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Project Background

Project

ACDS Calibrations Data App (CLOVER)

ACDS

The Australian Clinical Dosimetry Service (ACDS) is an independent dosimetry auditing program, providing quality assurance for radiation oncology providers and patients. Operating since February 2011, it covers 99% of Australian and selected New Zealand radiotherapy providers, offering a multi-level audit service on a four-year subscription basis.

Radiation Therapy Dosimetry

The most common treatment machine used for radiation therapy is the linear accelerator (Linac). These machines deliver ionising radiation to tumours with the aim to either cure the disease or improve the quality of life of patients living with cancer. Linacs need to be incredible accurate and reliable to ensure the required dose of radiation goes to the disease while minimising the dose to surrounding normal tissue. Often the thing that limits how much dose we can give a patient is amount of dose the surrounding organs can tolerate. With this in mind, radiation treatments have become very complex to maximise tumour control while minimising side effects.
The ACDS are independent auditors who can measure the dose delivered from a linac to ensure the machine is performing correctly, the algorithms are cal culating correctly and the software is operating as expected. What do we measure? Sometimes we use models (called phantoms) which simulate the shape of patients. They even have lungs that are a lower density than the rest of the phantom and a spine which is a higher density like bone. Each ‘case’ is a different treatment delivery or beam configuration. Each ‘point’ is a different location measured within the phantom. Each case may be delivered several times to measure multiple energies (beam strengths) or different planning algorithms.

Calibration and ionization chambers

To make sure the treatment machines delivery the correct dose we measure each one with ionization chambers and electrometers. There are variations from chamber to chamber which need to be accounted for when we calculate the dose. To work out what the chambers’ individual correction factor is, it is compared to the Primary Standard Dosimetry Lab’s (PSDLs) 60Co gamma ray source. Cobalt-60 (60Co) is used as the dose is highly accurate due to it being a radioactive source, constantly emitting a uniform dose. Linacs are driven by electricity and can have many points of uncertainty in the production of the radioactive beam. Chambers can also be cross calibrated (or compared) against a chamber which has been calibrated at the PSDL. An example of this would be Roos chambers used to measure electron beams. As the primary standard is an x-ray beam, Roos chambers can be cross calibrated with farmer chambers or similar. Dose can be measured in air or in water. For our purposes water is used, as this closely resembles human tissue. We use a combination of water tanks and solid water phantoms (water equivalent density).

Chambers
- Convert dose to charge

Electrometers
- Measure charge

Context

ACDS conducts dosimetry audits of radiotherapy clinics in Australia and New Zealand. The equipment used in these audits has specific factors for dose calculation. These products are updated every two years, including several mechanical specifications. At present, these data are stored in Excel spreadsheets, but ACDS hopes to have a simplified information system (application program) with GUI instead of spreadsheets. In this application, we need to be able to easily update data and information (that is, each new version of data set), and also an interface that can update specific data in the database, but still be able to archive the previous values.

Project requirements and problems

This project works to create and design an easy to use software application, with a database, to manage the information required for calculating factors in ACDS audits.

- The ACDS need to be able to access previous versions of the calibration data – based on the calendar date. With the current system (Excel Spreadsheet), the data is updated every 6 months and a new version of the spreadsheet is created. And a drop down menu on the home screen with options to choose previous versions of the spreadsheet available with which version data is being accessed clearly.
- People in ACDS can access the data stored in the database without password however the data should not be easily changed, so permissions for approval of new versions should be built in and the next version available for admin to update but not available for data to be exported until approval process is complete.
- Some data within the app may have expiry dates,so alerts are needed for calibrations which are soon to expire and maybe even a lock on data export for calibrations which have expired.
- Load all the information in Excel spreadsheet into the program/database
- ACDS staff should also be able to log in to the app remotely (possibly whilst on audit) and ideally have other apps access this data directly.
- have other ACDS apps run a query of the database with minimal user input
- Data can be exported in CSV or Excel format
- Some data will be linked to unique pieces of equipment
- Some data will be stored in tables which rarely require updates

