Methodology and elements of interpretation

Selection of themes, elements of data interpretation and analysis method of variations in medical practices

NIHDI – Healthcare Service – Research, Development, Quality Promotion Directorate

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Date of this version: 20 April 2021
Variations in practice - Methodology

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1. INTRODUCTION

The Appropriate Care Unit was created within the Research-Development-Quality Directorate of the NIHDI’s Healthcare Service as a result of the NIHDI’s 2016-2018 Administration Contract\(^1\). In Article 35, this Contract refers to ‘the setting up of an Appropriate Care Unit targeting, more specifically, an integrated approach to the rational use of resources’. The Appropriate Care Unit was set up since the second quarter 2017.

The concrete implementation of the Unit was formalised in the ‘2016-2017 Healthcare Monitoring Action Plan’, published by the NIHDI on 18 July 2016\(^2\). This plan lists around thirty measures aimed at optimizing health-care efficiency by encouraging appropriate practices and by avoiding unnecessary cares.

The plan states that the tasks of the Appropriate Care Unit include analysing the ‘relevance of care’, with the aim of identifying unexplained variations in consumption emerging after standardisation of the Belgian population. These variations are indeed potentially a sign of non-optimal use of resources.

The reports of ‘variations in medical practice’ contain the analyses carried out in this context. Each report focuses on a particular topic. The purpose of this document is to set out the overall shared methodology followed in all these analyses.

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\(^1\) (National Institute for Health and Disability Insurance, 2016)
\(^2\) (National Institute for Health and Disability Insurance, 2016)
2. Choice of topics

Each ‘variations in medical practice’ report focuses on one practice. This practice generally covers several nomenclature codes that are selected for their direct link to the practice, whether in terms of volume of intervention or expenditure.

The choice of practices selected for analysis is made according to different criteria. These criteria, which are detailed below, are (in no particular order): availability of data, coverage of specialties, existence of complementary equipment, topicality, potential benefits, existence of a professional network and obsolescence of practices.

1. Availability of data

Our Unit can only carry out analyses when the necessary databases are available. Initially, the database used is mainly the NIHDI’s N Documents. The use of this data base is a restricting factor in the choice of topics. For example, these data do not allow us to assess the redundancy of a practice or the combination of techniques for one patient. Later on, we will describe how we partially compensate for this lack by combining the analysis of the NIHDI’s N Documents with those of P Documents.

2. Coverage of specialties

The topics chosen for analysis cover the various fields of medicine. Our objective is that as many specialties as possible be represented through these analyses in order, on the one hand, to be sufficiently extensive and, on the other hand, to avoid any stigmatisation of one specialty in relation to another. In addition, our ambition in the long run is that each specialty should benefit from a complete overview of its practice through an exhaustive analysis of its own nomenclature.

3. Existence of complementary equipment

Our analyses are consolidated by the existence of extra analytical documentation on medical practice. This documentation may be internal (e.g. a report from the MEID\(^3\)), national (e.g. reports from insurance funds or the KCE\(^4\)), or international (similar analyses carried out in other countries). The existence of this material undoubtedly strengthens our analysis through the different angles of approach and the comparability of the data that it allows.

4. Topicality

We may prioritise certain topics on the basis of current concerns or specific requests from the authorities, as long as the data are available.

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3 NIHDI’s Medical Evaluation and Inspection Department
4 Belgian Healthcare Knowledge Centre
5. Potential benefits

We have identified the most prescribed codes by each medical specialty over the past year. From these codes, we were able to deduce a number of common practices within these fields. Given the frequency of these practices, our analyses will be of greater benefit for the general public, in terms of accessibility and quality of care, if unexplained variations are indeed observed.

6. Existence of a professional network

Through their informed viewpoint and through the intermediary they represent with service providers, the availability of scientific contacts linked to the practice being analysed contributes greatly to the impact that this analysis can have on the improvement of practices.

7. Obsolescence of practices

The analysis of obsolete or questionable practices is of particular interest in identifying their residual or problematic use. Such practices are identified, inter alia, by referring to national (KCE) and international recommendations such as the NICE\(^5\) or Choosing wisely\(^6\) recommendations.

\(^5\) National Institute for Health and Care Excellence (https://www.nice.org.uk)
\(^6\) http://www.choosingwisely.org
3. ANALYSIS METHODOLOGY

A. Sources of data

1. N Documents

Initially, we base our analyses mainly on the data in the NIHDI’s N Documents.

The N Documents are data sent monthly, within three months, by the insurer-organisations\(^7\) to the NIHDI. These data include the number of services, their dates and the fees. Every six months these data are compiled and supplemented by the insurance funds by adding data on patients: age, gender, social category and arrondissement of residence.

Regarding patients’ age, since 2009, data on people aged 95 and over have been grouped in N Documents. For the purpose of our analysis, we have also applied this rule to data prior to 2009 in order to ensure consistency.

The data in the N Documents does not allow us to group the services provided to an individual patient. As mentioned above, this limitation does have an impact on our initial selection of topics for analysis. Indeed, using N Documents alone, we cannot validly analyse services that are likely to be repeated within a year for the same patient or bilateral treatment that are potentially duplicated due to their bilateral nature. Nor can we analyse cases where various practices are combined to treat one patient. For these cases, we must use other databases, as explained in the next point.

From 2019 onwards, the analyses take into account the expenditure on services associated with the GPS system (global payment with standardization) introduced that year. The cost of these packages, if applicable, is systematically included in the expenditure mentioned.

2. Combined data

Analysis of combined data, taken from the P, ADH and SHA Documents, usually enables us to supplement data in the N Documents with further information on the redundancy of identical or similar practices for the same patient, as well as identifying the type of care (outpatient or hospital care).

