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Radiology Supply and Demand Model - Methodology Paper

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List of Acronyms and Abbreviations

ABS	Australian Bureau of Statistics
AFHW	Australia's Future Health Workforce
Ahpra	Australian Health Practitioner Regulation Agency
APC	Admitted Patient Care
AR-DRG	Australian Refined – Diagnostic Related Group
CT	Computerised Tomography
DRG	Diagnostic Related Group
EDDG	Emergency Department Diagnosis Group
ERP	Estimated Resident Population
ESRGs	Enhanced Service-Related Groups
FTE	Full-Time Equivalent
GLM	Generalised Linear Model
ICD-10	International Classification of Diseases, 10th Revision
MBS	Medicare Benefits Schedule
MET	Medical Education and Training
MeSHWPoD	Medical Specialist Health Workforce Prediction of Demand
MRI	Medical Resonance Imaging
NAP	Non-Admitted Patient
NAPEDC	Non-Admitted Patient Emergency Department Care
NEP	National Efficient Price
NHCDC	National Hospital Cost Data Collection
NHWDS	National Health Workforce Datasets
NNAPD	National Non-Admitted Patient Database
NWAU	National Weighted Activity Unit
PET	Positron Emission Tomography
PHDB	Private Hospital Data Bureau
PLIDA	Personal Level Integrated Data Asset
RANZCR	Royal Australian and New Zealand College of Radiologists
SA4	Statistical Area 4

1.0 Introduction

This paper provides the methodology used for the supply and demand model for the radiologist workforce. It aims to quantify the supply and demand for radiologists between 2025 and 2048 using data collected from several sources between 2018 and 2023.[1]

2.0 Modelling Overview

Radiology refers to the medical specialty involving the use and interpretation of medical imaging to support clinical diagnosis and treatment. Radiologists are specialist medical practitioners who provide radiology services, including diagnostic interpretation and, in some cases, image-guided procedures[2].

2.1 Scope

To practise in Australia, all radiologists must be registered with the Australian Health Practitioner Regulation Agency (Ahpra). All radiologists must undergo the Royal Australian and New Zealand College of Radiologists (RANZCR) Fellowship program or international specialist pathway for Specialist International Medical Graduates (SIMG) to become accredited to practise in radiology. SIMGs are defined as medical practitioners whose initial specialist qualification was from overseas.[3]