- Written in Python and MatLab

Resources

ACDS: https://www.arpansa.gov.au/our-services/testing-and-calibration/calibration/australian-clinical-dosimetry-service

Glossary of terms

Table of terms / abbreviation and their meaning

Term	Meaning
k	Correction factor
N	Calibration Factor
D	Dose
w	Water
a	Air
Q	Beam Quality (or beam energy)
B	Magnetic field
Q_o	Reference quality used for the calibration
Gy	Unit of dose (Gray) mGy - milliGray
C	Unit for electrical charge (Coulomb) nC - nanoCoulomb
FS	Field size – the size of the beam at the ISO
LR	Left to Right
SI	Superior (head) to Inferior (feet)
GT	Gun to Target – direction moving from the back of the machine to the front (mostly the same as SI)
RLAT	Right lateral
LLAT	Left lateral
AP	Anterior to Posterior (generally means gantry = 0 in our situation)
Sym/Asym	symmetric and asymmetric fields. Symmetric beams have field edges equidistant from the isocentre.
Wedge	beams can be modified to have more dose on one side of the field than the other.
Collimator Angle	the collimator houses the jaws (what defines the field size). As the collimator turns, the field rotates.
Multi leaf collimator	long fingers of lead so that the beam can be shaped in unique patterns
Intensity Modulated Radiation Therapy	The MLCs can move while the beam is being delivered to modulate (or alter) the dose, giving higher doses in some regions and lower doses in others. With IMRT the gantry is static (still) but the leaves move.
VMAT	Similar to IMRT however the gantry also moves while the dose is being delivered. VMAT can also use beams of different intensities as the gantry moves around.
SSD	distance from the source (or x-ray target) to the surface of the phantom/patient
SAD	distance from the source (or x-ray target) to the ISO
ISO	point in air that the machine moves around. Wherever the machine is moved, the centre of the beam points towards the isocentre. Linacs typically have an isocentre 100cm from the “source” of the beam.
TAR	ratio of absorbed dose in tissue to absorbed dose at the same point in air. Dependant on beam energy, field size and measured depth.

TPR	ratio of dose at a point in a phantom to the dose at the same point with a fixed reference depth.
TPR20,10	Tissue-phantom ratio in water at depths of 20 and 10 g/cm-2, for a field size of 10cm x 10cm and a SCD (source to point of calibration distance) of 100cm, used as the beam quality index for high-energy photon radiation. R50 - Half-value depth in water (in g cm-2), used as the beam quality index for electron beams.
R50	Half-value depth in water (in g cm-2), used as the beam quality index for electron beams.
kQ,B	For MR Linacs a factor needs to be applied that corrects for both beam quality Q and the presence of the magnetic field B.
N_D,w,Q_o	Calibration factor in terms of absorbed dose to water for a dosimeter at a reference beam quality Q_o. mGy/nC
N_D,w,Q_cross	Calibration factor in terms of water of absorbed dose for a dosimeter cross calibrated with another chamber
k_s	Factor to correct the response of an ionization chamber for the lack of complete charge collection (due to ion recombination).
k_pol	Factor to correct the response of an ionization chamber for the effect of a change in polarity of the polarizing voltage applied to the chamber.
KQ,Q_o	Factor to correct for the difference between the response of an ionization chamber in the reference beam quality Qo used for calibrating the chamber and in the actual user beam quality, Q. The subscript Qo is omitted when the reference quality is 60Co gamma radiation (i.e., the reduced notation kQ always corresponds to the reference quality 60Co).
k_shad - shadowing	correction to take into account the effect of the density of the dosimeter in the phantom. A beam travelling through a dosimeter will not be as strong on the back side due to attenuation

Requirements Elicitation

Summary

The aim of this elicitation is to:

- Show how we prepared for the first meeting with ACDS Team
- Show how we delegated responsibilities for team members
- Show the planned structure of the interview
- Explain the approach we used to produce this elicitation requirement

Interview plan

Goals

- Introduce our team to the ACSD team
- Understand the main goals of ACSD
- Determine the stakeholders of the project
- Determine desired functionalities of the project

Reasoning

It was chosen to conduct an interview as we could get direct input from the client. It was important to have this direct communication for the first requirement elicitation task for the project, it is an effective and quick way to identify important requirements for the project. It was also important to have collaboration with the client to form these requirements.