The P Documents contain data sent semi-annually and within four months by the insurer-organisations to the NIHDI. These data include the services provided by health care providers in the outpatient and hospital sectors, per provider, per prescribing doctor or per hospital establishment.

The ADH and SHA data are sent annually and within six months by the insurer-organisations to the NIHDI. They include all the services provided respectively in day admission and standard hospitalisation, in general hospitals per hospital stay.

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\(^7\) By the Healthcare Service’s Actuarial and Budget Directorate.
In certain cases where bilateral services or repetition of services per patient are customary, the number of services from Documents N has been divided by their redundancy value. Examples include cataract tests, breast imaging, dental care, etc. The titles of these tests are then filled in with the word "Adjusted", and the numbers and rates of services are adjusted throughout the document (with the exception of the tables and graphs in Appendix B- Frequency of practice occurrences and C-Patient Types of care, which remain based on raw numbers).

A statement of the redundancy values applied to the nomenclature codes is available in the appendix to this document.

3. Data by group of service providers

We also plan to complete our analyses by grouping the data by location of intervention. This will allow us to provide feedback to service providers that better reflects local practices.

B. Selection of analyses and extraction of raw data

The selections concern the nomenclature codes to be analysed as well as the population of insured persons taken into account in the analysis:

Selection of codes: Each analysis covers a number of codes relating to the practice under analysis that are used either in the analysis of the volume of services provided, or expenditures, or both. The nomenclature codes used to examine the number of services and expenses are therefore not necessarily identical.

Filter used for insured population: Where appropriate, certain filters may have been applied in order to limit the number of patients considered in the analysis. The filters may be based on gender or age or other criteria (for example, the number of caesarean sections will be reported at delivery, hysterectomies for women, prostatectomies for men). Before performing any analysis, we make an assumption as to whether or not we are dealing with a binomial distribution, i.e. whether or not it can be considered that the services being analysed are provided only once per year to each patient. This assumption will determine how the Funnel Plot graph is drawn, which will be discussed later (see page 22). Note that this assumption can be verified by analysing redundancies or frequencies of occurrence, as described below (see page Erreur ! Signet non défini.).

By default, the period of analysis covers the last ten years of available data. This period may be shortened if the analysis over ten-year period does not give a sufficiently uniform analysis, because the number or coverage of the codes has fluctuated during this time.

For each nomenclature code, the following variables are extracted by arrondissement, gender, age and reimbursement scheme:

- The number of insured persons for whom we know the arrondissement (of residence), gender, age and reimbursement scheme

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8 Since 2009, data on persons aged 95 and older are grouped together in the N Documents. For the purpose of our analyses, we also applied this rule to data previous to 2009.
- The **number of services provided** to patients for whom we know the arrondissement (of residence), gender, age and reimbursement scheme (as long as this code is included in the analysis of number of services, otherwise no services are taken into account)

- **Expenditure** for patients with known arrondissement (of residence), gender, age and preferential scheme (as long as this code is included in the expenditure being analysed – otherwise, the expenditure is not taken into account)

### C. Standardisation of data

The standardised analysis documents present data from 5 different standardisations. These standardisations of the number of healthcare services and expenditures are based on:

i. the **age**, the **gender** and the **reimbursement scheme** of the patient in order to obtain data per **domicile** (arrondissement or province or region)

ii. the **age** and the **gender** of the patient in order to obtain data per **domicile** (arrondissement or province or region) and **reimbursement scheme**

iii. the **age** and the **reimbursement scheme** of the patient in order to obtain data per **domicile** (arrondissement or province or region) and **gender**

iv. of the **patient's reimbursement scheme** in order to obtain data on the basis of the **residence (of the insured)** (district, province or region), **age group**\(^9\) and **sex**. Standardisation is adjusted by a factor taking into account the age share per age group and per sex.

v. of the **patient's reimbursement scheme** to obtain data per **age group** and per **sex**. Standardisation is adjusted by a factor taking into account the age share per age group and per sex.

The standardisation consists of 3 steps, which are described in the paragraphs below:

1. Calculation of the non-standardised annual rates of use
2. Calculation of the distribution in the total population
3. Calculation of the standardised annual rates of use

#### 1. Calculation of the non-standardised annual rates of use

For standardisations used to obtain data per location (patient’s domicile) (standardisations i, ii, iii and iv), we calculate the annual number of healthcare services per 100,000 patients, and the expenditure per patient per location (arrondissement, province or region), broken down by gender, age and reimbursement scheme. For the standardisation where data should not be obtained on the basis of the patient's domicile (standardisation v), these values are calculated by gender, age and reimbursement scheme.

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\(^9\) Since 2009, data on persons aged 95 and older are grouped together in the N Documents. For the purpose of our analyses, we also applied this rule to data previous to 2009.
2. Calculation of the distribution in the total population

Different distributions are used for the different standardisations, and these are calculated on the basis of the total Belgian population, i.e. all insured persons residing in Belgium for which the arrondissement, the gender, age and reimbursement scheme are known or estimated. The calculated distributions are as follows:

i. the **age-gender-reimbursement scheme** distribution, to standardise the data on the basis of the age, the gender, and the reimbursement scheme of the patient
   ➢ The age-gender-reimbursement scheme distribution is calculated as the number of insured persons by age, gender and reimbursement scheme relative to the total number of insured persons in the Belgian population.

ii. the **age-gender** distribution, to standardise the data on the basis of the age and the gender of the insured person.
   ➢ The age-gender distribution is calculated as the number of insured persons by age and gender relative to the total number of insured persons in the Belgian population.

iii. the **age-reimbursement scheme** distribution, to standardise the data on the basis of the age and the reimbursement scheme of the patient
   ➢ The age-reimbursement scheme distribution is calculated as the number of insured persons by age and reimbursement scheme relative to the total number of insured persons in the Belgian population.

iv. & v. the **reimbursement scheme** distribution, to standardise the data on the basis of the patient’s reimbursement scheme
   ➢ The distribution of the reimbursement scheme is calculated as the number of insured persons per reimbursement scheme compared to the total number of insured persons in the Belgian population.
   ➢ For data presented per age group and sex, the standardisation is adjusted by a factor taking into account the age share per age group and per sex.

