# 012 RT-HaND\_I; Updating from PACS- Technical Guide

September 2024

# Introduction

Diagnostic and follow-up imaging for Head and Neck Cancer patients available up until the implementation of EPIC (4th October 2023) were ingested into XNAT. Only scans considered pertinent by H&N clinicians to the diagnosis, staging, treatment and follow-up of head and neck cancer patients were ingested, a summary can be seen in Appendix 1 or the full inclusion/exclusion criteria are in document 12a RT-HaND\_I Imaging Study Descriptions, known Include vs Exclude.

# Background

PACS (Sectra) was queried for the study descriptions and accession numbers of all diagnostic imaging sessions contained for each patient. The resultant study descriptions returned were used to filter the accession numbers to enable the selection of the imaging sessions to ensure only relevant data was ingested using the REST-API into the data lake. Study descriptions considered relevant were any orders pertinent to the diagnosis, staging, progression or ongoing monitoring of treatment side effects of HNC. This included all staging FDG nuclear medicine scans (NM), all staging (e.g. CT chest/abdomen and pelvis) and relevant anatomy (head and neck area) CTs and MRIs and all dental x-ray (XR) and video fluoroscopy (VF) studies. Unspecified CTs were inspected and included if relevant. A brief summary is shown in Appendix 1. The data flow diagram for this process is shown below.

# 

# Ingestion:

## Existing patients imaging data update (aka prospective imaging data collection of existing patients)

To update the lake for previous retrospective patients, PACS should be queried for new studies since the last ingestion. The descriptions should be used to select the studies for ingestion. There is a list of agreed *include* and *exclude* studies to use to initially filter the list. This can be found in 012a: Imaging Study Descriptions known Include vs Exclude criteria. It is likely that not all study descriptions will be included on either the *include/exclude* list. This is due to updates in scanning protocols and new machines. A clinician should be consulted regarding the new study descriptions and the *include/exclude* lists updated accordingly. With imaging studies to be ingested filtered out, CSC can then ingest via REST-API with access to the PACS-XNAT pipeline given with respect to clinical priorities.

Patients known to be deceased should not be included in this query. A data extract from EDW can confirm known deceased patients.

## New patients image data upload (prospective imaging data collection of new patients)

Separately, PACS should be queried for new patients. There should be no date limitation on when these studies were performed. The descriptions should be used to select the studies for ingestion as above. After the initial data extraction of these patients, they should be transferred to the “existing” patient list and follow the above patient update pathway after the initial harvest.

# Updating the data availability summary spreadsheet

## Gathering ingestion information

After all the PACS images have been successfully ingested, a summary spreadsheet of each type of imaging session can be downloaded (e.g. MRI, CT, planar x-ray) from the front end of XNAT.

The imaging session spreadsheets should be in the form of 5 columns. The first column is Subject and the second is Date. Unfortunately, not all the same datatypes are available for each type of scan and so a best guess approximation of most useful parameters was employed for the final 3 columns. These are shown in the below table. They are saved as custom filters in XNAT but can easily be reconstructed in XNAT if not available. The spreadsheets should each be saved as the “Scan Type”.csv e.g. MR.csv. The below table displays the expected parameters within each spreadsheet.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Session Type | Session Description | Column 1 | Column 2 | Column 3 | Column 4 | Column 5 |
| MR | MRI scan | Subject | Date | MR ID | Scanner | Scans |
| CT | CT scan | Subject | Date | XNAT\_CTSESSIONDATA ID | UID | Scans |
| PET | PET-CT scan | Subject | Date | XNAT\_PETSESSIONDATA ID | UID | Scans |
| CR | Dental x-ray | Subject | Date | XNAT\_CRSESSIONDATA ID | ID | Session |
| DX | Dental x-ray | Subject | Date | XNAT\_DXSESSIONDATA ID | UID | Scans |
| RF | Video swallow | Subject | Date | XNAT\_RFSESSIONDATA ID | ID | Session |
| SR | Nuclear medicine | Subject | Date | XNAT\_SRSESSIONDATA ID | ID | Creator |
| XA | Video swallow | Subject | Date | XNAT\_XASESSIONDATA ID | ID | Creator |

“NM” is an imaging type available however only contains 1 patient’s 4 bone density scans currently and so is not necessary to include. Similarly, there are 33 “CE” sessions (dental x-rays) where it is not possible to download the data with the subject available and so these are not included. There is only 1 ultrasound scan and so this is not included.

## Gathering failures to ingest via XNAT

The CSC team will return a list of ingestion failures via .csv file of json code. This list contains the patient ID, accession number, study description and UID of the studies that could not be ingested via XNAT. This can be probed to check that the current failure rates are in line with historic failure rates and that there is not a pipeline issue.

In the preparation of the HN XNAT database, in a population of xx patients, upload failure rates were approximately 7% for CTs & MRIs with all investigated failures being due to imaging sessions being cancelled, images being found under different accession numbers or images being scheduled but not completed or no images available on PACS.

Failure rates for NM, Video and XR were typically higher and all presented examples where images are available on PACS but are not ingested by XNAT. This included some PET-CTs which are extremely likely to be useful for future research. For this reason, we documented accession numbers that existed but that were not ingested so that individual researchers can decide if they want to manually extract this information to increase their study numbers. For many of the scans it will be obvious that the accession number was unused and therefore no images were ingested because there was a corresponding scan the week after or the images are attached to another study from the same day, but for cases such as the un-ingested PET-CTs we hope it will be useful.

Scans scheduled for 01-01-2099 are explicitly excluded from this list. This list also serves a record to try to re-ingest the cases should XNAT or PACS updates allow the flow of these images from one system to another. Currently XNAT cannot tell if a scan on PACS has been “cancelled” or if there are no images available.

A python script has been written which transforms the .json output into a file that can be appended to the EDW data record. The script cleans out the multiple quotation marks and gaps and unexpected data forms and transforms the data into a 5 column table in the same form as the above XNAT table with ID, study date, accession number, study description and study instance UID returned. The output contained patients Hospital IDs so an additional section of the script takes each hospital ID and finds the corresponding NHS number so that it can be attached to the EDW data extract.

## Creating a master spreadsheet of all data in XNAT and all experienced failures of ingestion

All version-controlled python scripts are stored within the RTPHYS GitHub. Version 1.0 for both scripts are also contained within the appendix for reference. Patients without NHS numbers are stored within the XNAT database as NN\_patientID. Care must be taken when updating the spreadsheet that there are no patients with blank NHS numbers, as this is likely to break the code despite efforts to account for blank subjects.

