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# MRIP

## Assessing Radionuclide Usage for Diagnostics and Therapies in the NHS: A Cross-Nation Data Investigation

In this research report we present the findings from the curation and analysis of the data for current usage of medical radionuclides from the four nations in the UK.

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For the development of the Scenario Analysis Tool, a baseline model that summarises the current demand and supply of medical radionuclides in the UK was created. In the baseline model, the "current usage of radionuclides within the NHS" was used as a proxy for demand. However, anecdotal evidence suggests that this may not accurately reflect true demand, given issues such as limited access to scans, lengthy waiting lists, and the effects of Covid-19.

The sensitive nature of supply data and the complex production process of radionuclides, which involves potential delays and material loss due to radioactive decay, has led to significant uncertainty in supply chain calculations. As such, in this research report we only present the data curation and outputs of demand data from the baseline model and assume that the current supply meets existing requirements.

## 2. Methodology

The starting point for the demand data is the number of diagnostic and therapeutic procedures that use medical radionuclides carried out to date across England, Scotland, Wales, and Northern Ireland. These types of procedures fall under the following modalities: PET-CT, Single-photon emission computed tomography (SPECT), SPECT-CT, and Nuclear Medicine (NM). It is worth noting that SPECT and SPECT-CT are subcategories of NM and sometimes they are reported as such. Each nation records this information differently, using different procedural codes and storing it in different ways.

### 2.1 Data Collection

#### 2.1.1 Data from England

England diagnostic data is collected by the [NHS Diagnostic Imaging Dataset \(DID\)](#) [2] which is a central collection of detailed information about diagnostic imaging tests carried out on NHS patients, extracted from local Radiology Information Systems (RISs) and submitted monthly. Within the DID the diagnostic imaging tests are recorded using a SNOMED-CT [5] code and description and classified under a particular modality.

Data resulting from a Freedom of Information (FOI) Request to the NHS on the 18<sup>th</sup> of September 2023 was used. The FOI asked for the frequency of each imaging activity that contributes to the DID for the imaging modalities: Nuclear Medicine, SPECT-CT, and PET-CT for the financial years (FYs) 2012/13 to 2022/23.

The SNOMED-CT codes of the received data were mapped to the procedural codes listed under the ARSAC guidelines [6], Tables 5.1, 5.2 and 5.3, using the SNOMED-CT Browser [7] (searching by code and description), and imaging modalities. The mapping table was verified by experts and can be shared upon request.

#### 2.1.2 Data from Scotland

Scotland has two distinct initiatives that are used to collect relevant data to this project:

- [Scottish Clinical Imaging Network \(SCIN\)](#) [8] that delivers the PET-CT service in Scotland (at four sites: Aberdeen, Edinburgh, Dundee, and Glasgow). Data from the SCIN network is collected by the National Services Scotland (NSS) [9] including the number of PET-CT procedures carried out, as well as waiting and reporting times.
  - o For this project all PET-CT scans performed over the last 6 years in Scotland were extracted from the NSS.

- The procedures are reported giving name of radionuclide and radiopharmaceutical and exam description. An ARSAC code was estimated using radioisotope, radiopharmaceutical and relevant clinical grouping.
- National Radiology Information and Intelligence Platform (NRIIP) [10] is a national radiology dashboard for Scotland that collates information from local Radiology Information System (RIS) and codes the procedures using the NICIP coding system. Data from NRIIP is managed by Public Health Scotland (PHS).
  - Data for the number of NM exams performed in total for FY 20/21, 21/22 and 22/23 was provided for this project.
  - ARSAC codes were estimated from NICIP description searching through keywords in the ARSAC mapping table.

One point to note is that the NRIIP-PHS dataset also contains PET-CT data, but when compared to the SCIN-NSS provided dataset the numbers are different, with the SCIN-NSS ones being larger. The understanding is that some boards may not have provided the required updates to PHS-NRIIP if they had previously submitted records elsewhere and therefore this may explain the difference in numbers. Within the model, the decision was made to use the SCIN-NSS data for PET-CT procedures and the PHS-NRIIP for NM procedures.

### 2.1.3 Data from Wales

Two different datasets were used for Wales data:

- The Welsh Health Specialised Services Committee (WHSSC) [11], following a freedom of information request on 5<sup>th</sup> December 2023, provided the total number of PET-CT scans performed in Wales per financial year since 2018/19, but they did not provide a granular split per radionuclide.
- Betsi Cadwaladr University Health Board (BCUHB) [12] provided the total number of diagnostic NM and PET-CT procedures and NM therapeutic procedures for North Wales since 2013. This data was provided giving radioisotope and radiopharmaceutical.