3. Calculation of standardised annual rates of use

The standardised annual rates of use are calculated by multiplying the non-standardised rates by the concerned breakdown and adding them together on the basis of the insured person's domicile (standardisation i), the patient’s domicile and reimbursement scheme (standardisation ii), the patient’s domicile and gender (standardisation iii), the patient’s domicile, age group and gender (standardisation iv) and by age group and gender (standardisation v).
D. Indicators: graphs and tables

1. Table: NIHDI nomenclature codes selected for the analysis

The table ‘NIHDI nomenclature codes selected for the analysis’ contains the outpatient and hospital nomenclature codes covered by the analysis, specifying whether or not these codes are included in the number of healthcare services (‘used for rates?’) and/or in the expenditure (‘used as expenditure?’). It also gives their wording, their creation date, their possible deletion date, the N group to which the codes belong, and their value. The table also has two columns entitled ‘Inclusive’ and ‘Exclusive’: these are to be filled in where there is an additional conditional rule stating that the code is used to include certain services in the analysis (this code must be attested to account for the service) or to exclude them (the service can only be accounted for if this code is not attested).

The list of codes used for ‘expenditure’ is not intended to be exhaustive. Only those codes directly related to the practice under review are included here, as well as, depending on the case, additional codes (fees, equipment, etc.), if they are exclusively related to the practice under review. The evaluation of expenses is therefore underestimated, since, in order to be complete, we would need to take into account a whole series of related costs which we do not intend to analyse here.

2. Table: History of nomenclature codes

The table ‘History of nomenclature codes’ shows how the nomenclature codes have changed within the period considered with regard to their wording, their N group and their value. If there have been no changes during the target period, only the current data is displayed.

3. Table: Specialty of healthcare providers

The table Specialty of healthcare providers contains the following non-standardised data per speciality:

- Total number of healthcare providers: the number of healthcare providers per specialty who have certified more than one service
- Relevant healthcare providers: the number of providers who have certified, more than once, one of the nomenclature codes covered by the analysis
- % providers: the percentage of the ‘total number of healthcare providers’ per specialty, compared to the number of ‘relevant healthcare providers’
- Median number of healthcare services: the median number of healthcare services per ‘relevant healthcare provider’
- Number of healthcare services: the total number of services provided over the year
- % services: the annual number of healthcare services certified per specialty, as a percentage of the total number of services
- Expenditure: the annual expenditure for the codes under analysis
- % Expenditure: the expenditure per specialty as a percentage of the total expenditure
Specialties which account for less than 1% of the total number of services provided are grouped together in the ‘Other specialties’ category.

4. Table: Specialty of prescribers

The *Specialty of prescribers* table contains the following non-standardised data per specialty:

- Total number of prescribers: the number of prescribers per specialty who have prescribed more than one of the codes under analysis
- Relevant prescribers: the number of prescribers prescribing the nomenclature codes under analysis
- % prescribers: the ‘relevant prescribers’ as a percentage of the ‘total number of prescribers’
- Median prescription: the median number of services prescribed by each ‘relevant prescriber’
- Number of prescriptions: the total number of prescriptions, over the year, of the codes under analysis
- % Prescriptions: the number of prescriptions per year per specialty, as a percentage of the total number of prescriptions
- Expenditure: annual expenditure on the codes under analysis
- % Expenditure: expenditure per specialty as a percentage of total expenditure

Specialties accounting for less than 1% of the total number of healthcare services provided are grouped in the ‘Other specialties’ category.

If there was no prescriber for the service being analysed, "Not Applicable" is entered in the "Prescriber Specialization" field and only the service and expense totals are displayed.

5. Table: Trends in rates of use

Linear regressions were applied to test whether the evolution of the data over the last three years of the analysis period differs from the evolution of the data over the total analysis period, per province and region. Linear regression is applied to determine the regression line that best describes the linear relation between the year and the standardised rate (the standardised number of healthcare services per 100,000 insured persons). The graph below (see Figure 1) shows the most suitable regression line for a fictitious example. The regression lines were calculated using the least squares method.

It should be noted that the standardisation of the data was only carried out for the last year of the analysis. A change in the configuration of the population over time, whether in terms of age distribution, gender or reimbursement scheme, may therefore impact the trend according to the effect that one of these factors may have on the practice analysed.
The regression coefficient is the slope of the regression line and corresponds to the amount by which the standardised rate increases or decreases per year. The annual growth percentage is calculated using the following formula:

$$\text{Annual growth percentage} = \left( \frac{\text{standardised ratio}_{\text{last year}}}{\text{standardised ratio}_{\text{first year}}} \right)^{\frac{1}{\text{last year-first year}}} - 1$$

The first year is the first full year in the observed period in which the nomenclature codes were used. If no healthcare services appear in more than one of the last three years of the analysis period, the regression analysis is not performed due to too much uncertainty in the analysis and a ‘NA’ result is indicated.

