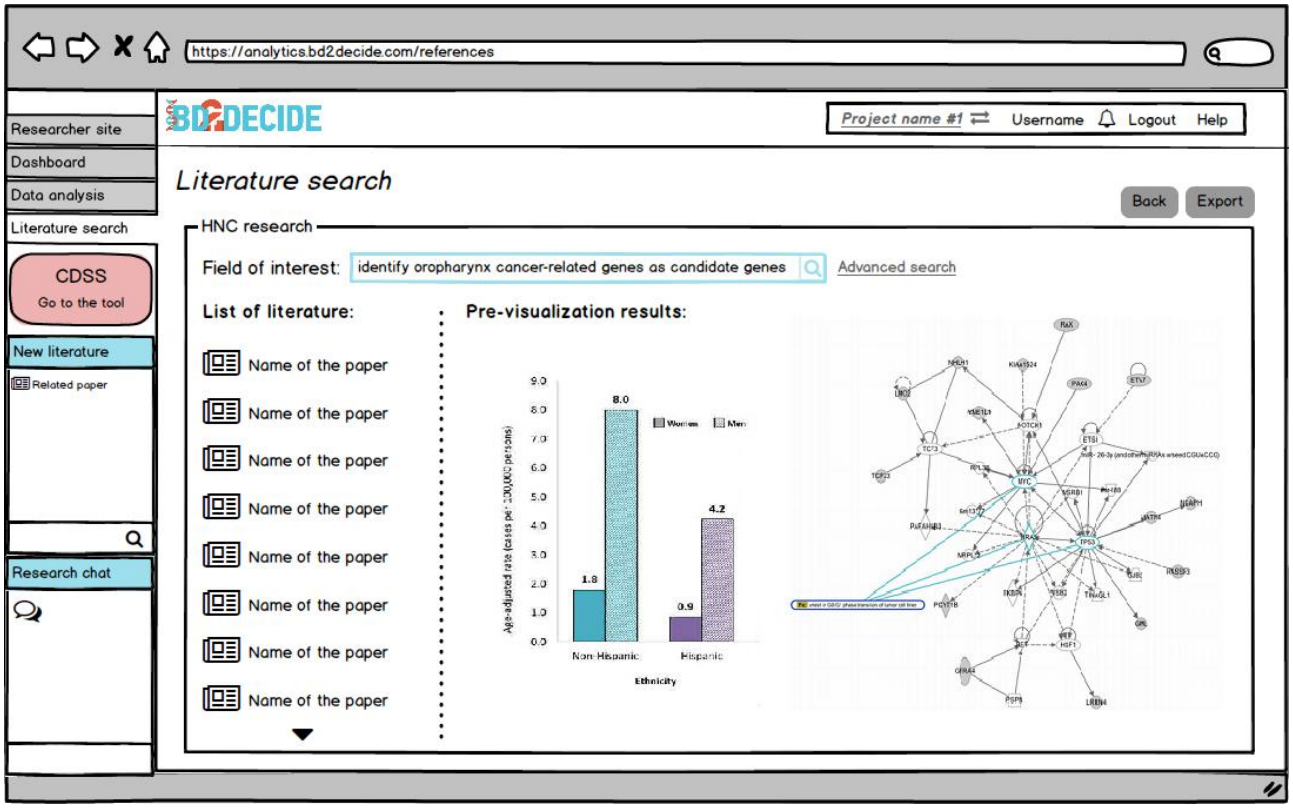


Figure 55: VAT literature search result

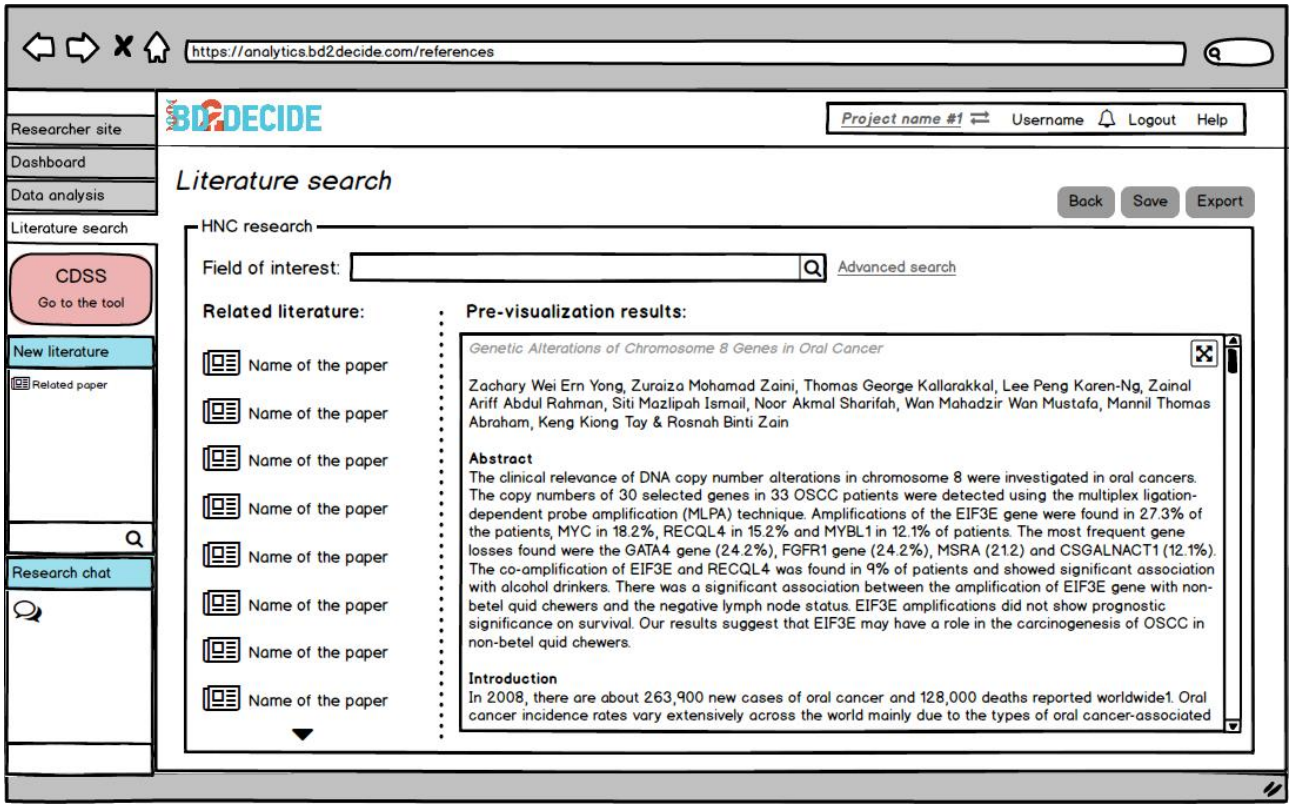
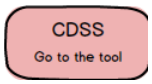


Figure 56: VAT literature pre-visualization of the selected paper

4.6 Other features

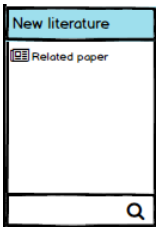
Other features are available in all the views of the VAT tool, making possible to access or to view all of them independently on which module the researcher is working on.

- CDSS button.



The button links with the Clinical Decision Support System tool.

- New literature window.

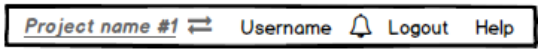


Within this window, the recommended papers are shown independently on which module the researcher is working on. These recommendations take into account the keywords defined within the BD2Decide project and those specified by the researcher in the project details (Figure 34). Thanks to the keywords defined, the literature research is always looking for new literature related to the current researcher project. Also, there is the possibility of typing something of interest in the below part of that window and then by clinking the magnifying glass to search for it as seen in Figure 56.

- Researcher chat.

An internal chat allows the user to get in touch and to communicate with other researchers.

- Toolbar.



These elements are a guide and a helpful bar that gives the following information to the researcher:

  - The first element (here named: Project name #1) is reserved to specify the project name the researcher is working on. By clinking on it, the application goes to the project view (Figure 34).

- The 'switch' icon, next to the project name, is a direct access that allows to change the current project the researcher is working on to another one project (the result of clicking this icon is the same as shown in Figure 33).
- 'Username' is the name of the researcher login.
- The 'bell' icon is an indicator of the researcher network activities. It changes when other researchers interact with the work shared by the user.
- 'Logout' is the link to logout the application.
- 'Help' link shows, in form of a manual guide, the details of the current section, in order to help the research to work in.

