|  |  |
| --- | --- |
|  | |
| Data Management–Assessment 2  TU060 : Case Study: MLHealth/TriCARE – *Predict* Project.  Data Management Plan  Data Protection Impact Assessment | |
|  | |
| Ciaran Finnegan – Part Time – First Year 2021/2022  MSc in Computer Science (Data Science)  Student No : D21124026  15/4/2022 |  |
|  |  |

Table of Contents

1 Introduction 3

1.1 Purpose of Report 3

1.2 The Data Management Plan 3

1.3 The Data Protection Impact Assessment 3

2 Data Management Plan 4

2.1 Project Predict: Data Flow Lifecycle 4

2.2 Project Predict: Data Quality Issues (Wk10) 5

2.3 Project Predict: Data Bias and Remediation (Wk9) 7

2.4 Project Predict: Data Privacy and Security (Wk11) 9

3 Data Protection Impact Assessment 10

3.1 Project Predict: Basis for Lawful Data Processing (Wk4) 10

3.2 Project Predict: Data Controllers and Processors (Wk4) 11

3.3 Project Predict: Safeguards 14

3.4 Project Predict: Data Collection and Consent 15

3.5 Project Predict: Ethical and Privacy Risk Matrix (Wk2 + ) 16

4 Conclusions 17

5 References 18

# Introduction

## Purpose of Report

Project Predict has achieved ethical approval in principle but part of the final funding process involves the generation of a Data Management Plan (DMP) and a Data Protection Impact Assessment (DPIA).

This document contains drafts of both the DMP and DPIA content and is initially intended for internal project sponsor review.

Section 4 of this document provides a brief synopsis of the key recommendations of both the DMP and DPIA.

## The Data Management Plan

The DMP is a formal document that explains how data should be handled through the lifecycle of the Project Predict initiative.

## The Data Protection Impact Assessment

The DPIA is a formal documentation of the risks that can arise out of the processing of patient data throughout the Project Predict lifecycle. It also includes remedies and actions to identify and minimise these risks as early as possible.

# Data Management Plan

## Project Predict: Data Flow Lifecycle

System data flow diagrams can often follow a Context Diagram/ Diagram 0 format**[1]**, but for our purposes we need to understand the lifecycle of data as it moves through the ***Predict* Project**.

The diagram below borrows from the circular format used by Folio3 Dynamics**[2]** to represent the key data lifecycle phases for the project. Stakeholders and individuals are marked in ***Italic Blue*** and the associated data types that are input/output by each phase are included.

Timeline

Description automatically generated

Figure 1 – Predict Project Data Lifecycle

For the purposes of this report the ML process is considered as an independent entity. It generates a triage recommendation and will ultimately act as a proxy for assessments carried out by nurses.

## Project Predict: Data Quality Issues (Wk10)

Below are a brief list of potential data quality issues and remediations, with which Project Predict should have a strategy to tackle;

*Publish a formal PDCA Model*

Be upfront and declare that a continuous commitment to data quality is a central tenant for Project Predict throughout the entire four-year lifecycle. A documented Plan-Do-Act-Check (PDCA) model will inspire confident that the sensitive medical data held on patients by Project Predict is being treated with the upmost respect. (Taylor et al., 2013) provide excellent guidelines in how to apply this in a healthcare setting, such as Project Predict**[3]**.

*Ensure Sensor Accuracy*

DigiHealth must incorporate appropriate validation routines into the system implemented for Project Predict so that faulty Medic sensors cannot introduce erroneous data, outside of possible medical ranges. The potential challenge with such Medical Internet of Things (IoT) is one of the challenges discussed in tr 2019 paper by Krishnan and Shasidhar**[4]**.

Similarly, sensor data must always be complete. Missing health metrics should also generate a system alert for correction.

*Realtime Update of Patient Dashboards for Nurses/ML Process*

Timeliness is a critical issue in the triage alerting process for Project Predict. Sensor data should be transmitted in real time, and not through a scheduled batch update. Patient dashboards that may need urgent attention should render as quickly as possible, with supplementary alerting to nurses/ML systems if immediate diagnosis is recommended. Senor data must also be timestamped to confirm that it is the most recent copy of data, and also allow a future trend analysis.

*Data Store Integrity*

The data model within the TriCARE datastore will store daily sensor data, Triage recommendations and outcomes, and then, at a later stage the Year Three Trial survey information. All of this information, which is from different sources, must seamlessly tie into a single patient data entity in the TriCARE systems, as implemented by DigiHealth.