**Expected inputs:**

* 8 .csvs downloaded from XNAT of MR, CT, PET, CR, DX, RF, SR, XA data as described above and named MR.csv, CT.csv, PET.csv, CR.csv, DX.csv, RF.csv, SR.csv and XA.csv accordingly, saved within a dated folder.
* 1 .csv file of Subject (NHS number) and Reference Date (RT start date) only, called “reference\_dates” saved within a dated folder. Patients without NHS numbers should be included using their XNAT subject ID: NN\_patientID
* 1 .txt file of json output from failed ingestions called “PACs-failures.txt”.
* 1 .csv file of HospitalID & NHSNumber only called “HospitalID-NHSNumber.csv”.

**Steps:**

* Prepare files described above.
* Run PACSIngestionErrorSummary script first, this is required as input for XNATImagingSummary script.
* Copy output from PACS ingestion error summary script to the location the python script is being run from as the 8 downloaded .csvs.
* Run XNATImagingSummary.py adjusting output file name as desired.
* Return output to EDW.

**Anticipated potential future improvements**

* All HospitalIDs are “old” style GSTT patient IDs but PACS still allows the querying of these so they do not need to be updated.
* PACS failures to ingest need to be added to the previous PACS failures to ingest txt file so that previous data is not lost when updating the data availability sheets.
* Currently the EDW update is performed manually. Potential future improvements are for the EDW to look for a location on the shared drive to absorb the summary spreadsheet to minimise manual processes and human involvement.

## Roles and responsibilities

|  |  |
| --- | --- |
| Role | Responsibility |
| Provide retrospective and prospective patient list | XNAT admin (with EDW assistance) |
| Query PACS for new patient data | CSC |
| Choose scans for ingestion | XNAT admin with clinician input |
| Ingest scans via REST-API | CSC |
| Document failures via .json | CSC |
| Investigate failures | XNAT admin |
| Update available data information & known failures | XNAT admin |
| Upload available data information to EDW | TY (As of Sept 2024) |