With these two distinct datasets the following assumptions have been made, and calculations performed:

- The understanding is that the PET-CT data for North Wales in the BCUHB dataset forms part of the PET scans in the WHSSC dataset, so the former are not included in calculations to avoid double counting.
- A scaling ratio of number of procedures from North Wales to all Wales has been calculated using PET-CT data from BCUHB and WHSSC, respectively. This scaling ratio has been used to scale other procedures from North Wales to all Wales.
- Estimated ARSAC codes have been listed based on a search and match of radioisotope and radiopharmaceutical, where there are several to choose from, the one with maximum dose and most common (based on other datasets) has been chosen.

#### 2.1.4 Data from Northern Ireland

For Northern Ireland, [Belfast Health and Social Care Trust \(BHSCT\)](#) [13] provided data from the five trusts in Northern Ireland with number of diagnostic and therapy procedures since April 2019 until Oct 2023:

- This data was provided giving modality, type of procedure, radionuclide, and exam descriptor. The data had been gathered using four different recording systems in use across the various Health and Social Care (HSC) Trusts and these are not all consistent in the exam codes and descriptors used.
- ARSAC codes were estimated from radionuclide match and exam descriptor searching for keywords in the ARSAC mapping table.

#### 2.1.5 Data on therapies from IDUG survey

The paper by Rojas, Bruno, et al. [3] was published in October 2023 and gives the number of therapeutic procedures in the UK for 2007, 2012 to 2021 as collected by the Internal Dosimetry Users Group (IDUG) survey.

The coverage of centres in the UK that responded to the survey is not known exactly, but we know it does not fully cover all treatment centres in the UK as not all of them responded. To calculate a scaling factor, we make use of the Environment Agency (EA) pollution inventory data [14] and the IPEM excretion factors [15]. The EA pollution inventory data is searched for therapeutic radionuclide material that has been excreted in 2021, for all the radionuclides listed in the IDUG survey paper [3]. The IPEM excretion factors are used to back calculate how much material would have been administered to patients, and then the diagnostic reference levels given in the ARSAC guidance are used to estimate the number of procedures done in 2021. We compare this to the number of procedures reported in the IDUG survey paper to estimate a scaling factor per therapeutic radionuclide. We scale the IDUG survey data accordingly using these factors.

To ensure consistency and avoid double counting, in the model the data for therapy procedures for the whole of the UK was sourced from the IDUG survey, rather than the individual nations' datasets described above, as the completeness of reporting varied significantly across nations.

## 2.2 Data merging and calculations

As explained previously, the data on number of procedures done in each of the nations was given differently, so we first needed to combine the data into a consistent format. We did this by using the ARSAC procedural codes (as per Tables 5.1 and 5.2 in [6]), which is the common variable across datasets, following these principles:

- For each nation dataset list all the unique ARSAC codes and populate as many rows as number of unique ARSAC codes.
- For each row, use the ARSAC guidance to fill in the radioisotope, radiopharmaceutical, clinical indication, type of procedure, modality, and amount of radionuclide user per procedure.
- To calculate the number of procedures per year per ARSAC code we use two methods:

- One is to calculate the minimum, average and maximum number of procedures per year – as the different nations’ datasets span different time periods, this was considered a way to compare them.
- A second is to look at specific years for which all nations’ datasets have data, which are 2019 (pre-pandemic) and 2021 (the last full years’ worth of data).
- We then calculate the amount of radionuclide material [GBq] used per year by multiplying the number of procedures per year by the amount of radionuclide material used per procedure for each ARSAC code, and then summing over the ARSAC codes corresponding to each radionuclide.
  - One point to note is that for the therapeutic procedures listed in the ARSAC guidelines [6], Table 5.3, there is no recommended administered activity – unlike the diagnostic procedures that report a Diagnostic Reference Level (DRL) in the table. To calculate the amount of radionuclide used in this case, we used consensus knowledge from nuclear medicine NHS experts.

### 3. Results

#### 3.1 Total number of procedures

Figures 2 and 3 show the total number of diagnostic, and Figure 4 the therapeutic, procedures carried out in the UK from 2012 to 2021, split per radionuclide.