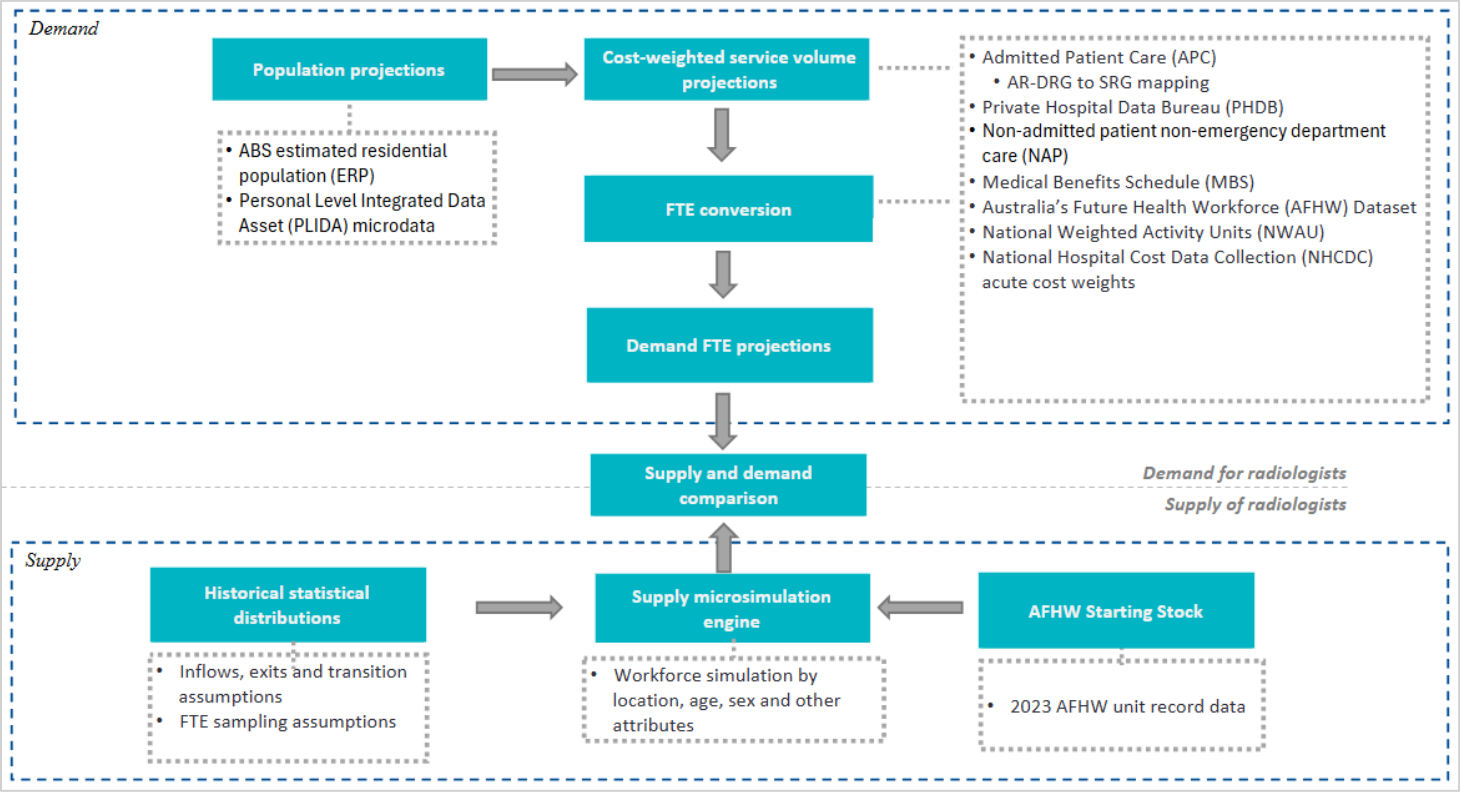
This study focuses on modelling supply of and demand for radiologists who are currently working clinical hours and who are not currently trainees. Radiology trainees are modelled as part of the training pipeline analysis (see section 3.3.1 New entries) which focuses on modelling trainees to inform inflows into the radiology workforce over the projection period.

Modelling has been undertaken at the Statistical Area 4 (SA4) geography (where data availability permitted). However, results will be published at state and territory level, with their aggregation forming the national results.

Figure 1 provides an overview of the modelling process. The following sections explains the steps in further detail.

[1] The workforce projections have been estimated over a longer period, as compared to the 15-year period for all allied health practitioner supply and demand studies, due to the relatively longer training pipeline for medical practitioners.
[2] The Royal Australian and New Zealand College of Radiologists (RANZCR), 2025, Clinical Radiology Training Program Handbook (version 2.4), accessed 22 June 2026.
[3] Please note that this definition differs from the standard way International Medical Graduates (IMGs) are typically described in the literature. In most cases, the definition is based on a practitioner's initial medical qualification rather than their specialist qualification.

Figure 1: Overview of the radiology modelling process



3.0 Radiology Supply

The radiology supply model uses Australia's Future Health Workforce (AFHW) data on Radiologists from 2018 to 2023.

The supply model uses the microsimulation approach where attributes such as entries and exits to the workforce and practitioner Full-Time Equivalent (FTE) are modelled distinctly. The supply methodology begins by identifying the current stock of radiologists, analysing their demographic profile and historically observed work patterns. Statistically significant predictors of future radiology workforce supply (such as age, sex, etc.) are selected, and their historical distributions are measured to allow the development of a microsimulation model.

The microsimulation works at a yearly time-step, tracking the progression of radiologists throughout their career. Each year, it accounts for new fellows, removes radiologists who take temporary or permanent leave, and simulates transitions of radiologists between geographic locations. The following sections describe how each component is defined and modelled in the supply model.