4.7 First user access

When the researcher logs in the tool for first time:

- All the modules are disabled (Figure 57, Figure 58) until the project is created.
- A welcome message appears to recommend the researcher to create his network profile (see Figure 57).

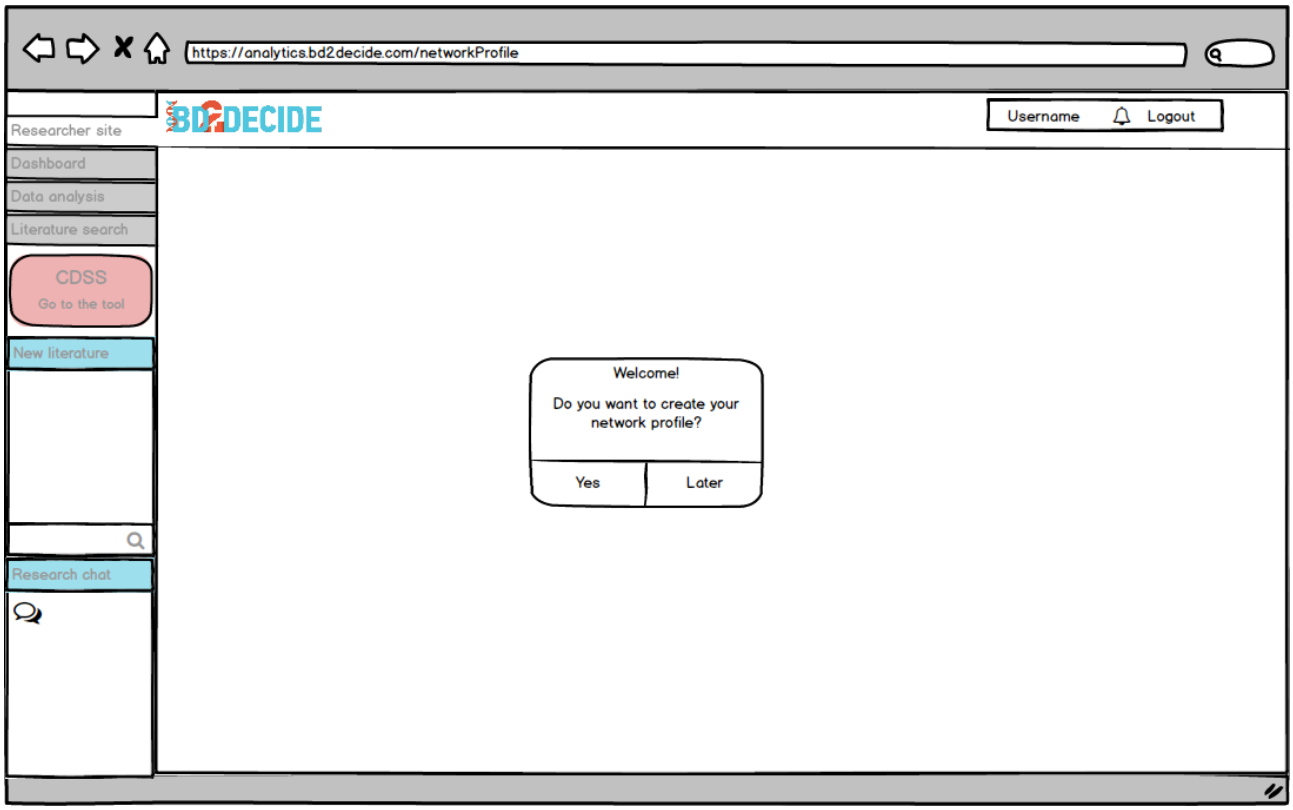


Figure 57: VAT welcome window (for first access)

- Once the profile is completed, the project can be created (see Figure 58). Otherwise, if the researcher chooses to create the network profile later, the project creation appears directly.