The regression coefficients of the analyses based on the entire period of analysis, and the analyses based on the last three years of the analysis period, can be compared with a t-test that takes into account the standard error of each regression coefficient and the number of years that was used in the regression. The result of the t-test is a p-value which allows us to determine the significance value of the test. Here we set the threshold for this value at 0.05. The graphs below (see Figure 2) are examples of provinces in which the regression coefficients differ significantly (L) and not significantly (R) from each other.
The ‘Comparison of trends per province and per region’ table contains the following data from the regression analysis per province and per region, as well as the total for the Belgian population, for the standardised number of healthcare services per 100,000 insured persons:

- The standardised rate of use for the last year
- The average annual growth percentage in the period from the first year up to and including the last year
- The average annual growth percentage in the last three years
- The significance of the p-value of the t-test

6. Table: trends in expenditure per healthcare service and per nomenclature code

This table shows, for each year of the period of analysis, expenditure per healthcare service, i.e. total expenditure divided by the total number of services, expressed by the combined nomenclature code (outpatient and hospital care).

For example:

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>432390-432401</td>
<td>31.04</td>
<td>31.83</td>
<td>32.22</td>
<td>32.57</td>
<td>33.02</td>
<td>33.55</td>
<td>33.63</td>
<td>33.63</td>
<td>33.85</td>
<td>34.35</td>
<td>34.39</td>
<td>1.03%</td>
</tr>
<tr>
<td>432412-432423</td>
<td>61.74</td>
<td>63.23</td>
<td>63.94</td>
<td>64.21</td>
<td>65.90</td>
<td>66.87</td>
<td>67.11</td>
<td>66.97</td>
<td>67.54</td>
<td>68.57</td>
<td>68.62</td>
<td>1.06%</td>
</tr>
<tr>
<td>432456-432460</td>
<td>334.01</td>
<td>341.26</td>
<td>345.40</td>
<td>350.04</td>
<td>355.93</td>
<td>352.79</td>
<td>332.56</td>
<td>361.32</td>
<td>367.98</td>
<td>372.56</td>
<td>374.57</td>
<td>1.15%</td>
</tr>
</tbody>
</table>

In this table, the average annual growth rate is calculated using the following formula:

\[
\text{Average annual growth rate} = \left( \frac{\text{Expenditure per service}_{\text{last year}}}{\text{Expenditure per service}_{\text{first year}}} \right)^{\frac{1}{\text{last year} - \text{first year}}} - 1
\]

This rate is therefore calculated by taking into account only the values for the first and last years of the period of analysis, without considering the intermediate variations.
7. Table: Summary of key data

The ‘Summary of Key Data’ table contains the following data for the Belgian population (data which are also contained in the different chapters of the report and whose methodological details are given in the relevant paragraphs of this document):

- Main healthcare providers:
  - The specialty identified as providing the majority of the practice under analysis, with the percentage of the total number of services provided

- Main prescribers:
  - The specialty identified as prescribing predominantly for the practice analysed, with percentage of total volume prescribed. If the practice is mostly not prescribed (provided at the initiative of the healthcare provider), the terms ‘not applicable’ are displayed.

- Standardised rates of use:
  - Average number of services per year
  - Standardised rate of use per 100,000 insured persons
  - Repetition rate of a practice per year for the same patient (≥ 2 occurrences per patient)
  - Percentage of healthcare services provided as outpatient services, including one-day hospitalisation

- Population:
  - Median age of the patient, per provision of service
  - Max/min ratio of the median age of the patient (based on arrondissement)
  - Percentage of services provided to women, with indication of the statistical significance of the observed difference (by applying an ANOVA test, see page 29)
  - Standardised ratio of services provided to patients under a preferential scheme, in relation to the standardised number of services provided to patients not eligible for a preferential scheme, with indication of the statistical significance of the observed difference (by applying an ANOVA test, see page 29)

- Trends:
  - Average annual growth percentage over the whole period of analysis
  - Average annual growth percentage for the last three years of the period of analysis
  - Statistical significance of the difference in trend between the two previous values
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- Geographical variations
  - On the one hand, the coefficient of variation (of the standardised use rate by district) calculated in the first three years of the analysis period and, on the other hand, this coefficient of variation for the last three years of the analysis period. The significance of the difference between these two values is indicated by an indication of the statistical significance of the difference between the two previous values.
  - The coefficient of variation is a measure of relative distribution: the distribution is measured relative to the average and is calculated as the standard deviation divided by the average. The coefficients of variation for the first and last three years of analysis are compared with each other using a χ2 test for an asymptotic distribution (Feltz & Miller test). The difference between the coefficients of variation is considered significant here if the p-value is less than 0.05.
  - As the coefficient of variation is a relative value, the importance of a dispersion can essentially be evaluated in a comparative logic. Indeed, if in general, one can agree that there is no dispersion for values of the coefficient of variation around 10 to 20%, for higher values, it will be appropriate to compare this coefficient with another one from a comparable analysis in order to be able to evaluate the relative importance of the geographical dispersion. In the same relative logic, the coefficient of variation found for a practice could also be compared to that observed for the attendance of patient population to the main medical specialty underlying this practice (see Appendix 3 of the "Patient analysis" file available online and referred to in Appendix 2 of this document).
    - Max:min ratio of the standardised (regional) rate of use, with indication of the statistical significance of the observed difference (by applying an ANOVA test, see page 29)
    - Max: min ratio of the standardised rate of use (per arrondissement)

- Expenditure
  - Average annual expenditure of the health insurance system
  - Average annual (standardised) expenditure of the health insurance system per person insured
  - Max:min ratio of the (regional) expenditure per person insured
  - Max:min ratio of the expenditure per person insured (per arrondissement)
  - Average cost of services per patient to the health insurance system

- Coding variations and practice alternatives:
  - Variations in practice coding, by choice of nomenclature codes, observed by province with indication of the degree of statistical significance of the result (see page Erreur ! Signet non défini.)
  - Variations in the choice of practice alternatives, observed by province with an indication of the degree of statistical significance of the result (see page Erreur ! Signet non défini.)