## Appendix 1: Study descriptions

|  |  |
| --- | --- |
| **Include Study Description** | **Exclude Study Description** |
| Abdomen & Pelvis - CT | Abdomen - CT |
| Abdomen & pelvis with contrast - CT | Abdomen - Mobile - X-Ray |
| Bitewing - Dental | Abdomen - MRI |
| Bone scan - N Med | Abdomen - US |
| Brain - CT | Abdomen - US (Urology use only) |
| Brain - MRI | Abdomen plain - X-Ray |
| Brain - MRI (KCL Scanner) | Abdomen with contrast - CT |
| Chest - CT | Abdominal & Distal Aorta - CT |
| Chest & abdo & pelvis with contrast - CT | Abdominal Aorta - CT |
| Chest & Abdomen - CT | Abdominal Stent Graft |
| Chest & abdomen with contrast - CT | Achilles Tendon Lt - US |
| Chest with contrast - CT | Acromio-clavicular jt Left - X-Ray |
| Chest, Abdomen & Pelvis - CT | Acromio-clavicular jt Right - X-Ray |
| Clin Oncology - CT (STH only) | Adrenal Both - CT |
| CT - Volume scan | Adrenal with contrast Both - CT |
| CT + contrast | Adrenals - MRI |
| CT Chest high resolution | Angiogram Lower Limb Left - CT |
| CT Face | Angiogram Lower Limb Right - CT |
| CT Face with contrast | Angiogram subclavian Both - CT |
| CT Facial bones | Angiogram Upper Limb Left - CT |
| CT Head | Angiography - MRI (specify) |
| CT Head with contrast | Angiography for TAVI Planning - CT |
| CT Mandible | Angioplasty Aorta |
| CT Neck | Angioplasty Tibial Left |
| CT NECK AND THORAX | Angioplasty Tibial Left |
| CT NECK AND THORAX AND ABDO AND PELVIS AND CONT | Ankle Both - CT |
| CT NECK AND THORAX WITH CONTRAST | Ankle left - X-Ray |
| CT Neck with contrast | Ankle Lt - MRI |
| CT plus Contrast | Ankle Lt - US |
| CT Radiotherapy planning scan | Ankle right - X-Ray |
| CT Sinuses | Ankle Rt - MRI |
| CT Thorax | Ankles both - X-Ray |
| CT Thorax & abdo & pelvis with contrast | Anterior Abdominal Wall - US |
| CT Thorax & abdomen | Aorta - CT |
| CT Thorax & abdomen & pelvis | Aorta - US |
| CT Thorax & abdomen with contrast | Aorta abdominal - MRA |
| CT Thorax abdomen and pelvis | Aorta whole - MRA |
| CT Thorax abdomen pelvis with contrast | Arterial stent Carotid Both |
| CT THORAX AND ABDO AND PELVIS WITH CONTRAST | Arterial stent Carotid Lt |
| CT THORAX AND ABDOMEN WITH CONTRAST | Arterial stent Carotid Rt |
| CT Thorax with contrast | Arterial stent Iliac Lt |
| DPT - Dental | Arterial stent Iliac Rt |
| DPT Lt Sectional - Dental | Arteriogram - Th |
| DPT Rt Sectional - Dental | Arthrogram shoulder Lt - MRI |
| DPT Teeth and Jaws - Dental | Aspiration Breast FN Lt - US |
| DPT Teeth only - Dental | Aspiration Breast FN Rt - US |
| Face - CT | Aspiration FN - US |
| Face with contrast - CT | Axilla Left - US |
| Face with contrast - MRI | Axilla Right - US |
| Facial bones - CT | Barium enema |
| Facial bones - Dental | Barium meal & F T |
| FL VIDEO SWALLOW | Barium meal & swallow |
| FL WATER SOLUBLE CONTRAST SWALLOW | Barium swallow |
| Full mouth periapicals - Dental | Bilateral mammograms |
| Head - MRA | Biliary Stent Insertion |
| Head with contrast - CT | Biopsy - CT |
| Head/neck & soft tissue - MRI | Biopsy - US |
| High resolution chest - CT | Biopsy (specify site) - X-ray |
| High resolution chest with contrast - CT | Bladder - MRI |
| Horizontal bitewings both - Dental | Bone biopsy (Radiology) |
| IAM - CT | Bone Density Forearm - N Med |
| IAM with contrast - CT | Bone Density IVA - N Med |
| Internal Auditory Canal - MRI | Bone Density Met Bone Clinic - N Med |
| Larynx - MRI | Bone Density PROBONO Study - N Med |
| Lateral Cephalogram - Dental | Bone marrow study - N Med |
| Left oblique lateral - Dental | Bone scan infection/fractures - N Med |
| Liver - CT | Bone SPECT - N Med |
| Liver triple phase - CT | Bone whole body with SPECT- N Med |
| Liver with contrast - CT | Brachial plexus - MRI |
| Liver/Biliary - MRI | Brain DAT - N Med |
| Lower 45 Occlusal - Dental | Bread meal |
| Lower Occlusal - Dental | Breast - MRI |
| Mandible - CT | Breast - MRI Guided Core Biopsy Left |
| Mandible PA - Dental | Breast Both - US |
| Mastoids - CT | Breast Left - US |
| MRA Neck | Breast Left - US 2nd Look |
| MRI - add Gadolinium | Breast Right - US |
| MRI claustrophobia | Breast Right - US 2nd Look. |
| MRI Face with contrast | Calcaneum left - X-Ray |
| MRI Head | Calcaneum right - X-Ray |
| MRI Internal auditory meatus Both | Calf Rt - US |
| MRI Larynx | Cardiac - MRI |
| MRI Liver & Spleen | Cardiac Angiogram - CT |
| MRI Neck | Cardiac Paediatric - MRI |
| MRI Orbit Both | Cardiovascular Adult - MRI |
| MRI Radiotherapy planning scan neck | Carotid DSA - Th |
| MRI SPINE WHOLE | Carotids - CT |
| MRI under General Anaesthetic | Cerebral veins - MRV |
| Neck - CT | Cervical spine - CT |
| Neck - MRA | Cervical spine - MRI |
| Neck & Chest - CT | Cervical spine - X-Ray |
| Neck & Chest with contrast - CT | Cervical spine oblique views - X-Ray |
| Neck & thorax & abdo & pelvis & cont - CT | CESM Both Breasts |
| Neck & thorax & abdomen - CT | Chest - X-Ray |
| Neck & thorax & abdomen & contrast - CT | Chest - Mobile - X-Ray |
| Neck with contrast - CT | Chest - US |
| NM Bone whole body | Chest Interstitial Lung Disease - CT |
| NM FLT PET CT | Chest lateral - X-Ray |
| NM Halfbody + H&N FDG PET CT | Chest NG Tube Placement - X-Ray |
| NM Halfbody FDG PET CT | Chest PA & Lat - X-Ray |
| NM PEARL FDG PET CT | Chest with contrast - CT (Paed Respiratory use) |
| NM Whole Body FDG PET CT | Chest X-Ray (Research) |
| Oblique laterals (both) - Dental | Clavicle left - X-Ray |
| Orbit - MRI | Clavicle right - X-Ray |
| Orbit with contrast Both - CT | Colostomy gram |
| Orbits - CT | Cone Beam CT Face |
| PA Cephalogram - Dental | Cone Beam CT Facial bones |
| Perfusion Weighted - MRI | Cone Beam CT Sinuses |
| Periapicals < 5 films - Dental | Cone Beam Mandible |
| Periapicals < 7 films - Dental | Cone Beam Mandible & Maxilla |
| Periapicals > 10 films - Dental | Cone Beam Mandible Right |
| Periapicals > 7 films - Dental | Cone Beam Maxilla |
| Periapicals 5 - 10 films - Dental | Cone Beam Maxilla Left |
| PET CT Scan | Cone Beam Orbits Both |
| PET- CT Scan | Contrast Enhanced Liver - US |
| Pituitary - MRI | Craniofacial soft tissues US |
| Pituitary with contrast - CT | CT - Volume scan |
| Radiotherapy Planning - MRI | CT attenuation correction - N Med |
| Radiotherapy Planning Scan - CT | CT Other Hospital |