*Data Audits*

The project needs to avoid an ad-hoc approach to checking data quality, and reliance on TriCARE employees conducting occasional reviews to capture data inconsistencies. A formal ‘data audit’ should take place each month by nominated TriCARE team members, which rewards the discovery of data issues and/or suggestions around data quality management.

*Data Storage*

Lastly, to avoid data synchronisation issues it is strongly encouraged that there is ‘one version of the truth. TriCARE should manage a single datastore, through the DigiHealth cloud infrastructure, and allow appropriate access to MLHealth researchers. There is research on current options to allow data replication across healthcare sites**[5]** but in this is likely beyond the scope of Project Predict and introduces a possibility of unnecessary data duplication and data consistency errors.

## Project Predict: Data Bias and Remediation (Wk9)

**Potential Bias Issue with Project Predict ML Modelling**

*TriCARE Population and Lack of Diversity*

A health monitoring system, such as Project Predict, is arguable more attractive to an older client base where health issues are more common. The 500 patients are on average above retirement age, although with some younger outliers.

The sample profile presents two obvious problems; the first is that an older Irish population is likely to be less diverse as significant inwards migration to Ireland did not occur until the late 1990s and beyond**[6]**. The second is that patients in their 20s appears to be a very small proportion of the TriCARE sample.

An ML model built with this data will skew somewhat to an older white Irish demographic (the ratio of males to females is also approximately 2:1). This data imbalance will introduce a bias in the auto ML triage recommendations.

*Understanding/Correcting Triage Recommendations*

The models built by MLHealth must be open to interpretation, so that analysts and stakeholders can understand what features of the Medic sensor data, and the patient medical profile, prompted a specific triage recommendation.

If the MLHealth data scientists elect to use the newer, popular, neural network approaches to building models, then the goal of an explainable (and auditable) recommendation will be much more complex.

**Proposed Remedies**

*Constant Re-Training of the Triage ML Model*

The Project Predict lifecycle does allow for a process of re-training as new, more ethnically diverse patients are introduced into the system.

However, this may take to long to correct for bias and never really address the fact that younger patients will always be a significant minority in the training dataset.

A policy of artificial data generation is recommended to create ‘non-real’ patients that will temper the ‘real-world’ bias in the MLHealth triage modelling process. However, this must be approached with caution as ML research in other areas has shown that artificial techniques like SMOTE can also introduce distortion into ML datasets**[7]**.

*Adopting Advances in Neural Network ‘Explainability’*

The data scientists in MLHealth should look closely at recent research by Sinanc et al (2021)**[8]** if a neural network model is to be deployed in Project Predict. Such an approach offers a feature ‘heat map’ that explains the attributes that primarily drove the triage recommendation.

This would allow stakeholder to understand the local behind an ML decision and offer possible means of redress in the event of a dispute.

## Project Predict: Data Privacy and Security (Wk11)

*Data Security*

There is a somewhat informal perception that cloud-based data storage is inherently less secure than ‘on-premise’ data storage. In reality, the major Cloud service providers are so conscious of the potential reputational damage of a data breach that their security infrastructure tends to be superior to many commercial in-house environments**[9]**.

The key recommendation for Project Predict is that MLHealth and TriCARE must establish that all Cloud based data systems used by DigiHealth and Medic are with one of the major established providers, such as Amazon (AWS) or Microsoft (Azure).

Authentication Protocols

Given the involvement of four major software and hardware providers in the delivery of Project Predict, it will be essential that rigid login profiles, and associated privileges, are established as early as possible in the development lifecycle.

No one developer or analyst should have access to sensitive patient information unless absolutely required.

# Data Protection Impact Assessment

## Project Predict: Basis for Lawful Data Processing (Wk4)

If you are processing personal data, what is the lawful basis for processing this

data? (Justify your answer)

Project Predict must adhere to legal requirements, as set out in Article 6 of the 2016 EU GDPR legislation, that each participated patient has given clear consent for their personal data to be collected, processed and stored by the system**[10]**. The system implemented by all parties (MLHealth/ TriCARE/ DigiHealth) must also inherently observe the legal requirement to process the patient data fairly and transparently, as per the principles in Article 5 of the GDPR legislation**[11]**.

A legal audit should take place, both at the start of the project, and at least once during the Year 3 Trial, to ensure that Project Predict remains compliant with the Irish Data Protections Act (2018). The legislation supplements GDPR and Project Predict needs to comply, in particular, with Section 57 and ensure that each patient *consents to automated decisions* being made by the MLHealth ML triage process.