If the max: min ratio cannot be calculated because the minimum is 0, it is indicated NA (not available) in the table.
If the period between the base year (i.e. the first year of the period of analysis) and the last year is less than three years, NA (not available) shall be indicated for the trend.

If the results show a significant difference, the degree of statistical significance is symbolised by one to three asterisks, in increasing order of significance: *Threshold value of $p \leq 0.05$ / **Threshold value of $p \leq 0.01$ / ***Threshold value of $p \leq 0.001$. Otherwise, NS is displayed ("not significant").

8. **Graph: Volume distribution of the nomenclature codes provided**
   
   This graph is a 100% stacked bar chart, showing the relative distribution of the percentages of services delivered, by nomenclature code, over the years. The graph only represents the nomenclature codes used to determine the volume of services provided, excluding those that would be used only in expenditures. If more than 15 nomenclature codes (or combinations of codes) were to be presented in a graph, only those nomenclature codes representing more than 5% of services in at last one year are shown. Nomenclature codes representing less than 5% of services are then grouped in a category called ‘Other’.

![Graph](image)

*Figure 3: Example of a graph showing the trend in percentages of services provided, by nomenclature code*
9. Graph: Rate of use and coefficient of variation by age group and by gender

The annual rate of use by age group (see Figure 4) is presented in a bar chart by gender. The associated coefficient of variation is shown by a red line above the bar chart. The coefficient of variation is a relative measurement of the magnitude of geographical variations. To calculate this coefficient, the standard deviation is divided by the average standardised rate of use per arrondissement. The vertical axis on the left side of the graph shows the standardised annual rate of use, and the right-hand axis shows the coefficient of variation. The horizontal axis shows the distribution by age groups. The horizontal blue dashed lines represent the total annual rate of use, and the red dashed lines show the overall coefficient of variation (i.e. all age groups combined).

The line of the coefficient of variation is thicker for those age groups for which the value of the coefficient can be validly interpreted, i.e. if that age group is sufficiently represented by its size and by its rate of use of the particular practice.

If a selection is made by gender, only the graph relating to the selected gender is presented. If a selection is made by age, the value of the bars will be zero for groups that contain none of the selected ages.

![Graph showing rate of use and coefficient of variation by age group and by gender.](image-url)

**Figure 4: Example of a graph by age group and by gender, with the coefficient of variation**
10. Graph: Comparison of standardised rates of use, by gender

On this graph, annual rates of use are shown, by age group, for each gender. A green curve is used for women, and a grey curve for men.

11. Graph: Standardised rates of use by gender and by province

Standardised annual rates of use by province (based on the place of residence of the patient), and by gender, are represented by a bar chart with double bars (see Figure 6). The grey bars correspond to the standardised annual rates of use for men, while the green bars show the standardised annual rates of use for women. The grey and green dashed lines show the total annual rates of use for men and women, respectively. If a selection is made by gender on the population, this graph will not be displayed.
12. Graph: Percentage of outpatient services

The percentage of outpatient services, i.e. the number of outpatient services provided as a proportion of all services provided (outpatient and hospital), is shown by a bar chart (see Figure 7). This contains one bar per region, as well as a bar for Belgium as a whole which is also represented by a dotted line.

Figure 7: Example of a graph showing the percentages of outpatient services, by region

13. Graph: trend in the percentage of outpatient services provided

The graph relating to the evolution of the percentage of outpatient services over the years contains a dashed coloured line per province, and a continuous black line for the Belgian population as a whole (see Figure 8). The horizontal axis shows the years, from the first to the last year of the period of analysis for which the services are recorded. The vertical axis gives the percentage of outpatient services.

Figure 8: Example of a graph showing the change in the percentage of outpatient services per province
14. Graph: Standardised rate of use, by reimbursement scheme and by region

The standardised annual rates of use by region of the patient’s residence and by applicable reimbursement scheme are shown by a bar chart (see Figure 9). The red bars are the standardised annual rates of use of insured persons eligible for a preferential scheme. The red dashed line shows the total annual rates of use for patients covered by a preferential scheme, while the grey dashed line shows these rates for patients not covered by a preferential scheme.

![Figure 9: Example of a graph showing the rates of use by region and by reimbursement scheme](image)

15. Graph: trend in standardised rates of use

The change in the rates of use is illustrated by two graphs, one showing region and the other showing arrondissement (see Figure 10). These graphs contain a dashed coloured line by place (region or arrondissement) and a continuous black line for the Belgian population as a whole. On the horizontal axis are indicated the years, from the first up to and including the last, of the period of analysis for which services are recorded. The vertical axis shows the standardised rate, i.e. the standardised number of services per 100,000 persons insured.

The graph showing trends per region shows all the regions and the standardised rates of use per year. The graph on the evolution by arrondissement shows trends over a three-year period of the average of the standardised rate (moving average). For example, for 2015 it is the average of the rates from 2013 to 2015 included that is represented, and for 2016 it is the average of the rates from 2014 to 2016 included.