| Radiotherapy Planning Scan Neck - MRI | CT Other Hospital - Report only |
| Radiotherapy planning scan pelvis - MRI | CT Other Hospital. |
| Right oblique lateral - Dental | CT+CON |
| Sinuses - CT | CTOH |
| Sinuses - MRI | CTPLUSCO1 |
| Sinuses with contrast - CT | CTVOL |
| Spinal Cord - MRI | Cystogram |
| Temporo-mandibular joint Both - CT | Cysto-Metrogram |
| Temporo-mandibular Jt Both - MRI | Delayed imaging - N Med |
| Thorax - MRI | Discogram - Th |
| Thorax with Contrast - MRI | Doppler - US (specify) |
| TMJs open & closed - Dental | Doppler arm veins Left - US |
| Trigeminal Nerve - MRI | Doppler arm veins Right - US |
| Upper Occlusal - Dental | Doppler Artery - US (state site) |
| Video swallow | Doppler Carotid - US (state side) |
| Video/fluoroscopy Speech | Doppler Groin Lt - US |
| Video/fluoroscopy swallow | Doppler Groin Rt - US |
| Whole Body - MRI | Doppler leg veins Left - US |
| Whole Spine - MRI | Doppler leg veins Right - US |
| XR Dental maxillary occlusal | Doppler Penis - US |
| XR Dental periapical 10 | Doppler Renal Both - US |
| XR Dental periapical 5 | Doppler Renal Tx arterial - US(specify) |
| XR Facial bones | Doppler Vein - US (state site) |
| XR Orthopantomogram full | Drain insertion - X-ray |
| XR Orthopantomogram Lt | Drain Removal |
|  | Drainage - CT |
|  | Drainage - US |
|  | Duodenography |
|  | Dynamic joint - US |
|  | Dynamic muscle - US |
|  | Dynamic renal MAG3 + lasix - N Med |
|  | Dynamic renal MAG3 scan - N Med |
|  | Elastography of Liver - US |
|  | Elbow Both - US |
|  | Elbow left - X-Ray |
|  | Elbow Lt - MRI |
|  | Elbow Lt - US |
|  | Elbow right - X-Ray |
|  | Elbow Rt - MRI |
|  | Elbow Rt - US |
|  | Elbows both - X-Ray |
|  | Embolisation (site to be specified) |
|  | Endoanal - US |
|  | Enema - CT |
|  | Enema - CT (Iodine Allergy) |
|  | Enema - CT (No Iodine Allergy) |
|  | Enterography - CT |
|  | ERCP |
|  | ERCP & Sphincterotomy |
|  | Extracorporeal lithotripsy renal left |
|  | Extremity - US |
|  | Facet joint - Th |
|  | Facial bones - X-Ray |
|  | FB localisation - X-Ray |
|  | Feet both - X-Ray |
|  | Femoral Line Insertion |
|  | Femoral-Popliteal PTA |
|  | Femur Both - MRI |
|  | Femur left - X-Ray |
|  | Femur right - X-Ray |
|  | Femurs both - X-Ray |
|  | Fenestrated Aortic Stent |
|  | Finger - X-Ray |
|  | Finger index Lt - X-Ray |
|  | Finger index Rt - X-Ray |
|  | Finger little Lt - X-Ray |
|  | Finger little Rt - X-Ray |
|  | Finger middle Lt - X-Ray |
|  | Finger middle Rt - X-Ray |
|  | Finger ring Lt - X-Ray |
|  | Finger ring Rt - X-Ray |
|  | Fingers Left - X-Ray |
|  | Fingers Right - X-Ray |
|  | Fistulogram |
|  | Fistuloplasty |
|  | Flexion & extension views - X-Ray |
|  | Fluoroscopic guided aspiration |
|  | Fluoroscopic guided stent insertion |
|  | Fluoroscopy Other Hospital |
|  | Foot Both - CT |
|  | Foot Both - US |
|  | Foot left - X-Ray |
|  | Foot Lt - MRI |
|  | Foot Lt - US |
|  | Foot right - X-Ray |
|  | Foot Rt - MRI |
|  | Foot Rt - US |
|  | Foot/ankle Lt - MRI |
|  | Foot/ankle Rt - MRI |
|  | Forearm with contrast Lt - CT |
|  | Forefoot Rt - CT |
|  | Foreign body localisation - US |
|  | Gastric emptying dual - N Med |
|  | Gastrojejunostomy |
|  | Gastrostomy access recannulation |
|  | Gastrostomy Follow Up |
|  | Gastrostomy Tube Change |
|  | Gastrostomy Tube Insertion |
|  | Gastrostomy tube removal |
|  | GFR Individual Kidney - N Med |
|  | GFR/EDTA clearance - N Med |
|  | Groin and inguinal region - US |
|  | Guided ablation - CT |
|  | Guided aspiration Chest - CT |
|  | Guided aspiration neck - CT |
|  | Guided biopsy abdomen - CT |
|  | Guided biopsy bone - CT |
|  | Guided biopsy Chest - CT |
|  | Guided biopsy liver - CT |
|  | Guided biopsy Liver - US |
|  | Guided biopsy lung - CT |
|  | Guided biopsy neck - CT |
|  | Guided biopsy salivary gland - US |
|  | Guided core biopsy axilla left - US |
|  | Guided core biopsy axilla right - US |
|  | Guided core biopsy breast Lt - US |
|  | Guided core biopsy breast Rt - US |
|  | Guided drainage abdomen - CT |
|  | Guided drainage Chest - CT |
|  | Guided drainage Chest - US |
|  | Guided embolisation - CT |
|  | Guided FNA & Core breast biopsy Lt - US |
|  | Guided FNA & Core breast biopsy Rt - US |
|  | Guided FNA axilla left - US |
|  | Guided FNA axilla right - US |
|  | Guided FNA Biopsy Neck - US |
|  | Guided injection ankle Lt - US |
|  | Guided injection ankle Rt - US |
|  | Guided injection elbow Lt - US |
|  | Guided injection elbow Rt - US |
|  | Guided injection foot Both - US |
|  | Guided injection foot Rt - US |
|  | Guided injection shoulder Both - US |
|  | Guided injection shoulder Lt - US |
|  | Guided injection shoulder Rt - US |
|  | Guided joint inj - US |
|  | Guided marker insertion breast Lt - US |
|  | Guided marker insertion breast Rt - US |
|  | Guided nerve root injection cervical - CT |
|  | Guided nerve root injection lumbar - CT |
|  | Guided nerve root injection sacral - CT |
|  | Guided skin marking breast Lt - US |
|  | Guided skin marking breast Rt - US |
|  | Hand and wrist Both - US |
|  | Hand Both - US |
|  | Hand left - X-Ray |
|  | Hand Lt - MRI |
|  | Hand Lt - US |
|  | Hand right - X-Ray |
|  | Hand Rt - MRI |
|  | Hand Rt - US |
|  | Hands both - X-Ray |
|  | Head - US |
|  | Head spectroscopy - MRI |
|  | Hepatic iron load - MRI |
|  | Herniogram |
|  | Hickman line insertion - X-ray |
|  | Hip & spine bone density scan - N Med |
|  | Hip AP & lat - X-Ray |
|  | Hip Both - CT |
|  | Hip left - X-Ray |
|  | Hip Lt - MRI |
|  | Hip right - X-Ray |
|  | Hip Rt - MRI |
|  | Hip with contrast Both - CT |
|  | Hips - MRI |
|  | Hips - US |
|  | Hips AP - X-Ray |
|  | Humerus left - X-Ray |
|  | Humerus right - X-Ray |
|  | IA DSA (specify site) |
|  | IA DSA Abdominal Aorta |
|  | IA DSA Abdominal Aorta & Distals |
|  | IA DSA Arch Aorta |
|  | IA DSA Carotid |
|  | IA DSA Renal |
|  | IA DSA Upper Limb |
|  | IA Femoral Angiogram |
|  | IAORAP |
|  | IGSJXG |
|  | Iliac PTA |
|  | Interventional Radiology Referral - Adult |
|  | IV DSA Abdominal Aorta & Distals |
|  | IV DSA Carotid |
|  | IVC Filter Removal |
|  | IVU - CT |
|  | IVU/IVP - X-ray |
|  | Kidney - CT |
|  | Kidney - MRI |
|  | Kidney Both - US |
|  | Kidney Both - US (Urology use only) |
|  | Kidney Lt - US |
|  | Kidney Lt - US (Urology use only) |