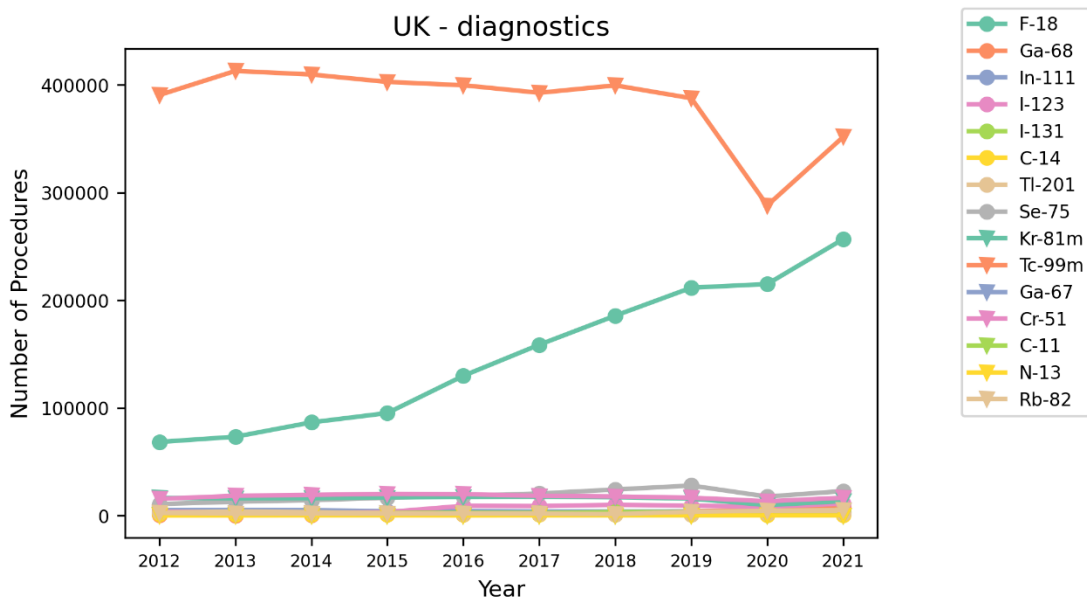


Figure 2: Number of diagnostic procedures done in the UK.

The radionuclides that are mostly used for diagnostic procedures are Tc-99m (NM) and F-18 (PET-CT); the effects of the Covid-19 pandemic are much more noticeable on Tc-99m than on F-18 (See Fig. 2). Figure 3 shows the same data as Figure 2 without Tc-99m and F-18 in order to see more clearly the radionuclides with smaller volumes of procedures.

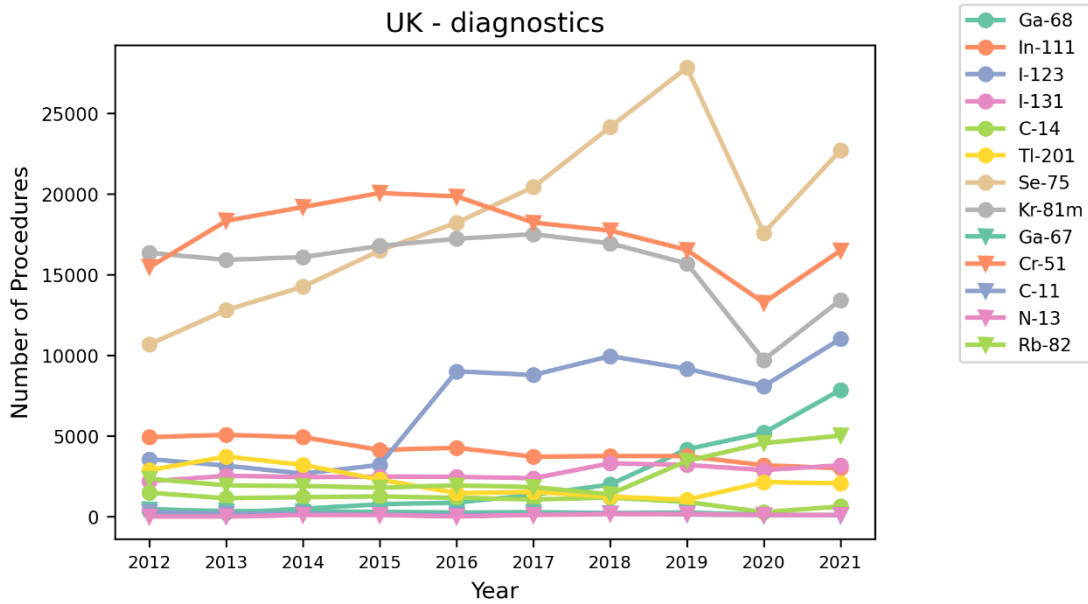


Figure 3: Number of diagnostic procedures done in the UK without including Tc-99m and F-18.

From Figure 4 we can see the most used therapeutic radionuclides over the past years have been I-131 and Ra-223, and there is a noticeable increase in the use of Lu-177 since 2018.