Preparation before our first interview with clients

1. Team must read through the project overview and provided documents from the resources channel on Slack to get background info on ACDS and the project.
2. Cover our member's roles and responsibilities during the session
3. Prepare interview structure and questions for the client (Maybe discuss with the other team).
4. Ensure to request permission to record the interview
5. Cover tools that help in constructing elicitation requirements

Interview Outline

- Questions were taken from the previous team meeting (Meeting minutes- 17/3/22)

Time	Topic	Content
10 min	Introductions	▪ Introduce ourselves and explain our interests
		▪ Ensure we can record the meeting
25 min	Easy questions	▪ Ask about current process, perhaps a demo. ▪ What is the most important part to improve? What are main frustrations with their current process? ▪ Web app or standalone application? ▪ How secure should the database be?
25 min	Hard Questions	▪ What is important to have in the UI? ▪ Who are the main users of the software? What are their roles? How will they use it differently from each other?

Meeting Summary

The interview begun with a quick introduction of all the client members and their seperate roles and responsibilities at the ACDS. Firstly, the client explained their current process of managing the data used to conduct their audits. They walked us through their spreadsheets and explained what all of the values meant and how they obtained values and updated data in the spreadsheet. They made it clear that their current process is very slow and complex, the solution to replace this system must be quick and easy to use. After their explanation of their current process, we begun to question them about the important requirements for the project. The functionality for version control was important, the client wants to be able to see the changes in a device from the past. Different permissions for different users is also required, only certain staff at the ACDS are responsible for making changes to the data. Similarly, functionality to approve changes to data before submitting them to the database will be included. Timestamps of these changes was also a requested feature from the client. For the more technical requirements, the client requested the software be an online portal or cloud based system so they are able to access this data on their own devices as opposed to being a standalone application on a company computer. As this software will be one component of a larger existing software system at the ACDS, functionality to export the data into a CVS or excel format is essential so it can work with the rest of the system. Lastly the client requested that the GUI be simple and flexible. It must show upcoming expiring audits and show different things depending on permission levels of the user.

Post interview Discussion

- delegate tasks to team members for Sprint 1

- Come up with platform proposals and present them to client

Client meeting minutes from this interview 2022-03-17 Client meeting notes with ACDS team

Role delegation

Name	Role
Edward Bond	
Michael Hannon	▪ Facilitator
Sean Wong	▪ Note taker
Xi Zhao	
Xiangnan Zhou	
Ze Xin Edward Lin	

Collaboration tools

Team communications:

- Slack
  - consists of all teams involved in ACDS, Project supervisor (Nicholas) and Client (Sabeena)
- Discord
  - Our private team chat
- Zoom
  - For meetings with client and supervisor

File sharing

- Confluence
- Github
- Slack

Task management

- Trello

Meeting scheduling

- when2meet

Meeting guidelines

- Client meetings
  - Schedule on slack?
  - Working hours
  - Discussion with other team before every client meeting (Create shared document for questions with team US-Koala to have a more productive interview)
- Supervisor meetings
  - Weekly standup every Friday at 12:30 via Zoom
- Team meetings
  - weekly team meeting (time tbd)
  - more meeting if necessary

Communication guidelines

- Check Slack and discord messages regularly to be updated with client and team progress
- Ensure to inform team of any concerns or help needed

Question guidelines

Requirement to address	Question
Understand current process of the system	• Ask about current process, perhaps a demo.
Identify goals	• What is the most important part to improve? What are main frustrations with their current process?
Identify the security requirement	• How secure should the database be?
Identify technology	• Web app or standalone application?
Identify client's preferred UI layout	• What is important to have in the UI?
Identify stakeholders and user classes	• Who are the main users of the software? • What are their roles? • How will they use it differently from each other?