|  | Kidney Rt - US |
|  | Knee - MRI (specify) |
|  | Knee Both - CT |
|  | Knee Both - US |
|  | Knee left - X-Ray |
|  | Knee left multiple views - X-Ray |
|  | Knee Lt - MRI |
|  | Knee right - X-Ray |
|  | Knee right multiple views - X-Ray |
|  | Knee Rt - MRI |
|  | Knee Rt - US |
|  | Knee skyline view - X-Ray |
|  | Knee skyline view Lt - X-Ray |
|  | Knee skyline view Rt - X-Ray |
|  | Knee wt. Bearing - X-Ray |
|  | Knee wt. Bearing Lt - X-Ray |
|  | Knee wt. Bearing Rt - X-Ray |
|  | Knees both - X-Ray |
|  | KUB - CT |
|  | KUB - X-Ray |
|  | Kyphoplasty thoracic - CT |
|  | Lateral Neck - soft tissue - X-Ray |
|  | Lateral Skull - X-Ray |
|  | Lateral Thoracic & Lumbar spine - X-Ray |
|  | Left ankle - CT |
|  | Left elbow - CT |
|  | Left hand - CT |
|  | Left hip - CT |
|  | Left wrist - CT |
|  | Leg length - CT |
|  | Leg length measurement Rt - X-Ray |
|  | Liver biopsy (Radiology) |
|  | Localisation - US |
|  | Localisation Breast Lt - US guided |
|  | Localisation Breast Rt - US guided |
|  | Localisation Rt Mammogram |
|  | Loopogram |
|  | Loopogram gastrointestinal tract |
|  | Lower leg Both - MRI |
|  | Lower limb - CT |
|  | Lower limb Both - MRI |
|  | Lower limb with contrast Both - CT |
|  | Lumbar spine - CT |
|  | Lumbar spine - MRI |
|  | Lumbar spine - X-Ray |
|  | Lumbar spine (multiple views) - X-Ray |
|  | Lumbar spine oblique views - X-Ray |
|  | Lumbo-sacral spine - X-Ray |
|  | Lung biopsy (Radiology) |
|  | Lung perfusion quantification - N Med |
|  | Lung ventilation Perfusion Spect - N Med |
|  | Lutetium 177 Dotate Therapy - N Med |
|  | Lutetium 177 somatostatin analogue scan - N Med |
|  | Lymphangiogram Bilateral |
|  | Lymphoedema - N Med |
|  | Magnification Lt Mammogram |
|  | Magnification Rt Mammogram |
|  | Mammogram left |
|  | Mammogram Lt + Compression |
|  | Mammogram right |
|  | Mammogram Rt + Compression |
|  | Mandible - X-Ray |
|  | Mass - US |
|  | Meckels - N Med |
|  | Mediastinum - MRI |
|  | Mesenteric Angiogram |
|  | MIBG scan - N Med |
|  | MIDI Research Study - MRI |
|  | Mobile image intensifier Abdomen - Th |
|  | Mobile image intensifier Cervical Spine - Th |
|  | Mobile image intensifier Hip Lt - Th |
|  | Mobile image intensifier Hip Rt - Th |
|  | Mobile image intensifier Lower Limb Lt - Th |
|  | Mobile image intensifier Lower Limb Rt -Th |
|  | Mobile image intensifier Lumbar Spine - Th |
|  | Mobile image intensifier Pelvis - Th |
|  | Mobile image intensifier Thoracic Spine - Th |
|  | Mobile image intensifier Thorax - Th |
|  | Mobile image intensifier Upper Limb both - Th |
|  | Mobile image intensifier Upper Limb Lt - Th |
|  | Mobile image intensifier Upper Limb Rt - Th |
|  | MOH |
|  | MRCP - MRI |
|  | MRCP and Secretin Study - MRI |
|  | MRI Other Hospital |
|  | MRI Other Hospital - Report only |
|  | MROH |
|  | MRRESCH |
|  | MUGA - N Med |
|  | Myocardial Perf 1D St/Re Adenosine - NM |
|  | Myocardial Perf 1D St/Re Dobutamine - NM |
|  | Myocardial Perf 1D St/Re Treadmill - NM |
|  | Myocardial Perf. Stress only Adenosine |
|  | Myocardial Perfusion Rest Only - NM |
|  | Myocardial Perfusion Scan - NM |
|  | N84 |
|  | Naso-gastric Tube Insertion |
|  | Naso-jejunal Tube Insertion |
|  | NCGDHB |
|  | NCGENLVD |
|  | NCGENWM |
|  | NCGPSMA |
|  | NCHBHN |
|  | NCPF18C |
|  | NCPR333C |
|  | NCPRP303 |
|  | NCPRP304 |
|  | NCPRP331 |
|  | NCPRP333 |
|  | NCPRP341 |
|  | NCPRP342 |
|  | NCPRP348 |
|  | NCPRP373 |
|  | NCPRP404 |
|  | NCPRP405 |
|  | NDEXMBC |
|  | Nephrostogram Both |
|  | Nephrostomies Bilateral |
|  | Nephrostomy tube change |
|  | Nerve Block - CT |
|  | Nerve Block - X-Ray |
|  | NLABEL |
|  | NM Brain FDG PET CT |
|  | NM CU64 PET CT |
|  | NM F18 choline PET CT |
|  | NM Injection |
|  | Nuclear Clearance GFR |
|  | Nuclear Medicine Other Hospital |
|  | Obstetric foetal anatomy scan - US |
|  | Obstetric foetal growth - US |
|  | Obstetric US Request. |
|  | Octreotate Scan - N Med |
|  | Octreotide scan - N Med |
|  | Oesophageal Dilatation |
|  | Oesophageal Stent Insertion |
|  | Open Reduction Internal Fixation -Th |
|  | Operative Cholangiogram -Th |
|  | Operative Specimen - X-Ray |
|  | Orbit foreign body demonstration Both - X-Ray |
|  | Orbits - X-Ray |
|  | Orthopaedic pinning Lower Limb Lt - Th |
|  | Orthopaedic pinning Lower Limb Rt - Th |
|  | Orthopaedic pinning Upper Limb Lt - Th |
|  | Orthopaedic pinning Upper Limb Rt - Th |
|  | Osteotomy - Th |
|  | Other Examination - N Med |
|  | Pancreas - CT |
|  | Pancreas - MRI |
|  | Pancreas with contrast - CT |
|  | Parathyroid scan - N Med |
|  | Patella Lt - X-Ray |
|  | Patella Rt - X-Ray |
|  | Pelvic Floor - US |
|  | Pelvis - CT |
|  | Pelvis - general - US |
|  | Pelvis (non-gynae) - MRI |
|  | Pelvis AP - X-Ray |
|  | Pelvis AP for Hip Surveillance - X-Ray |
|  | Pelvis Gynae - US (Women's US STH) |
|  | Pelvis rectum - MRI |
|  | Pelvis SIJ Both - MRI |
|  | Pelvis with contrast - CT |
|  | Penis - MRI |
|  | Percutaneous Cholangiogram |
|  | Peripheral Angiogram - MRI |
|  | Permacath insertion - X-ray |
|  | PET Injection |
|  | Pharmacologic stress - N Med |
|  | PICC line insertion |
|  | Portacath removal - X-ray |
|  | Proctogram |
|  | Prostate - MRI |
|  | Prostate Arterial Embolisation |
|  | Prostate Arteries - CT |
|  | Prostate Brachytherapy - CT |
|  | Prostate screen - US |
|  | PTA No Angio. |
|  | PTA subclavian |
|  | PTC drainage/Biliary drainage |
|  | Pulmonary angiogram - CT |
|  | Radius & Ulna Left - X-Ray |
|  | Radius & Ulna Right - X-Ray |
|  | Reconstruction - CT |
|  | Red cell mass - N Med |
|  | Renal - US |
|  | Renal angiogram - CT |
|  | Renal Angiogram - MRI |
|  | Renal Both - MRA |
|  | Renal scan DMSA/scarring - N Med |
|  | Renal transplant - MRA |
|  | Renal Transplant - US |
|  | Renal with contrast Both - CT |
|  | Research PDL1 Expression in Cancer Study - N Med |
|  | Rest imaging - N Med |
|  | Retrograde Bilat - Th |
|  | RF Ablation |
|  | Rheumatology US Request |
|  | Ribs Rt - X-Ray |
|  | RIG Insertion |
|  | Right ankle - CT |
|  | Right elbow - CT |
|  | Right foot - CT |
|  | Right knee - CT |
|  | Right wrist - CT |
|  | Sacro-iliac joints - X-Ray |
|  | Sacrum - X-Ray |
|  | Salivary gland - MRI |
|  | Salivary glands Parotid - US |
|  | Salivary glands Submandibular - US |