The baseline projections assume an initial equilibrium between supply and demand in the base year, 2023.

3.1 Key data inputs

The key datasets used for the radiology supply modelling are extracted from the following sources:

#	Source	Description and use in model
1	Australia's Future Health Workforce (AFHW) dataset	The AFHW datasets are created from the National Health Workforce Datasets (NHWDS) for modelling purposes. A sequence of rules (supply criteria) is applied to each NHWDS to determine which practitioners meet the definition of supply for each profession (and sub-groups where applicable). The headcount and workload of these practitioners, along with other variables required for modelling, are included, derived or imputed in the AFHW datasets. The AFHW dataset contains unit record data on radiologists, including demographic variables and information on their career (such as hours worked which is converted to FTE).
2	Yearly snapshot of vocational trainees in the RANZCR training program sourced from the Medical Education and Training (MET) Data Collection	Contains the number of commencing and total vocational trainees by speciality, training stage (basic vs advanced) and state.

3.2 Historic and starting stock

The AFHW data is a unit record longitudinal dataset, where each respondent is assigned a unique identifier that can be linked across multiple years. To be in scope, radiologists must:

1. be registered as a medical practitioner and have radiology as one of their specialties registered with Ahpra
2. be working in medicine in Australia including those on extended leave, and
3. indicate a radiology specialty/subspecialty as the specialty they worked the most or second most hours in.

3.2.1 Total hours (Full-Time Equivalent)

Total specialist hours (clinical and non-clinical)[4] of radiologists are used in modelling supply. If a radiologist is employed but on extended leave (defined as a period of over 3 months), their hours are halved for simplicity, assuming they worked an average of 6 months during the year.

One FTE is defined as 40 self-reported weekly average hours in the AFHW dataset (across 46 weeks in the year).

3.3 Measuring entries, exits and transitions

The AFHW dataset enables tracking of individuals as they age, relocate, progress in their careers and transition in and out of the workforce. Historical data relating to entries, exits and transitions is used to determine future trends based on the analysis of historical demographic probabilities and distributions.

The demographic probabilities and distributions are sampled to understand the effects of age, sex, state/territory of primary workplace and place of specialist qualification on workforce patterns.

3.3.1 New entries

New entries into the radiology workforce include individuals entering through both the domestic RANZCR Fellowship Program and the RANZCR international pathways.

The supply model incorporates a training pipeline analysis that predicts the number of RANZCR fellows entering the workforce based on the data on vocational trainees in the RANZCR training program from the MET data collection.

3.3.2 Exits and re-entries

Exits from the radiology workforce are determined using historical AFHW data by tracking individual specialist's participation over time. Radiologists who appear in the AFHW data in one year but not the next are classified as having exited the workforce. Exits are modelled by age, sex, place of initial specialist qualification and state of primary workplace as covariates.

These one-period exits are further classified as temporary or permanent exits:

- **Temporary exits or re-entries**: refer to a radiologist who leaves the workforce after working for at least one reporting period (i.e. one year) but returns to the medical specialty within a 4-year period.[5] The point of re-entry is estimated based on the rate at which radiologists who leave the workforce, return in subsequent years. The modelling of re-entry probabilities includes the same covariates as exits i.e., age, sex, state of primary workplace and place of initial specialist qualification.

[4] Clinical hours are defined as hours reported in clinical roles which involve direct patient care. Non-clinical hours are defined as hours reported in non-clinical roles (including teacher, researcher, administrator including managers) that do not involve direct patient care.
[5] The 4-year period is used because scope of practice considerations become less relevant beyond that timeframe. This approach is used for both historical and future workforce exits.

- **Permanent exits**: refer to a radiologist who, after working for at least one reporting period (i.e. one year), leaves the workforce and does not return within a 4-year period.

3.3.3 Interstate transitions

Interstate movement of radiologists is estimated based on the probability of radiologists changing their primary place of work from one state/territory to another. Covariates used to determine transition rates and destinations are the current state of the radiologist's primary workplace, sex, age and place of initial specialist qualification.