The trend in the average rate of use is not presented for all 43 Belgian arrondissements. Only the arrondissements with the five highest and lowest averages standardised rates of use over the last three years of the period of analysis are shown.
16. Graph: ‘Dot plot’ distribution of rates of use

A dot plot graph is a scatter plot in which, for each observation, the points are plotted on a categorical scale. These simple graphs can be used to highlight groupings and gaps, as well as outliers. Here, the dot plot is used to present the distribution of the standardised annual rates of use by arrondissement, with each dot representing an arrondissement, first for all patients, and then by gender (see Figure 11). If a selection is made on the basis of gender, only the data for the selected gender are shown.

In order to convert the continuous data into categorical data, the rates of use are rounded to the nearest multiple (unit, ten, hundred, etc.), depending on the size of the maximum rate.

The graph also illustrates boxes with the 25th, 50th and 75th percentile of the unrounded rates, first for all patients, and then by gender. The 25th percentile is indicated by the bottom line of the box, the 75th percentile by the top line, and the 50th percentile by the middle line of the box.

Figure 11: Example of a ‘dot plot’ graph of rates of use
17. Graph: Maps showing distribution by arrondissement

On a map of Belgium (see Figure 12), where the arrondissement boundaries are represented by thin lines and the province boundaries by thick lines, the arrondissements are coloured according to a scale of comparison with, firstly, the median rate of use, and, secondly, the median expenditure. This comparison is expressed as a percentage of difference compared to the median rate or median expenditure: between -10 and 10 %, the value for the arrondissement is taken as equal to the median value; between 10 and 30 %, the value for the arrondissement is considered as 20 % higher than the median value; between -10 and -30 %, the value for the arrondissement is considered to be 20 % below the median value, etc. These percentages are calculated based on standardised rates of use for the last year of the analysis. They are divided into categories of 20 %. The following colours have been defined for the different categories of the comparison scale:

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<th>Colour</th>
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<tr>
<td></td>
<td>Below - 50 %</td>
<td>The rate for the arrondissement is at least 50% below the overall rate.</td>
</tr>
<tr>
<td></td>
<td>Between -50 % and -30 %</td>
<td>The rate for the arrondissement is between 30 % and 50 % below the overall rate.</td>
</tr>
<tr>
<td></td>
<td>Between -30 % and -10 %</td>
<td>The rate for the arrondissement is between 10% and 30% below the overall rate.</td>
</tr>
<tr>
<td></td>
<td>Between -10 % and 10 %</td>
<td>The rate for the arrondissement is between 10% and 30% above the overall rate.</td>
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<tr>
<td></td>
<td>Between 10 % and 30 %</td>
<td>The rate for the arrondissement is between 10% and 30% higher than the overall rate.</td>
</tr>
<tr>
<td></td>
<td>Between 30 % and 50 %</td>
<td>The rate for the arrondissement is between 30% and 50% higher than the overall rate.</td>
</tr>
<tr>
<td></td>
<td>Above 50 %</td>
<td>The rate for the arrondissement is at least 50% higher than the overall rate.</td>
</tr>
<tr>
<td></td>
<td>No service</td>
<td>No services of this type have been provided in this arrondissement over this 3-year period.</td>
</tr>
</tbody>
</table>

Figure 12: Example of the map of Belgium showing the geographical variation in the rates of use

In order to best interpret these maps, it is useful to put them into perspective with the maps of attendance to the various health professionals available in the "Patient analysis" file, according to the methodology explained in Appendix 2 of this document.
18. Graph: ‘Funnel plot’ distribution of rates of use, per arrondissement (Methodology under revision)

This funnel plot is a scatter plot which shows the annual rates of use (i.e. the standardised number of services provided per 100,000 insured persons) by arrondissement, in relation to the size of the population of the arrondissement. In addition to the dots per arrondissement, the confidence limits are also displayed on the graph. These confidence intervals reflect the expected variation in annual rates of use when the assumption is made that the only source of variation is stochastic or arbitrary. When the service in question is binomial (see page 7), these confidence limits have a typical shape, in the form of funnel-shaped curves: the smaller the population of an arrondissement, the greater the expected variation, and, conversely, the larger the population, the smaller the expected variation.

The graph below (see Figure 13) is an example of a funnel plot showing the standardised rate of use of a service, per 100,000 insured persons, per Belgian arrondissement. The horizontal line represents the national annual rate of use (i.e. the number of times the service was provided per 100,000 insured persons in the Belgian population). The funnel-shaped lines show the 95% (two standard deviations from the median) and the 99.7% (three standard deviations from the median) confidence limits.

The arrondissements above the funnel-shaped curves are considered to be in the ‘upper average’. Similarly, the arrondissements below the funnel-shaped curves are considered to be in the ‘below average’. The arrondissements between the curves are considered to be ‘average’. The arrondissements outside the upper and lower 99.7% confidence limits are considered ‘outliers’. For these outliers, the variation observed has other causes than the sole stochastic and arbitrary cause, other factors are involved. Only the titles of these outliers are spelled out.

Figure 13: Example of a ‘funnel plot’
In the case of a binomial distribution of the data, the confidence limits for each arrondissement depend on the national annual rate of use and the population size of the arrondissements. The 95 and 99.7% confidence limits are calculated for each of the 43 Belgian arrondissements using the following formula:

1. Calculation of the **standardised annual rate of use** (number of services per insured person) per arrondissement $i$:

$$ Y_i = \frac{\text{number of healthcare services}_i}{\text{number of insured persons}_i} $$

2. Calculation of the **national annual rate of use** (number of healthcare services per insured person)

$$ \theta = \frac{\sum_i \text{number of healthcare services}}{\sum_i \text{number of insured persons}} $$

3. Calculation of the **standard error** in the arrondissement $i$ on the basis of aggregate data

$$ SE_i = \sqrt{\frac{\theta \times (1 - \theta)}{\text{number of insured persons}_i}} $$

4. Determination of **confidence intervals** by district $i$

- lower 95% confidence interval $i = \theta - (1.96 \times SE_i)$
- upper 95% confidence interval $i = \theta + (1.96 \times SE_i)$
- lower confidence interval 99.7% $i = \theta - (3 \times SE_i)$
- upper confidence interval 99.7% $i = \theta + (3 \times SE_i)$

In case of a non-binomial distribution of the data, the "confidence intervals" are arbitrarily set at P10 and P90. These limits are independent of the size of the district and are therefore not represented by the funnel curves, but by horizontal lines. In this case, the districts considered as "outliers" are those with an annual use rate below P10 or above P90.