|  | Scanora + X Section Tomos - Dental |
|  | Scaphoid left - X-Ray |
|  | Scaphoid right - X-Ray |
|  | Scapula right - X-Ray |
|  | Scapula Rt - CT |
|  | SEHCAT - N Med |
|  | Sentinel node breast - N Med |
|  | Sentinel node breast/melanoma - N Med |
|  | Sentinel node melanoma - N Med |
|  | Sentinel node oral with ICG - N Med |
|  | Sentinel node other - N Med |
|  | Shoulder axial view left - X-Ray |
|  | Shoulder Both - CT |
|  | Shoulder both - US |
|  | Shoulder both - X-Ray |
|  | Shoulder left - X-Ray |
|  | Shoulder Lt - CT |
|  | Shoulder Lt - MRI |
|  | Shoulder Lt - US |
|  | Shoulder right - X-Ray |
|  | Shoulder Rt - CT |
|  | Shoulder Rt - MRI |
|  | Shoulder Rt - US |
|  | Sialogram - Parotid Lt |
|  | Sialogram - Parotid Rt |
|  | Sialogram - Sub mandibular Lt |
|  | Sialogram - Sub mandibular Rt |
|  | Sialogram fluoroscopy - Sub mandibular Rt - Dental |
|  | Sialogram parotid fluoroscopy Rt - Dental |
|  | Sialogram Parotid Lt - Dental |
|  | Sialogram Parotid Rt - Dental |
|  | Sialogram Sub mandibular Lt - Dental |
|  | Sialogram Sub mandibular Rt - Dental |
|  | Sialogram submandibular fluoroscopy Lt - Dental |
|  | Sinuses - X-Ray |
|  | Skeletal Survey - CT |
|  | Skeletal Survey - MRI |
|  | Skeletal survey - X-Ray |
|  | Skull - X-Ray |
|  | Small bowel enema |
|  | Small bowel meal |
|  | Small bowel meal - MRI |
|  | Small Parts - US |
|  | Soft tissue (other) - MRI |
|  | Soft tissues - X-Ray |
|  | Spine C T L S with contrast - CT |
|  | Spine cervical with contrast - CT |
|  | Stereo Biopsy Mammogram - X-Ray |
|  | Sterno-clavicular jt Both - X-Ray |
|  | Sternum - MRI |
|  | Sternum - X-Ray |
|  | Stress imaging - N Med |
|  | Superior venocavogram |
|  | T38 |
|  | T41 |
|  | T47 |
|  | Temporo-mandibular jt Left - X-Ray |
|  | Tendon - US |
|  | Testes - US (specify side) |
|  | Testicular embolisation Left |
|  | Theatre (other) - X-Ray |
|  | Thigh Rt - US |
|  | Thoracic & Abd Aorta - CT |
|  | Thoracic inlet - X-Ray |
|  | Thoracic spine - CT |
|  | Thoracic spine - MRI |
|  | Thoracic spine - X-Ray |
|  | Thrombectomy |
|  | Thrombin Injection - X-ray |
|  | Thrombolysis Follow on (Radiology) |
|  | Thumb left - X-Ray |
|  | Thumb right - X-Ray |
|  | Thyroid - Parathyroid - US |
|  | Thyroid - US |
|  | Thyroid ablation therapy - N Med |
|  | Thyroid cancer therapy - N Med |
|  | Thyroid post Iodine therapy - N Med |
|  | Thyroid pre Iodine therapy - N Med |
|  | Thyroid scan Iodine - N Med |
|  | Thyroid scan Technetium - N Med |
|  | Thyroid scan using 131 Iodine - N Med |
|  | Thyrotoxicosis - N Med |
|  | Tibia & Fibular left - X-Ray |
|  | Tibia & Fibular right - X-Ray |
|  | Tibial nail plating - Th |
|  | Tibial PTA |
|  | Toe - X-Ray |
|  | Toe great Lt - X-Ray |
|  | Toe great Rt - X-Ray |
|  | Toes Lt - X-Ray |
|  | Toes Rt - X-Ray |
|  | Tomosynthesis Both Breasts |
|  | Tomosynthesis Left Breast |
|  | Tomosynthesis Right Breast |
|  | Transit Study abdomen - X-Ray |
|  | Transjugular Liver Biopsy |
|  | Transrectal - US |
|  | Transrectal Prostate - US (Urology use only) |
|  | TRUS Biopsy - US |
|  | Tubogram |
|  | Tunnelled Line Insertion |
|  | UA Ankle-Brachial Pressure |
|  | UA Ankle-Brachial Pressure. |
|  | UA Aortic Aneurysm |
|  | UA Aortic Aneurysm. |
|  | UA AV Fistula |
|  | UA AV Fistula. |
|  | UA AVF Maturation |
|  | UA Carotid & Vertebral |
|  | UA Carotid & Vertebral. |
|  | UA Dig/Raynauds. |
|  | UA Duplex Lower Limb |
|  | UA DVT |
|  | UA Guidance during EVLT |
|  | UA Guidance During Foam Sclerotherapy |
|  | UA Iliac A/V |
|  | UA Intima-media Thickness |
|  | UA Lower Limb Arterial |
|  | UA Lower Limb Arterial. |
|  | UA Lower Limb Deep Veins |
|  | UA Lower Limb Venous |
|  | UA Lower Limb Venous. |
|  | UA Monitoring |
|  | UA Monitoring. |
|  | UA Neck Veins |
|  | UA Neck Veins. |
|  | UA N-V Assessment |
|  | UA OPD |
|  | UA Other Hospital |
|  | UA Post Op Duplex |
|  | UA Renal Assessment |
|  | UA Special |
|  | UA Special. |
|  | UA Surveillance AAA |
|  | UA Surveillance AAA. |
|  | UA Surveillance Aortic EVAR |
|  | UA Surveillance Carotid |
|  | UA Surveillance Limb Graft |
|  | UA Surveillance Limb Graft. |
|  | UA TransCranial Doppler |
|  | UA TransCranial Doppler. |
|  | UA Upper Limb Arterial |
|  | UA Upper Limb Arterial. |
|  | UA Upper Limb Venous |
|  | UA Upper Limb Venous. |
|  | UA Vein Map |
|  | UA Vein Map. |
|  | Upper abdomen - US |
|  | Upper arm both - CT |
|  | Upper arm Lt - MRI |
|  | Upper limb Both - US |
|  | Upper limb Lt - US |
|  | Upper limb Rt - US |
|  | Ureteric Stent insertion - Right |
|  | Ureteroscopy - Th |
|  | Urethrogram |
|  | Urinary tract - US |
|  | Urinary Tract - US (Urology use only) |
|  | Urinary trct w resid & flow rate - US |
|  | Urogram - CT |
|  | US - Guidance During Foam Sclerotherapy |
|  | US - Special |
|  | US - Upper Limb Arterial |
|  | US - Upper Limb Venous |
|  | US - Vein Map |
|  | US Other Hospital |
|  | USD - Cheek Rt US |
|  | USD - Craniofacial soft tissues US |
|  | USD - Craniofacial soft tissues US - Dental use only |
|  | USD - Guided biopsy Neck US |
|  | USD - Guided FNA US |
|  | USD - Neck left US |
|  | USD - Neck right US |
|  | USD - Neck US |
|  | USD - Parotid Gland Lt US |
|  | USD - Parotid Gland Rt US |
|  | USD - Parotid Gland US |
|  | USD - Submandibular Gland Lt US |
|  | USD - Submandibular Gland Rt US |
|  | USD - Submandibular Gland US |
|  | USD - Thyroid US |
|  | USOH |
|  | USOH1 |
|  | Uterus/cervix/testes - MRI |
|  | V/Q scan - N Med |
|  | VA Mammotomy Lt stereotactic guided |
|  | Vascath insertion - X-ray |
|  | Venogram - CT |
|  | Venogram - MRV |
|  | Venogram bilateral |
|  | Venogram cerebral - CT |
|  | Venogram Lt arm |
|  | Vertebroplasty |
|  | Water soluble enema |
|  | Water soluble meal |
|  | Water soluble swallow |
|  | White cell scan Technetium - N Med |
|  | Whole body bone density scan - N Med |
|  | Whole spine - CT |
|  | Whole spine - X-Ray |
|  | Wrist Both - US |
|  | Wrist both - X-Ray |
|  | Wrist left - X-Ray |
|  | Wrist Lt - MRI |
|  | Wrist Lt - US |
|  | Wrist registration - N Med |
|  | Wrist right - X-Ray |
|  | Wrist Rt - MRI |
|  | Wrist Rt - US |
|  | X18 |
|  | XDOH |
|  | X-Ray in Theatre |
|  | X-Ray Other Hospital |
|  | XROH |
|  | Z18 |
|  | Z64 |
|  | ZINJ |
|  | ZPDELAY |