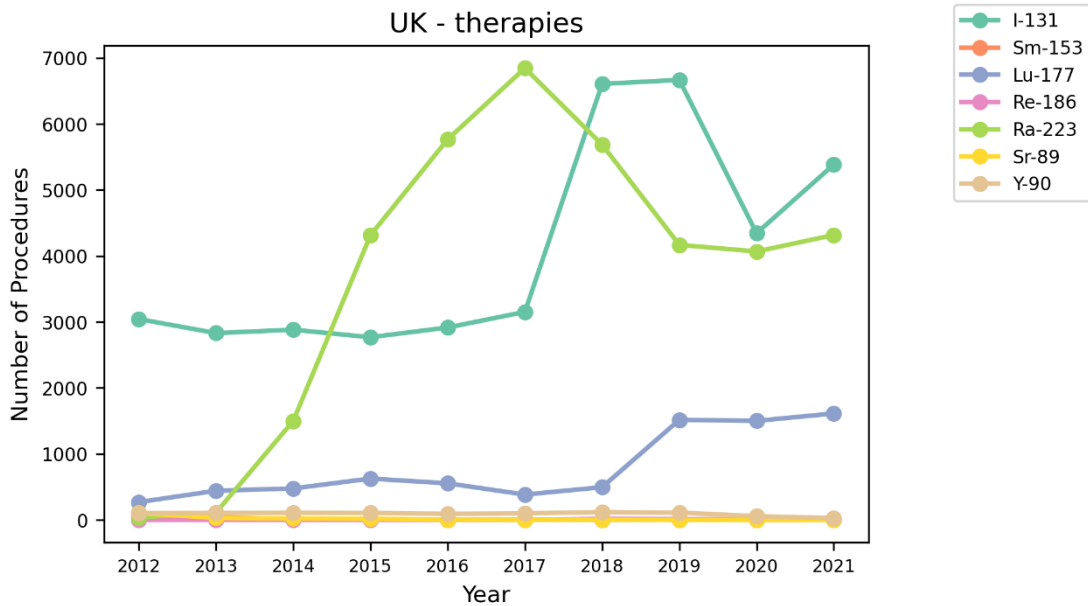


Figure 4: Number of therapeutic procedures done in the UK.

Figure 5 shows the split of number of diagnostic procedures per nation. It is worth noting that the timing of data collection initiation varies across nations, complicating direct comparisons. England's data goes back to 2012, whereas Scotland's PET data has been recorded from 2016 and NM data from 2018; Wales has data for Tc-99m from 2013 onwards, but for other radionuclides not until 2017; Northern Ireland has data from 2018 onwards.

Figure 6 shows the same data as Figure 5 without Tc-99m and F-18 in order to see more clearly the radionuclides with smaller volumes of procedures. From this figure we can see the devolved nations have access to fewer radionuclides than England. Despite these differences, the use of F-18 has

increased across all nations, including during the pandemic years, in contrast to Tc-99m, which has seen a reduction. These trends highlight disparities in radionuclide availability and usage patterns, emphasizing the need for coordinated efforts to standardize data collection and address regional disparities in radionuclide access.

An equivalent split per devolved nation of the therapeutic procedures cannot be done with this data; as explained above, for therapies we used the IDUG survey data for the whole of the UK rather than the individual nations' datasets to ensure consistency and avoid double counting.

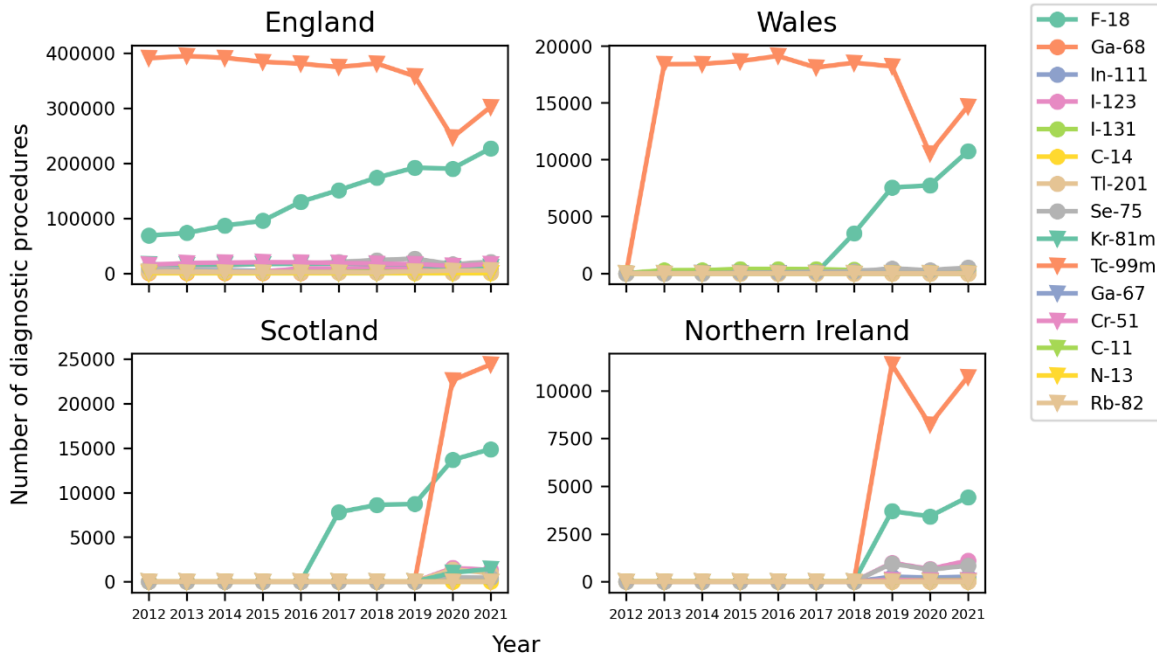


Figure 5: Number of diagnostic procedures done, split per nation.