## Project Predict: Data Controllers and Processors (Wk4)

**Data Controllers[12]**

*MLHealth*

Company Directors. Joint Controllers.

* Autonomous management responsibility for collection and processing of patient data (sensor and survey).
* Manage direct contracts with patient group, and ultimately profit from Project Predict commercial activity.
* Decide where and how patient data is stored, and for how long.

Data Scientists. Controllers.

May appear as ‘Processors’ given that they build ML Triage model on behalf of ML Health management. However;

* Data scientist group exercise significant control over patient data in terms of building ML triage models and, more crucially, retraining these models over time to alter triage performance.
* They are very interested in the specific outcome of the processing and will re-engineer patient data as required to improve ML model accuracy.

*TriCARE*

Company Directors. Joint Controllers (with MLHealth directors).

* Mirror responsibilities of MLHealth directors and participate in collection of patient data for a common Project Predict purpose.

**Data Processors[12]**

*MLHealth*

Researchers. Processors.

* Follow instructions of MLHealth management to obtain and supplement patient data throughout the Year 3 trial.
* Only MLHealth management/data scientists take operational actions based on this data.

*TriCARE*

Nurses. Processors.

* They do make decisions based on the Medic Sensor data but only within their contracted duties for TriCARE.
* They do not own the data collection process or have any control over which patients to assess.

Triage Team. Processors.

* Take data input from Nurses (or ML model) in terms of a triage recommendations and will make a decision on appropriate medical interventions. However, this is again done within the confines of an agreed contract with TriCARE, and the Triage Team does not own the data process.

*DigiHealth*

Company Directors. Processors.

* Although this group does have a commercial interest in ensuring their system is managing data flows within Project Predict, this is all within a contract relationship with the Project Predict owners.
* DigiHealth management will apply their expertise and judgement relation to medical data management, but they do not control the lawful basis for collection and processing of that data.
* They do not decide for how long patient data is stored in the system.

Other Employees. Processors.

* All data processing implementation is carried out under contract agreement with a project Controller (TriCARE).

*Medic*

All Employees. Processors.

* All data processing is under instruction by, and contract with, TriCare and DigiHealth.

## Project Predict: Safeguards

There are numerous safeguard recommendations that could be made for Project Predict but two are singled out here in terms of *Purpose* and *Identification*.

*Purpose*

Article 26 of the Irish 2018 Data Protection Act is clear that confidential personal information must not be shared by action (or inaction) of a Data Controller**[13]**. Project Predict directions must be certain the processes are in place that no parties share sensitive patient information with external entities for the purposes or Marketing, or other non-authorised activity. Article 27 provides the basis for civil proceeding that any patient within the system would be entitled to peruse in the even of a data ‘leak’. Security protocols must be in place, through user authentication, or database level encryption, to prevent such an eventuality.

*Identification*

Anonymisation is a process that would render it impossible to associate medical data with an identified patient**[14]**. It would have the advantage of allowing Project Predict to sidestep most of the rigours of GDPR and related Irish legislation.

However, the recommendation of this report is that this is not practical for this system. Year 3 survey data must integrate into the ongoing daily Medic senor data readings for each patient. Therefore, the Project Predict system always retains a means to re-establish patient identify, so no one remains truly anonymous, particularly in the eyes of the data protection laws.

That said, the triage model does not need personal identification details such as name or address. These could be replaced with numerical pseudonyms for most purposes within the project. Mappings of the pseudonyms to real names will be required to process Year 3 survey data but this information should be stored in a more restricted section of the project data store.

## Project Predict: Data Collection and Consent

*Collection of Consent*

It is assumed that any patient supported by the TriCARE organisation at the beginning of the Project Predict lifecycle has already committed to a signed contract agreement. However, given the extended nature of data processing within Project Predict, added terms and conditions must be additional agreed by each individual though a supplementary signed document.

Any patient who does not agree to the terms of Project Predict must not be included in the joint initiatives by MLHealth and TriCARE. Consent is a key tenant of GDPR regulation and Project Predict must respect the will of each individual and their desires for privacy. This data will not be incorporated in the ML modelling process, and these patients must not be approached for the Year 3 Trial survey.

*Withdrawal of Consent*

GSPR legislation is very clear on the ‘right to erasure’**[15]** should any patient within the Project Predict system wish to with withdrawn consent to further involvement.