## Appendix 2: PACSIngestionErrorSummary.py

import pandas as pd  
import re  
# Step 1: Give link to textfile of json output of PACS failures.   
file\_path = 'PACs-failures.txt' # Replace with the actual path to your text file  
with open(file\_path, 'r') as file:  
 data = file.read()  
# Step 2: Clean the data by fixing quotes and ensuring proper spacing  
# Normalize the data by fixing inconsistent double quotes, spaces, and any potential newline issues  
normalized\_data = re.sub(r'""', '"', data) # Fix double quotes if present  
normalized\_data = re.sub(r'\s+', ' ', normalized\_data) # Replace multiple spaces and newlines with single spaces  
normalized\_data = re.sub(r'"\s\*"', '""', normalized\_data) # Ensure there are no empty quotes with spaces in between  
#testing demonstrated that by normalising twice the data was then in a pattern searching format.  
# Normalize the data by fixing inconsistent double quotes, spaces, and any potential newline issues  
normalized\_data = re.sub(r'""', '"', normalized\_data) # Fix double quotes if present  
normalized\_data = re.sub(r'\s+', ' ', normalized\_data) # Replace multiple spaces and newlines with single spaces  
normalized\_data = re.sub(r'"\s\*"', '""', normalized\_data) # Ensure there are no empty quotes with spaces in between  
  
# Print normalized data for debugging purposes (optional)  
print("Normalized Data:")  
print(normalized\_data)  
  
# Step 3: Pattern matching. Use regex to capture relevant fields (accessionNumber, id, studyDate, etc.)  
pattern = re.compile(  
 r'"accessionNumber":\s\*"([^"]+)"\s\*' # Capture accessionNumber  
 r'"id":\s\*"([^"]+)"\s\*' # Capture id  
 r'"studyDate":\s\*"([^"]+)"\s\*' # Capture studyDate  
 r'"studyDescription":\s\*"([^"]+)"\s\*' # Capture studyDescription  
 r'"studyInstanceUid":\s\*"([^"]+)"', # Capture studyInstanceUid  
 re.DOTALL  
)  
  
# Step 4: Find all matches  
matches = pattern.findall(normalized\_data)  
  
# Print matches for debugging purposes (optional)  
print("Matches Found:")  
print(matches)  
  
# Step 5: Create a DataFrame from the extracted matches  
df = pd.DataFrame(matches, columns=["AccessionNumber", "ID", "StudyDate", "StudyDescription", "StudyInstanceUid"])  
#rearrange data frame to be in the same order as .csv files downloaded from XNAT  
df = df[["ID", "StudyDate", "AccessionNumber", "StudyDescription", "StudyInstanceUid"]]  
# Display the DataFrame  
print("DataFrame:")  
print(df)  
# Save the DataFrame to a new CSV file  
df.to\_csv('PACs-non-ingested.csv', index=False)  
df\_pacs = pd.read\_csv('pacs-non-ingested.csv')  
#The code can be truncated here if new ingestions contain NHS numbers already. The next section converts between HospitalIDs and NHS numbers.  
  
# Load the HospitalID-NHSNumber spreadsheet containing the old and new IDs  
df\_ids = pd.read\_csv('HospitalID-NHSNumber.csv')  
  
# Merge the dataframes based on the matching IDs ('ID' in pacs-non-ingested with 'HospitalID' in HospitalID-NHSNumber)  
df\_merged = pd.merge(df\_pacs, df\_ids[['HospitalID', 'NHSNumber']], left\_on='ID', right\_on='HospitalID', how='left')  
  
# Replace the old 'ID' with the new 'NHSNumber' and rename the column to 'Subject'  
df\_merged['ID'] = df\_merged['NHSNumber']  
df\_merged = df\_merged.drop(columns=['HospitalID', 'NHSNumber']) # Drop the unnecessary columns  
#rename ID to be subject in line with csvs downloaded from XNAT  
df\_merged = df\_merged.rename(columns={'ID': 'Subject'})  
  
# Save the updated data to a new CSV file  
df\_merged.to\_csv('pacs-non-ingested.csv', index=False)  
#Either combine the .txt files of non-ingested PACS data from previous iterations of ingestions OR combine the .csvs before adding to XNATImagingSummary otherwise we will lose details of previous failed ingestions.