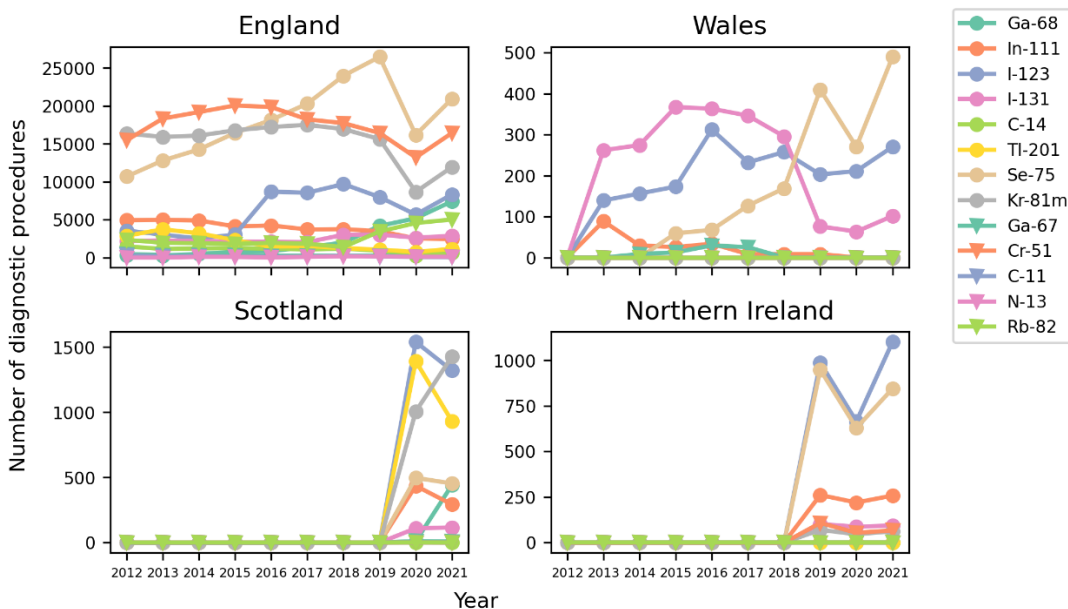


Figure 6: Number of diagnostic procedures done, split per nation, without including Tc-99m and F-18.

### 3.2 Scaled number of procedures per population

In this section we present the same figures as the previous section but scaled by 100,000 population for ease of comparison. Population numbers from the Office of National Statistics have been used, mid-2012 to mid-2021 edition of the dataset [16].