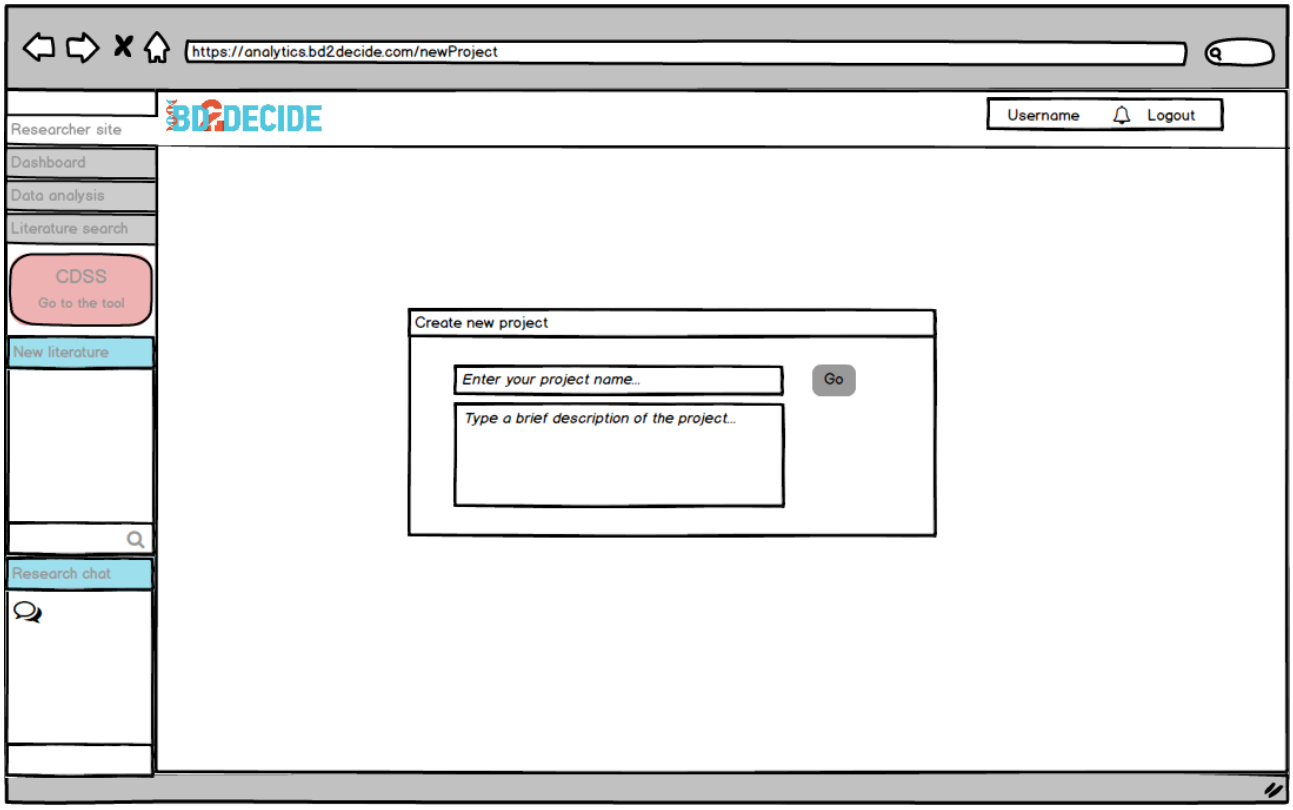


Figure 58: VAT creation of the first project (for first access)

4.8 User management

As defined in D2.2, the following roles are defined in order to customize the access within the VAT:

- System administrator: user with rights to manage users.
- Internal researcher: researchers within the application who belong to a certain project. They can have clinical or biological profiles.
- External researcher: other researchers who temporally take part in project. They can have clinical, biological or student profiles.

If the researcher has only system administrator role, she/he only can access the view in Figure 59. Within this module, the user is able to:

- Create new users.
- Modify or delete existing users.
- Create new roles.

- Modify or delete existing roles.
- Assign or refuse the roles to the users.