## Appendix 3: XNATImagingSummary.py

import pandas as pd  
  
# Function to sort, expand, and calculate the difference from the provided date  
def sort\_and\_expand(df, reference\_dates\_df, scan\_type):  
 # Extract columns by position, assuming the structure you provided  
 df.columns = ['Subject', 'Date', 'ID', 'UID', 'Scans'] # Generic column names for consistent access  
 reference\_dates\_df.columns = ['Subject', 'Reference Date'] # Columns for the new spreadsheet  
 df = df[df['Subject'].notna() & (df['Subject'] != '')]  
 # Merge the scan data with the reference dates based on 'Subject'  
 df = df.merge(reference\_dates\_df, on='Subject', how='left')  
 # Exclude any rows where Subject is "nan"  
 df = df[df['Subject'].notna() & (df['Subject'] != '')]  
 # Convert both 'Date' and 'Reference Date' to datetime for proper calculations  
 df['Date'] = pd.to\_datetime(df['Date'], errors='coerce')  
 df['Reference Date'] = pd.to\_datetime(df['Reference Date'], errors='coerce')  
  
 # \*\*Exclude any rows where the 'Date' is 01-01-2099\*\*  
 df = df[df['Date'] != pd.Timestamp('2099-01-01')]  
 #bin off blank subjects or nan  
 df = df[df['Subject'].notna() & (df['Subject'] != 'nan')]  
 # Group by 'Subject'  
 grouped = df.groupby('Subject')  
  
 expanded\_rows = []  
  
 # Iterate over each subject and their corresponding rows  
 for subject, group in grouped:  
 # Get the reference date for the subject  
 reference\_date = group['Reference Date'].iloc[0]  
  
 # Sort the rows by 'Date', placing rows with missing dates at the end  
 group = group.sort\_values(by='Date', key=lambda x: pd.to\_datetime(x, errors='coerce')).reset\_index(drop=True)  
  
 # Collect sorted data  
 sorted\_dates = group['Date'].tolist()  
 sorted\_ids = group['ID'].tolist()  
 sorted\_uids = group['UID'].tolist()  
 sorted\_scans = group['Scans'].tolist()  
  
 # Create a dictionary for the expanded columns  
 expanded\_row = {'Subject': subject}  
  
 # Add Reference Date or "not applicable" if missing  
 if pd.notna(reference\_date):  
 expanded\_row['Reference Date'] = reference\_date.strftime('%Y-%m-%d')  
 else:  
 expanded\_row['Reference Date'] = "not applicable"  
  
 # Expand columns for each scan (numbering them sequentially)  
 for i in range(len(sorted\_dates)):  
 # Date column  
 date\_value = sorted\_dates[i].strftime('%Y-%m-%d') if pd.notna(sorted\_dates[i]) else "null"  
 expanded\_row[f'{scan\_type} Date {i + 1}'] = date\_value  
  
 # Difference from reference date, or "not applicable" if no reference date  
 if pd.notna(sorted\_dates[i]) and pd.notna(reference\_date):  
 difference = (sorted\_dates[i] - reference\_date).days  
 elif pd.notna(sorted\_dates[i]) and not pd.notna(reference\_date):  
 difference = "not applicable"  
 else:  
 difference = "null"  
  
 expanded\_row[f'{scan\_type} Difference from Reference Date {i + 1}'] = difference  
  
 # For ID, UID, and Scans, replace missing values with "null"  
 expanded\_row[f'{scan\_type} ID {i + 1}'] = sorted\_ids[i] if pd.notna(sorted\_ids[i]) else "null"  
 expanded\_row[f'{scan\_type} UID {i + 1}'] = sorted\_uids[i] if pd.notna(sorted\_uids[i]) else "null"  
 expanded\_row[f'{scan\_type} Scans {i + 1}'] = sorted\_scans[i] if pd.notna(sorted\_scans[i]) else "null"  
  
 # Check for missing scans, ensuring that all columns are present for each scan type  
 max\_scans = len(sorted\_dates)  
 num\_columns\_to\_fill = 5 # Corresponding to Date, Difference, ID, UID, Scans  
 while max\_scans < num\_columns\_to\_fill:  
 max\_scans += 1  
 expanded\_row[f'{scan\_type} Date {max\_scans}'] = "null"  
 expanded\_row[f'{scan\_type} Difference from Reference Date {max\_scans}'] = "null"  
 expanded\_row[f'{scan\_type} ID {max\_scans}'] = "null"  
 expanded\_row[f'{scan\_type} UID {max\_scans}'] = "null"  
 expanded\_row[f'{scan\_type} Scans {max\_scans}'] = "null"  
  
 expanded\_rows.append(expanded\_row)  
  
 # Convert the list of expanded rows back into a DataFrame  
 expanded\_df = pd.DataFrame(expanded\_rows)  
  
 return expanded\_df  
# Load the original data for all scan types e.g. 8 .csvs plus the PACS-not-ingested csv from PACSIngestionError script.  
scan\_types = ['CT', 'MR', 'PET', 'CR', 'DX', 'RF', 'SR', 'XA', 'PACs-not-ingested']  
#Assumes scans are saved in location with date in title, edit below as required.  
dataframes = {scan\_type: pd.read\_csv(f'300924/{scan\_type}.csv') for scan\_type in scan\_types}  
  
# Ensure 'Subject' columns are of type string  
for scan\_type in scan\_types:  
 dataframes[scan\_type]['Subject'] = dataframes[scan\_type]['Subject'].astype(str)  
  
# Load the reference dates file  
#Again assumes within a dated folder, edit accordingly  
reference\_dates = pd.read\_csv('300924/reference\_dates.csv') # This contains Subject and Reference Date columns  
reference\_dates['Subject'] = reference\_dates['Subject'].astype(str) # Ensure Subject is string  
  
# Sort and expand the data for all scan types using the reference dates  
expanded\_dataframes = {scan\_type: sort\_and\_expand(dataframes[scan\_type], reference\_dates, scan\_type) for scan\_type in  
 scan\_types}  
  
# Merge all expanded datasets on the 'Subject' column  
merged\_data = expanded\_dataframes['CT']  
for scan\_type in scan\_types[1:]:  
 merged\_data = merged\_data.merge(expanded\_dataframes[scan\_type], on='Subject', how='outer')  
  
# Replace missing values with "null" in the entire merged dataset  
merged\_data = merged\_data.fillna('null')  
  
# Save the final merged and sorted data to a new CSV file  
merged\_data.to\_csv('final\_sorted\_merged\_scans\_with\_nulls.csv', index=False)  
  
# Print the first few rows of the merged data  
print(merged\_data.head())