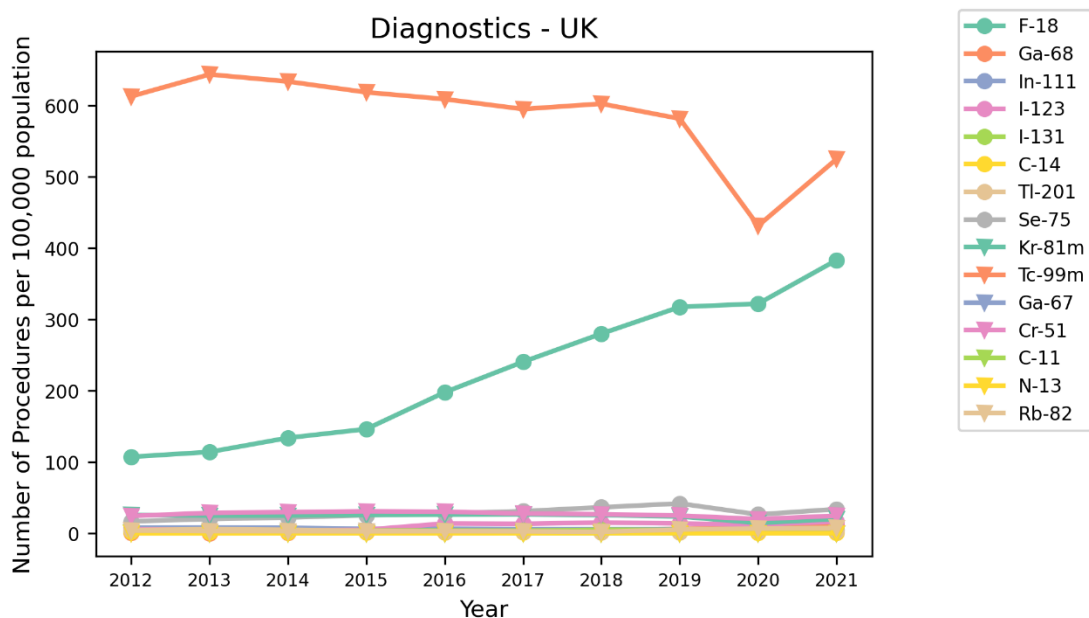


Figure 7: Number of diagnostic procedures in the UK, scaled by 100,000 population.

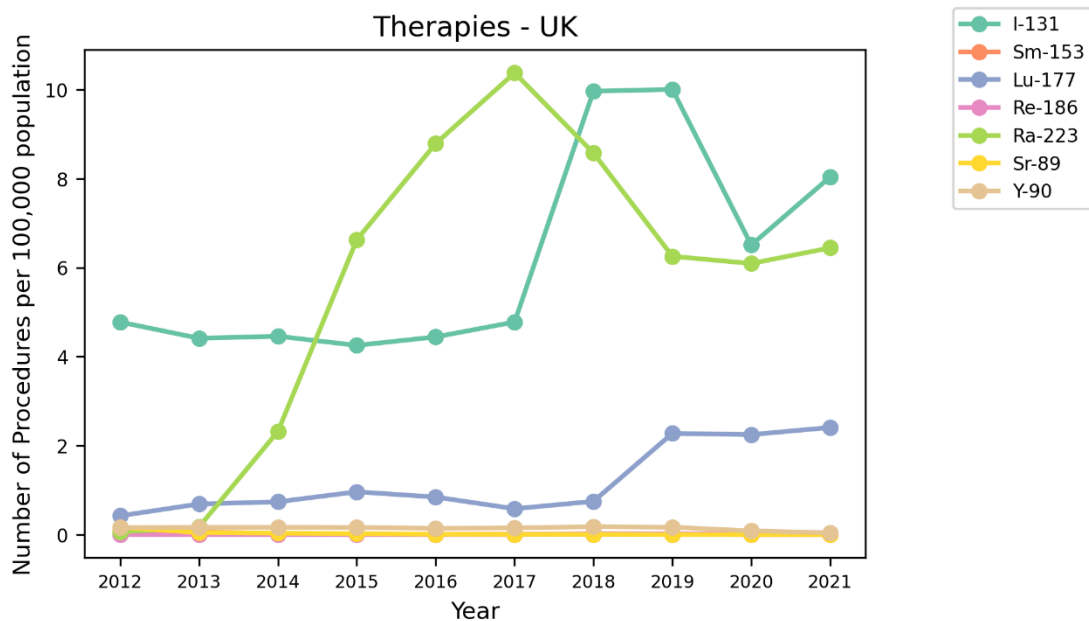


Figure 8: Number of therapeutic procedures in the UK, scaled by 100,000 population.