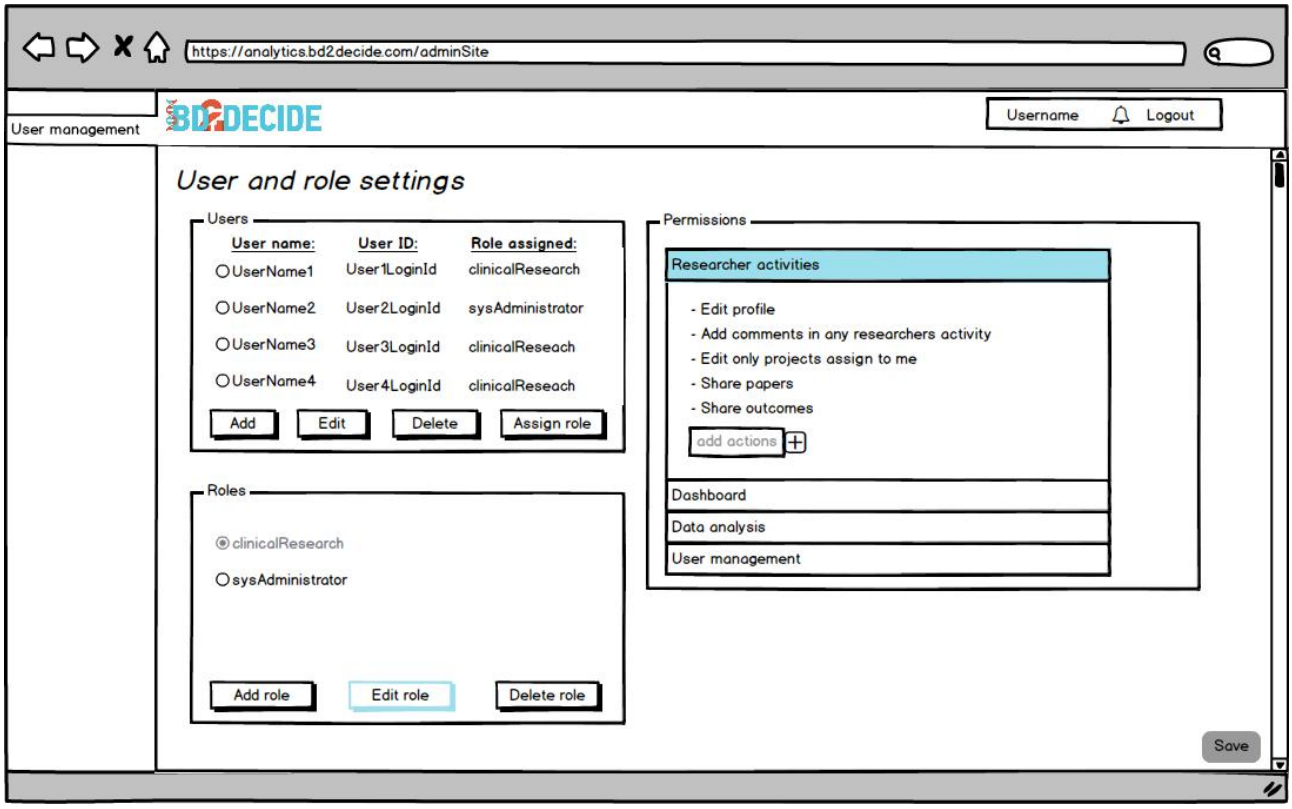


Figure 59: VAT user management site

5 CONCLUSIONS

This document accompanies the BD2Decide Deliverable D5.2. The document presented the mock-up implementation of the visualisation concepts defined for the interaction of the BD2Decide stakeholders with the respective platform, towards providing assessments and making decisions for the treatment process of HNC patients. More specifically, this document described the implementation of the visualisation mock-ups, which aim to address the requirements of both the health professionals and the clinical researchers. The presentation of the visualisation concepts has distinguished between the screens for each stakeholder group. To this end, the first part of the deliverable presented those screens that aim to support clinicians in managing the data of the patients selected for retrospective and prospective studies, making decisions on their status along the HNC treatment process enabling them to collaborate in the form of tumor board meetings and assessing the perceived quality of life of these patients following the treatment decisions. In a second part, the document elaborated on the screens targeting the clinical researchers and how these stakeholders could benefit from BD2Decide, in order to browse and visualise big datasets aggregating clinical and population data.

The outcome of this deliverable is an instrument for the close engagement of the end users in the development of the BD2Decide platform. Through optimising the conceptual view of the platform visualisation components, a better understanding of project technical and clinical groups is achieved, since the design considerations of the technical partners are fully integrated and aligned to the perceived outcome of the project, as this is reflected from the clinical partners.

This deliverable was based on the analysis of the work performed in Tasks 2.1 and 2.2 for the user requirements analysis and the user interaction design sketching. The results of this deliverable will be capitalised within WP5 for the implementation of the CDSS and the VAT tools, and their components (i.e. PDS, DPEE and TBCE). A next and final version of the visualisation mock-ups is scheduled for M24 (December 2017). In this version, through an iterative user engagement process, the final form of the platform interface screens will be developed and presented. The development will consider the continuous feedback from the end users, the progress of the tools implementation in both WP5 and WP6, and the challenges for the visualisation activities that already presented in this document.