3.3.4 Estimating full-time equivalent (FTE) of entries, re-entries and transitions

The number of FTE each radiologist works is a central component of the model. FTE is a measure which can vary significantly between individuals and years. One FTE is defined as 40 self-reported weekly average hours worked.

To account for the variations in FTE by various demographics of radiologists, the simulated radiology workforce FTE distribution is estimated by age, sex, place of initial specialist qualification, state of primary workplace and whether they work in the private or public sector (or both). This is done by:

1. Re-sampling an existing radiologist's FTE annually to reflect their demographic attributes, as it may change from year to year. Additionally, their FTE is adjusted by a time-dependent modifier based on changes to the average FTE observed over the past 5 years.
2. Additional FTE adjustments, in the form of a series of multipliers, is then applied to a radiologist's FTE, following one of the workforce status changes below:
    - a workforce exit or entry, or
    - a change in state/territory of workplace

These adjustments are applied after the new FTE re-sampling has been applied. This is because the adjustments effectively adjust for breaks in regular employment.

3.4 Supply modelling

A microsimulation process is used to project supply for radiologists. An overview of this process is shown in Figure 2 below. The supply model uses the following attributes:

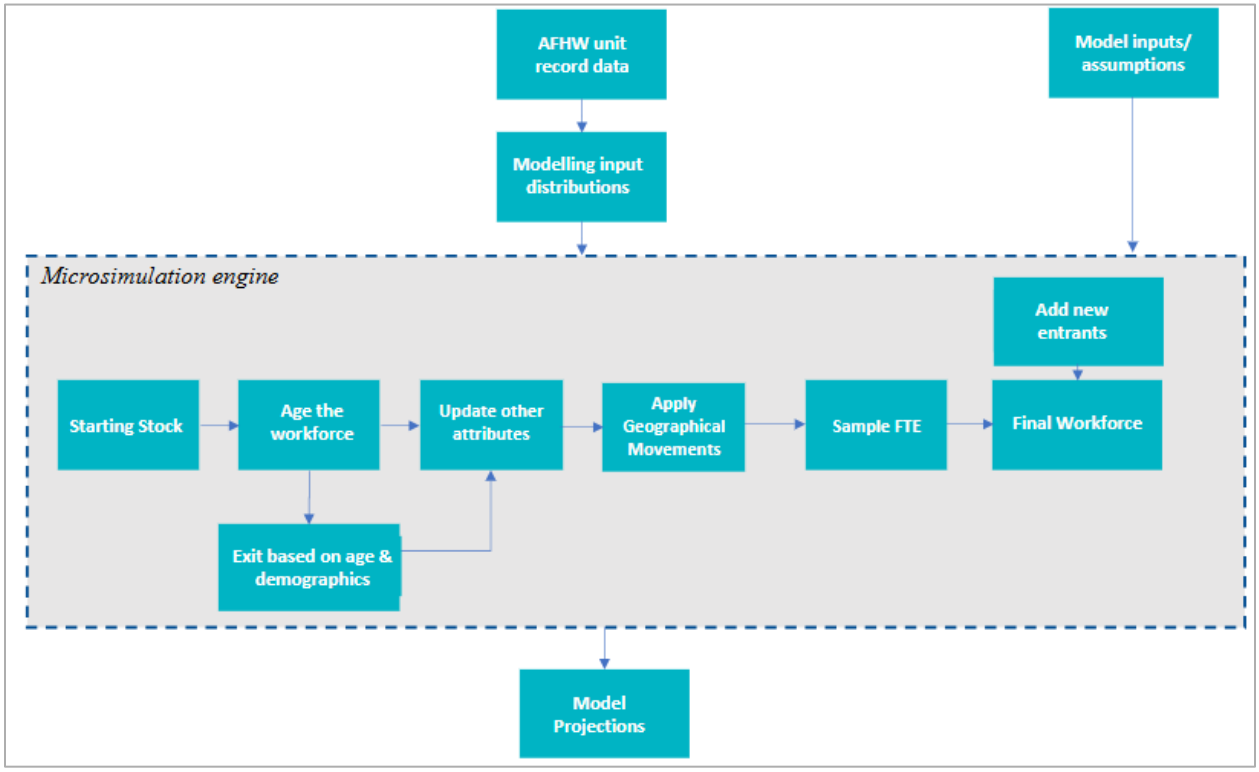
1. Full-time Equivalent (FTE) based on 40 hours per week
2. sex
3. age
4. specialty graduation country (domestic RANZCR Fellowship Program versus international pathways)
5. primary work location (state/territory, SA4).