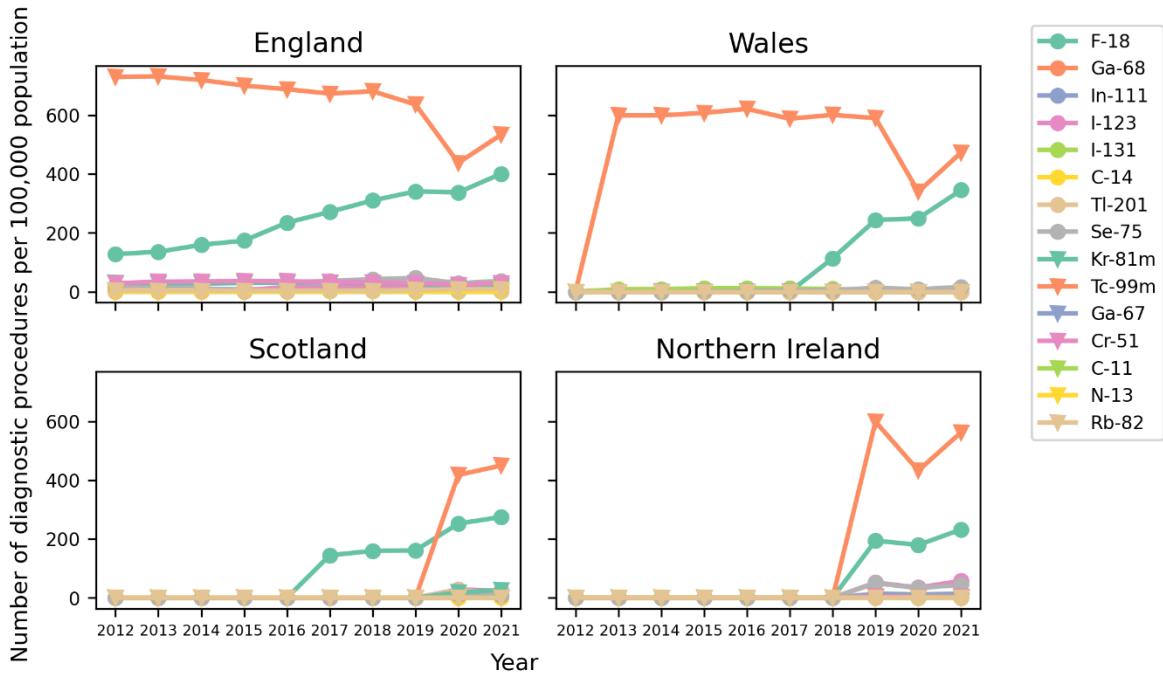


Figure 9: Number of diagnostic procedures done, split per nation, and scaled by 100,000 population.

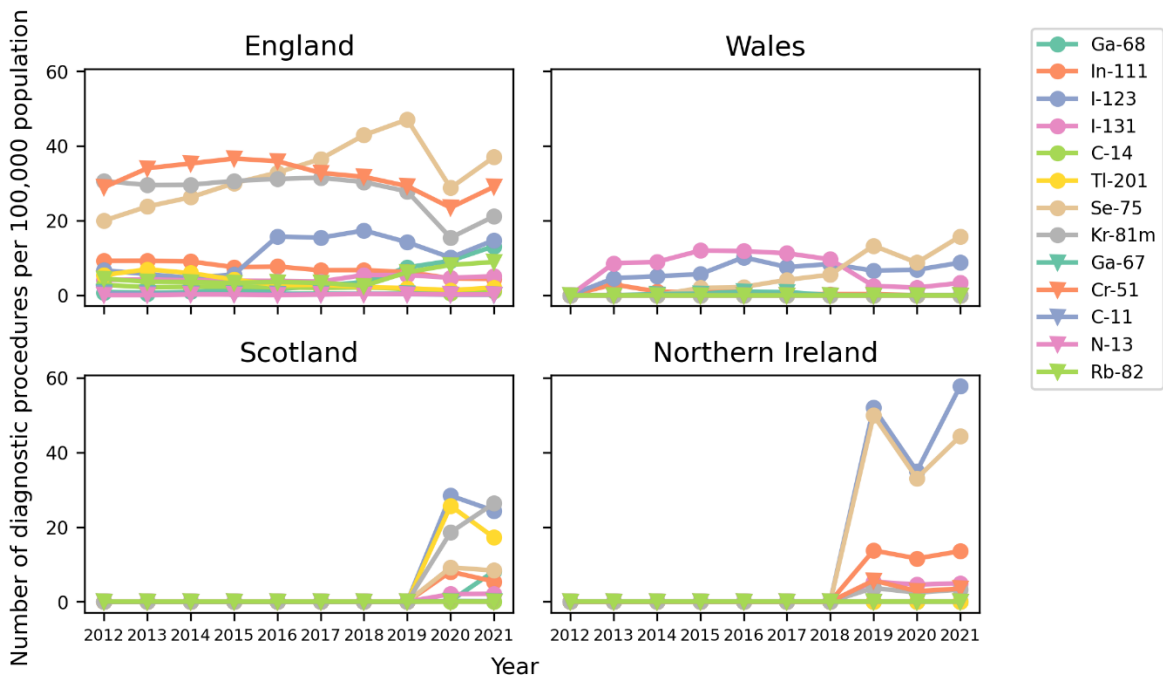


Figure 10: Number of diagnostic procedures done, split per nation, and scaled by 100,000 population, without Tc-99m and F-18.

### 3.3 Scaled number of procedures per radionuclide

Figure 11 shows the number of diagnostic procedures in each nation scaled by 100,000 population for selected radionuclides (F-18, Ga-68, Tc-99m, I-131). I-131 is the only radionuclide in the dataset that is used for both diagnostic and therapeutic procedures; the yellow line highlights the therapies whereas the nation lines show the diagnostic procedures.