The Joint Controllers within MLHealth and TriCARE must respond as quickly as possible to such a request and provide evidence that the patient data was deleted from the project data stores.

## Project Predict: Ethical and Privacy Risk Matrix (Wk2 + )

Ipso Lorem…

Ipso Lorem…

<Diagram>

# Conclusions

One could ipso lorem…

.

# References

[1] Polkovnikov, I. (2016). Unified Control and Data Flow Diagrams Applied to Software Engineering and other Systems. Retrieved 15 April 2022, from <https://doi.org/10.48550/arXiv.1610.02374>

[2] Saud, D. (2022). What Are The Three Main Goals Of Data Lifecycle Management (DLM)? - Folio3 Dynamics Blog. Retrieved 5 May 2022, from <https://dynamics.folio3.com/blog/what-are-the-three-main-goals-of-data-lifecycle-management-dlm/>

[3] Taylor, M., McNicholas, C., Nicolay, C., Darzi, A., Bell, D., & Reed, J. (2013). Systematic review of the application of the plan–do–study–act method to improve quality in healthcare. *BMJ Quality &Amp; Safety*, *23*(4), 290-298. doi: 10.1136/bmjqs-2013-001862

[4] Krishnan, S., & Shashidhar, N. (2019). eDiscovery Challenges in Healthcare. *International Journal Of Information Security Science*, *8*(2), 30-43. Retrieved from <https://www.researchgate.net/profile/Sundar-Krishnan/publication/335202708_eDiscovery_Challenges_in_Healthcare/links/5d566f4d92851cb74c6facf1/eDiscovery-Challenges-in-Healthcare.pdf>

[5] Orwa, P. (2020). Replication As A Way To Achieve Interoperability in Healthcare. Retrieved 9 May 2022, from <http://erepository.uonbi.ac.ke/bitstream/handle/11295/153117/REPLICATION%20AS%20A%20WAY%20TO%20ACHIEVE%20INTEROPERABILITY%20IN%20HEALTHCA.pdf?sequence=1>

[6] Ireland Immigration Statistics 1960-2022. (2022). Retrieved 9 May 2022, from <https://www.macrotrends.net/countries/IRL/ireland/immigration-statistics>

[7] Priscilla, C., & Prabha, D. (2020). Influence of Optimizing XGBoost to handle Class Imbalance in Credit Card Fraud Detection. *2020 Third International Conference On Smart Systems And Inventive Technology (ICSSIT)*. doi: 10.1109/icssit48917.2020.9214206

[8] Sinanc, D., Demirezen, U., & Sağıroğlu, Ş. (2021). Explainable Credit Card Fraud Detection with Image Conversion. *ADCAIJ: Advances In Distributed Computing And Artificial Intelligence Journal*, *10*(1), 63-76. doi: 10.14201/adcaij20211016376

[9] Clouder, A. (2021). Top 10 Benefits of Cloud Computing. Retrieved 10 May 2022, from <https://www.alibabacloud.com/blog/top-10-benefits-of-cloud-computing_597739>

[10] Art. 6 GDPR - Lawfulness of processing - GDPR.eu. (2022). Retrieved 10 May 2022, from <https://gdpr.eu/article-6-how-to-process-personal-data-legally/>

[11] Art. 5 GDPR - Principles relating to processing of personal data - GDPR.eu. (2022). Retrieved 10 May 2022, from <https://gdpr.eu/article-5-how-to-process-personal-data/?cn-reloaded=1>

[12] Controllers and processors. (2022). Retrieved 10 May 2022, from <https://ico.org.uk/for-organisations/guide-to-data-protection/guide-to-the-general-data-protection-regulation-gdpr/key-definitions/controllers-and-processors/>

[13] Data Protection Act 2018. (2022). Retrieved 10 May 2022, from <https://www.irishstatutebook.ie/eli/2018/act/7/enacted/en/print#sec26>

[14] What is personal data?. (2022). Retrieved 10 May 2022, from <https://ico.org.uk/for-organisations/guide-to-data-protection/guide-to-the-general-data-protection-regulation-gdpr/what-is-personal-data/what-is-personal-data/#pd5>

[15] The right to erasure (Articles 17 & 19 of the GDPR) | Data Protection Commission. (2022). Retrieved 10 May 2022, from <https://www.dataprotection.ie/en/individuals/know-your-rights/right-erasure-articles-17-19-gdpr#:~:text=This%20is%20also%20known%20as,it%20was%20collected%20or%20processed>.