In each iteration of the microsimulation:

1. The workforce is aged, and some radiologists exit the workforce based on their age, sex, specialty graduation country and state of primary workplace.
    a) Exits are sampled to determine if the exit is permanent or temporary.
    b) Radiologists that temporarily exit will re-enter the workforce during a subsequent period of up to 4 years, in accordance with the historical distribution of re-entries following up to 4 periods of absence.
2. Geographical movements are applied to radiologists based on historic state/territory migration patterns broken down by sex, age, place of initial specialist qualification and state/territory of primary workplace.
3. FTE is updated based on smoothed historical FTE year-on-year changes by age, unless a radiologist:
    a. geographically transitions to a different state/territory or
    b. returns from a temporary exit.
4. Radiologists that are flagged for re-entry are brought back into the workforce when their pre-assigned leave duration has elapsed. Leave duration is determined by factors such as age and place of initial specialist qualification, with a maximum of 4 years for temporary exits. The FTE for re-entering specialists is sampled from a distribution modelled on historical AFHW data.
5. New radiologists are added to the workforce either as:
    a. new domestic fellows or
    b. new fellows through international pathways.
6. The modelling process iterates annually, where the number of radiologists in the following year is calculated as the number of radiologists in the current year, minus the number of radiologists exiting and transitioning-out, plus those entering the workforce and transitioning-in in the new year. In other words:

$$\text{Supply}_{(t+1)} = \text{Supply}_{(t)} - \text{Exits}_{(t+1)} + \text{Entries}_{(t+1)} + \text{Net transitions while staying employed}_{(t+1)}$$

Figure 2: The supply microsimulation process



4.4 Assumptions

#	Caveat/Limitation	Description and implications
1	Static sampling assumptions	The microsimulation module applies static sampling distributions based on historical data from 2018 to 2022 to simulate projected behaviour, except for average FTE distribution which is adjusted based on historical trends.
2	COVID-19 impact	The effects of COVID-19 on affected years (2020–21) are unclear and will be confirmed with further analysis of updated data. It is likely that some trainees were unable to progress due to the pandemic. If so, stage transition disruptions could affect subsequent years as well.
3	Technological change	Technological improvements during the projection period that may affect workforce FTE in providing care are not considered.

4.0 Radiology Demand

Demand is measured in terms of observed utilisation of medical services which captures expressed (observed) service demand for radiology services across a variety of care settings. Historical patterns of usage are examined and used to estimate the future demand for radiologists, accounting for differences in service demand across various age groups and geographies. Estimation of future demand for radiology services also considers the Australian Bureau of Statistics (ABS) Population Projections.

The model, known as the Medical Specialist Health Workforce Prediction of Demand (MeSHWPoD) is used by the Department of Health, Ageing and Disability (the Department) to provide demand projections for the specialist workforce. For further details on MeSHWPoD methodology with worked examples, please refer to Attachment A.

4.1 Key data inputs

The key datasets used for the radiology demand modelling are extracted from the following sources:

#	Source	Description and use in model
1	Medical Benefits Schedule (MBS) data	Contains data on patients billed through the MBS, including patient demographics such as age, sex, location, service provider location, the specific MBS item and benefit paid. A hospital flag indicator is used to exclude any MBS services delivered in hospitals to avoid overlap with Admitted Patient Care (APC) data/Private Hospital Data Bureau (PHDB) data.
2	Admitted Patient Care (APC) data	Contains data on episodes of care for admitted patients in all public and private acute, and maternity/women's hospitals, free standing day hospital facilities, and hospitals specialising in other specialised acute medical or surgical care. The data includes patient demographics such as age, sex, location of residence, service provider location and type of facility (used to derive sector). It also includes detailed data on procedures and diagnoses based on Australian Refined – Diagnostic Related Group (AR-DRG) classification.
3	Private Hospital Data Bureau (PHDB)	Contains data on episodes of care for admitted patients in private hospitals (although three of these hospitals are treated as public for reporting purposes). The structure