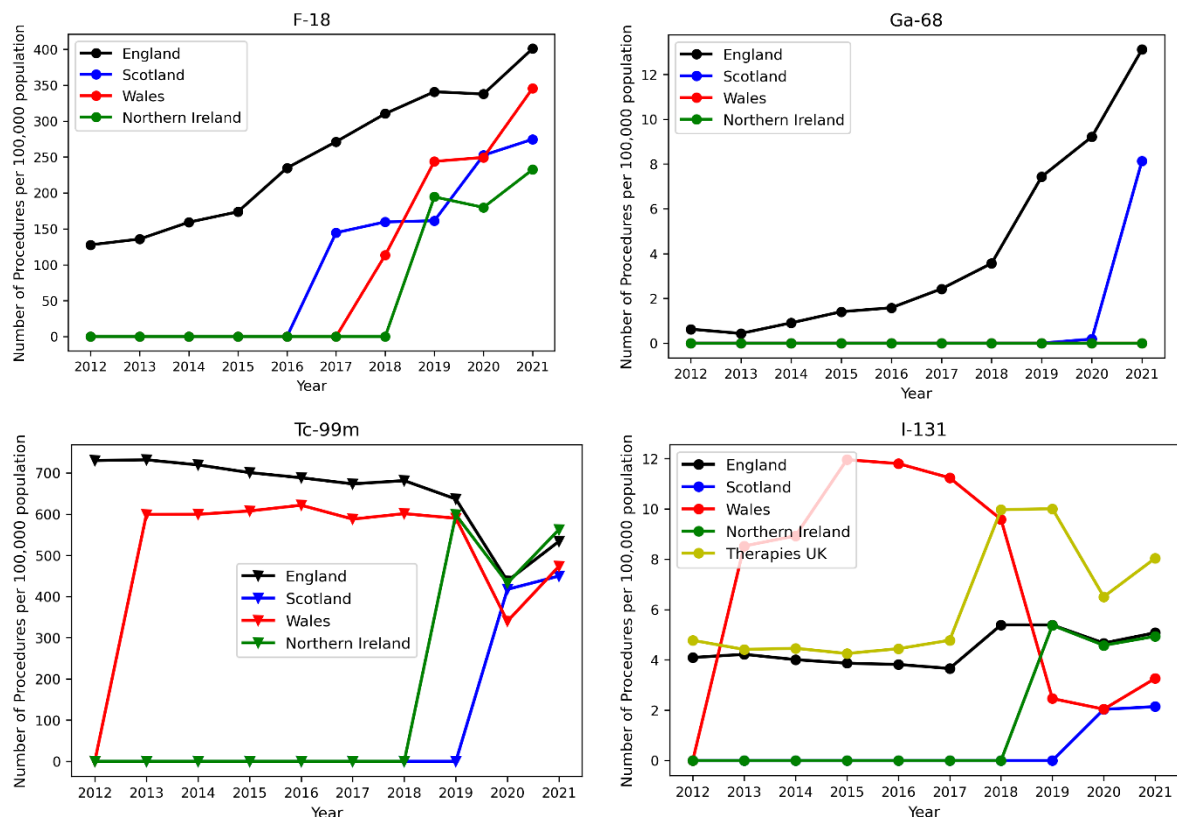


Figure 11: Number of diagnostic procedures per nation scaled by 100,000 population for selected radionuclides (F-18, Ga-68, Tc-99m, I-131). The extra yellow line for I-131 show the therapeutic procedures done with I-131.

England exhibits a higher usage of F-18, likely attributable to the PET-CT block contract. But overall F-18 shows a steady increase over the years in all nations, with a plateau around the Covid-19 pandemic time for all except Scotland. In contrast, Tc-99m shows an overall reduction trend; however, Scotland did not experience the same significant dip during the pandemic as observed in other nations. The utilization of I-131 for diagnostics is notably higher in Wales compared to other regions, as well as the use for therapeutics. Ga-68 seems to only be used in England and Scotland, with a large increase in Scotland for the last year.

This variation in radionuclide usage across the UK highlights regional differences in treatment practices and contractual influences, underscoring the need for a more nuanced understanding of these trends to optimize resource allocation and healthcare delivery.

## 4. Discussion

In this paper we have presented the diagnostic and therapeutic radionuclide usage across the four nations of the UK, which was developed as part of a Scenario Analysis Tool for modelling supply and demand of medical radionuclides in the UK. We have compared the usage patterns across the different nations; these have highlighted differences in access to certain diagnostic and therapeutic radionuclides, which aligns with anecdotal feedback from stakeholders.

We have presented a method to standardise the disparate diagnostic datasets, given that each nation uses a different coding system to record the data relating to medical radionuclide procedures. Improving the standardisation and completeness of diagnostic data collection across the four nations is crucial for understanding the demand based on current usage of medical radionuclides in the UK.

Furthermore, there is a significant need for more systematic therapeutic data collection, rather than relying solely on voluntary entries from surveys which has proved inadequate. Additionally, recording detailed information on the dose administered to the patient would greatly enhance subsequent data analysis of amount of radionuclide used.

Finally, to gain a true understanding of the demand and supply dynamics, it is essential to have better data on the radionuclide landscape; this is currently privately owned and managed and therefore the datasets are not publicly available.

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