**19. Table and graph: Frequency of practice occurrences**

Some services may be invoiced several times for the same patient in the same year, even on the same day. This may be due to a repetition of the service, but also when two services are invoiced for the same day, due to the bilateral nature of the anatomical topography of the operation.

The table and pie-chart graph illustrate the importance of repetition of the service under analysis provided to the same patient over the course of a year: twice or more than three times in the year (see Figure 14).

The frequencies of occurrences presented here are based on the raw number of services from the P, SHA and ADH documents, even when the analysis is "adjusted", i.e. when the numbers and use rates have been divided by the annual occurrence per patient (see also Data Sources: Combined Data). A statement
of the redundancy values applied to the nomenclature codes when an analysis is "adjusted" is available in the appendix of this document.

These occurrence frequency analyses are conducted using the following databases: P, ADH and SHA documents. Due to data availability limitations, the year used to analyse frequency of services is the year prior to the year of analysis globally used in this report.

The graph ‘Distribution of the standardised rates of use per arrondissement, by number of persons insured’ can be interpreted as a funnel plot when a service is almost always provided only once a year.

20. Table and graph: Distribution of types of care

This pie chart shows the type of care (for the service or practice under analysis) provided to patients, broken down by the various sectors and sub-sectors: outpatient (private or polyclinic), hospital care (one-day or inpatient) (see Figure 15).

These occurrence frequency analyses are performed using the data in the P, ADH and SHA documents. Due to data availability limitations, the year used to analyse frequency is one year prior to the year of analysis globally used in this report. Here again, even when the analysis is called "adjusted", this is also the raw data for annual services, from the P, SHA and ADH documents.
21. Graph: Distribution of coding variations

There may be variations in the choice of codes used to record the same practice. This potential variation is illustrated by a 100% stacked histogram graph for both regions and provinces (see Figure 16).
In this representation, the distribution by region and province of the volumes of the nomenclature codes defined for the analysis is analysed to determine whether this distribution is homogeneous across the territory. The data are those of the latest year available.

In order to verify whether the variations observed are significant, a statistical test was applied. The results are displayed in a table below the graph. The number of asterisks represents the degree of statistical significance: *Threshold value of \( p \leq 0.05 \) / **Threshold value of \( p \leq 0.01 \) / ***Threshold value of \( p \leq 0.001 \).

22. Graph: Distribution of variations in the choice of practice alternatives

If different practice alternatives could be identified for the practice analysed through groupings of nomenclature codes, they are illustrated by this histogram, which makes it possible to visualise the distribution of choice between the different techniques over the whole territory on the one hand, but also by region and by province (see Figure 17). The graph is also a 100% stacked histogram. For the same analysis, up to two distribution logics can be presented, identified in the reports as "Group 1" and "Group 2".

In some cases, among the identified practice alternatives, sub-alternatives exist. If they can be clearly identified, then they will be illustrated in the histogram in a gradient of the same colour in order to clearly visualise the different sets of alternatives.

The groupings of nomenclature codes corresponding to each alternative are presented in a separate table, together with the degree of statistical significance of the variations.

![Histogram Illustrating Distribution of Alternative Techniques](image)

**Figure 17:** Example of a histogram illustrating the distribution of alternative techniques for the same practice (alternative 1 in blue, alternative 2 in purple - with colour gradient for identified sub-alternatives)
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23. Graph: Distribution of variations in the use of low-variability care

Analyses from 2019 onwards take into account expenditure on services associated with GPS (Global Payment with Standardization). The graph below represents the proportion in volume of GPS codes associated with services for the latest year available, again in the form of a 100% stacked histogram broken down by region and by province (see Figure 18). Services that are not associated with a GPS code are represented by the code 0 (No GPS).

As for the two previous graphs, the statistical significance of the variations observed between regions and provinces is summarised in a separate table. Pseudocodes descriptions of relevant packages are also presented in addition to the graph.

![Graph showing distribution of variations in the use of low-variability care](image.png)

**Figure 18:** Example of variations in the use of low-variability care
4. STATISTICAL ANALYSIS

In order to ensure that the rate of use and the expenditure can be properly compared, all the data were standardised for the Belgian population on the basis of age, gender, and preferential reimbursement scheme.

All the data presented in this document are based on the entire population, and are summarised by descriptive statistics (average, median). No statistical tests are therefore needed to compare central trends.

Nevertheless, according to certain secondary hypotheses, some statistical analyses may be relevant to perform on these data. Where this is the case, the statistical difference is considered to be significant if the p-value is less than 0.05 (bidirectional). The following hypotheses explored in this report are as follows:

1) To what extent does a criterion explain differences in rates of use?
   This is analysed by means of a 3-factor ANOVA test (F test). The differences between regions (df:2), genders (df:1) and reimbursement schemes (df:1) were tested using weightings. These values were calculated using type III sums of squares. The p values were corrected for multiple comparisons, using the Tukey-Kramer method. The analysis only covers the last year of the data presented in the reports.