#	Source	Description and use in model
		and variables collected is similar to those in the APC data.
4	Non-Admitted Patient Emergency Department Care (NAPEDC) data	Contains data on episodes of care for patients who physically present to emergency departments. The data includes patient demographics such as age, sex, location of residence, service provider location, the length of stay measured in minutes, and various classifications relating to the principal diagnosis of each presentation.
5	National Non-Admitted Patient Database (NNAPD)	Contains data on services provided to non-admitted patients in Australian public hospitals, including the types of services provided, service delivery settings and selected patient characteristics. This data collections exclude non-admitted patient services provided during emergency department care and to admitted patients.
6	Population and household projections based off ABS data	Population and household projections developed by the Department based on ABS Series B population projections and the ABS Census household distribution type. Population projections by age group, sex, geography and year.
7	National Weighted Activity Unit (NWAU)	NWAU is used as part of the National Funding Model and is a measure of health service activity expressed as a common unit, against which the National Efficient Price (NEP) is paid. It provides a way of comparing and valuing each public hospital service, including emergency care, subacute care, admitted care and non-admitted care, weighted for clinical complexity.
8	National Hospital Cost Data Collection (NHCDC)	NHCDC public sector, collected through the states and territories, is an annual and voluntary collection of public hospital data. The NHCDC is used to develop the national efficient price, which determines the level of funding public hospitals receive annually.

4.2 How services for radiologists are defined

Defining services within the scope of practice for radiologists is done using dataset-specific methods, explained below.

4.2.1 MBS data and Derived Major Specialty

A provider may have more than one registered specialty with Medicare. The Derived Major Specialty (DMS) classification provides a single specialty, derived to represent the major/highest qualification and/or major activity of a provider during the observed period according to the type of services delivered. Radiology services from MBS data are derived using the DMS group(s) for radiologists.

More specifically, DMS codes have 3 progressive levels. The first level is determined solely by the provider's highest registered specialty. The second and third levels are determined by the provider's qualifications and major services provided.

Providers who are classified as DMS level 2: Diagnostic Radiology, are identified as in-scope for the radiology demand model.

4.2.2 APC and PHDB data

Each patient's separation recorded in the Admitted Patient Care (APC) and Private Hospital Data Bureau (PHDB) datasets is assigned both a Diagnostic Related Group (DRG) and an Australian Refined Diagnostic Related Group (AR-DRG). These classifications are used to group patients with similar clinical conditions and/or procedures, reflecting comparable patterns of resource utilisation. DRGs and AR-DRGs can be mapped to Enhanced Service-Related Groups (ESRGs), which further categorise patients based on specific diagnoses or interventions, aligned with the medical specialty of the attending clinician.

The APC dataset comprises patient and diagnostic information from public hospitals, whereas the PHDB dataset captures equivalent data from private hospital settings.

In general, demand for medical specialties is inferred through the analysis of ESRGs associated with those specialties. However, a direct linkage between primary diagnoses (as represented by AR-DRGs) and the radiology specialty does not exist. This limitation presents challenges in accurately quantifying demand for radiology services based solely on diagnostic classifications.

To overcome this, the demand estimation model adopts the assumption that all admitted patient activity may potentially require radiological input. Accordingly, activity across all DRGs is apportioned using cost weights derived from the National Hospital Cost Data Collection (NHCDC). These cost weights are disaggregated by service categories, including imaging. The model calculates the ratio of imaging-related cost weight to the total cost weight for each AR-DRG. This ratio is then applied to estimate the volume of radiology services associated with each diagnostic group, thereby providing an estimate of radiology demand.

4.2.3 NAPEDC data

In NAPEDC data, principal diagnosis codes (based on ICD-10 codes) are mapped to Emergency Department Diagnosis Groups (EDDG). To estimate the demand for radiology services in emergency settings, a similar method used for APC and PHDB data is applied. Specifically, the ratio of emergency department imaging-related costs to the total cost is calculated for each EDDG. This ratio is then used as the cost weight to estimate the volume of radiology services associated with each group, providing a proxy for demand in emergency departments.

4.2.4 NNAPD data

To determine in-scope outpatient radiology services within the NNAPD data, the Non-Admitted Services Classification (Tier 2) is used. Tier 2 categorises a hospital's non-admitted services into classes which are generally based on the nature of the service provided and the type of clinician providing the service.

Table 3: In-scope Tier 2 classification codes for radiology NNAPD data

Tier 2 classification	Description
30.01	General Imaging
30.02	Medical Resonance Imaging (MRI)
30.03	Computerised Tomography (CT)
30.04	Nuclear Medicine
30.06	Positron Emission Tomography (PET)
30.07	Mammography Screening

4.3 Definition of demand activity

Radiology services from each data source are grouped into 3 categories:

1. MBS billings
2. Public and Private Hospital (Admitted)
3. Public Hospital Non-admitted (Emergency Department).

It is worth noting that the number of services alone is not a sufficient metric for comparison, as each require varying levels of resources, particularly in terms of workforce effort. Raw service volumes do not account for factors such as the severity of conditions, complexity of procedures, or degree of medical input required.

To address this, services or separations are converted into a more universal metric known as units of demand activity. This metric is weighted to better represent the relative effort required by specialists for each service or separation and allows for a more accurate comparison of resource use within each category.

MBS billings

The weighting factor is calculated as the benefits paid for in-scope services (year x provider location x patient sex x patient age x patient location) divided by the reference cost which is the average benefit paid for in-scope services for a given specialty and year. The number of services is then multiplied by this weighting factor to calculate the weighted demand activity.

An adjustment is applied to radiology specialist telehealth items in the historical data used in the demand activity projections. Previous analysis undertaken relating to the telehealth impact on FTE estimation indicated that telehealth items required 20% less FTE than the equivalent face to face items. This 20% adjustment factor is applied across all telehealth items claimed by radiologists in the historical data.

Public and Private Hospital (Admitted) separations and Public Hospital Non-admitted

In the context of estimating radiology demand, where cost weights are used to apportion activity from all DRGs/EDDGs, no additional weighting is applied to the count of services. This is because the cost-weight-based approach already incorporates an implicit adjustment for resource intensity, including imaging-related effort.

4.4 Projection of demand activity

The process of projecting the count of services over the forecast period consists of the following key steps:

1. Calculate and project service utilisation using a Generalised Linear Model (GLM) - The covariates in the GLM model include year, patient age group, patient sex, and patient/provider location. Population projections are used for estimation of the population at risk.
2. Demand activity projections are then converted to FTE by comparing demand activity against the supply FTE from AFHW dataset. Specifically, it involves the following steps:
    a. Estimate historical FTE-to-activity ratios by state/territory and use that to project the FTE-to-activity ratio for the forecast period.
    b. Multiply the projected FTE-to-activity ratio with the demand activity projections for each state/territory for each forecast year. This forms the baseline projection.

4.5 Assumptions

#	Caveat/Limitation	Description and implications
1	Admitted and non-admitted patient demand activity	Demand estimation model adopts the assumption that all admitted demand activity may potentially require radiological input. Accordingly, activity across all DRGs/EDDGs is apportioned using imaging cost weights derived from the National Hospital Cost Data Collection (NHCDC).
2	COVID-19 impact	The effects of COVID-19 are not explicitly accounted for but are captured implicitly through two ways: 1. the latest hospital and MBS data, available up to 2022, incorporates pandemic-driven changes in demand, which subsequently influence future predictions 2. the provision of COVID-19 telehealth and telephone MBS item codes reflects some of the pandemic-related adjustments. The model may not fully reflect the long-term shifts in demand patterns resulting from the pandemic.

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All information in this publication is correct as at August 2026