2) To what extent do the trends observed differ from one period to another?
   To check whether there is a break in trend between the overall period of analysis and the trend covering only the 3 most recent years (for the whole country, by province and by region), the coefficients of regression for the two periods were compared, using a t-test which takes into account the standard error of each of the regression coefficients and the number of years used in the regression (see Table:).

3) To what extent does the geographical variation differ from one period to another?
   The coefficient of variation for the whole period covered and the one for the three most recent years were compared using the chi-square test for an asymptotic distribution\(^{10}\) (see Table: Summary of key data).

4) To what extent do the distributions of coding choices, practice alternatives and use of GPS differ between geographical areas?
   The chi-squared test is used to determine whether the differences in the distribution of the different choices between geographical areas are significant.

---

5. BIBLIOGRAPHY


As mentioned in the section "Erreur ! Source du renvoi introuvable.", for some "adjusted" analyses, a correction factor was applied to the rates in order to correct the repetition effect of a practice in the same patient in the same year. The correction factor was applied by nomenclature code retained in volume for the analysis or by group of codes. The table below shows the various correction factors applied by published analyses for the year 2019 and adjusted; they are listed in alphabetical order. Note that these factors are derived from redundancy calculations for the year preceding the year of the analysis, i.e. 2018:

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Tous les codes en volume
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<td>Tous les codes en volume</td>
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<tr>
<td>Treatment of urolithiasis</td>
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<tr>
<td>Vasectomy (men) (Adjusted)</td>
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<td>1,96</td>
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<tr>
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<td>Treatment of urolithiasis</td>
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<td>1,34</td>
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<tr>
<td>Vasectomy (men) (Adjusted)</td>
<td></td>
<td>1,96</td>
</tr>
</tbody>
</table>
APPENDIX 2: PATIENT ATTENDANCE

The patient attendance analysis file for the different medical disciplines can be downloaded online. It completes the analysis of variations in medical practices in that, before a healthcare professional chooses whether or not to provide a certain practice to an insured person, the insured person has the possibility of contacting this healthcare provider, whether it be for a question of identifying a need by the insured person or for a question of geographical or financial access.

The 'Ratio' table in this file presents in figures the use rates to a certain type of healthcare professional for all insured persons in Belgium in the year 2018\textsuperscript{11}. For dentists (see Figure 19), for example, it can be seen that, overall, around 53% of the population had access to this profession in 2018, with a slight female predominance, but it can be especially noted that there is a difference in access linked to the type of reimbursement scheme of the insured person, to the detriment of the preferential scheme, a difference which is mainly marked for the professions of periodontics and orthodontics.

![Figure 19: Dentist-centred extract from the "Ratio" table in the "Analysis of the patient base" file](image)

Taking this information into account is useful to better interpret the results of the practice variation analyses. For example, if the ratio of patient care with and without a preventive dental care preferential scheme is 0.72, while the same ratio based on dentist attendance is 0.75, i.e. essentially the same, it can be deduced that the preventive dental care ratio is not due to a different attitude of dentists towards patients with one or the other reimbursement scheme, but is simply due to the difference in attendance at the dentist of these two audiences. The same type of interpretation in the light of the patient analysis can be made on other factors such as age, gender or geographical distribution.

\textsuperscript{11} There may be a time lag between the year of analysis of practice variations and the year of analysis of the patient base. This is due to a different administrative delay in obtaining the exploitation source files for the two analyses.
With regard to this geographical parameter, in the same way as is done in the context of analyses of variations in practices, the analyses of patients can be mapped in order to assess whether the attendance of a certain medical discipline is homogeneous throughout the territory. The maps obtained are presented in the "Maps" tab of this same file. The whole point is then to compare the maps obtained in the context of variations in practices with those of the same scale obtained from the analysis of the patient base, both of which are based on the administrative residences of the insured persons and on standardised data. In the example of bronchoscopy, 94% of which is performed by respirologists (see Figure 20), it can be seen that districts 1 and 3 stand out for their more frequent use of bronchoscopy, whereas this use is rarer in districts 2 and 4. At the same time, we can see on the map of visits to respirologists that more insured persons than the median use a respirologist in district 3, whereas this use is median for district 4 and low for districts 1 and 2.

![Figure 20: Comparison of the mapping of the use rates of bronchoscopy (left) with the mapping of the use of respirologists (right)](image)

On this basis, one can wonder whether the high use rate of bronchoscopy in district 3 could potentially be related to the fact that contacts with respirologists are more frequent there, while the low use rate of bronchoscopy in district 1 could conversely be related to the fact that contacts with respirologists are rarer there. To corroborate this, it is possible to calculate a corrected map calculating the use rate of a practice in relation to the rate of attendance at the healthcare professional who provides it. If we carry out this exercise again for bronchoscopy (see Figure 21), we confirm our presumptions, showing that the use rate of bronchoscopy corrected according to the frequency of visits to respirologists is in fact lower than the median in district 3, explaining at the same time that the high use rate observed on the map of variations in practices taken in isolation is essentially due to the high frequency of visits to respirologists in this district. Conversely, the corrected use rate for district 2 confirms that
bronchoscopy is used more frequently in this district, as shown on the practice variation map. The explanation for this high rate is therefore not linked to the density of respirologists and is therefore to be sought elsewhere.

The comparison of the maps of variations in practices and frequency of visits to the various healthcare professionals, insofar as a practice can be clearly attributed to a type of provider, therefore makes it possible to put into perspective the effect that the inhomogeneous density of healthcare professionals on the Belgian territory might have on the use of a medical practice. This therefore makes it possible to test the hypothesis of the density of healthcare professionals in a territory as a potential cause of variations in medical practices.