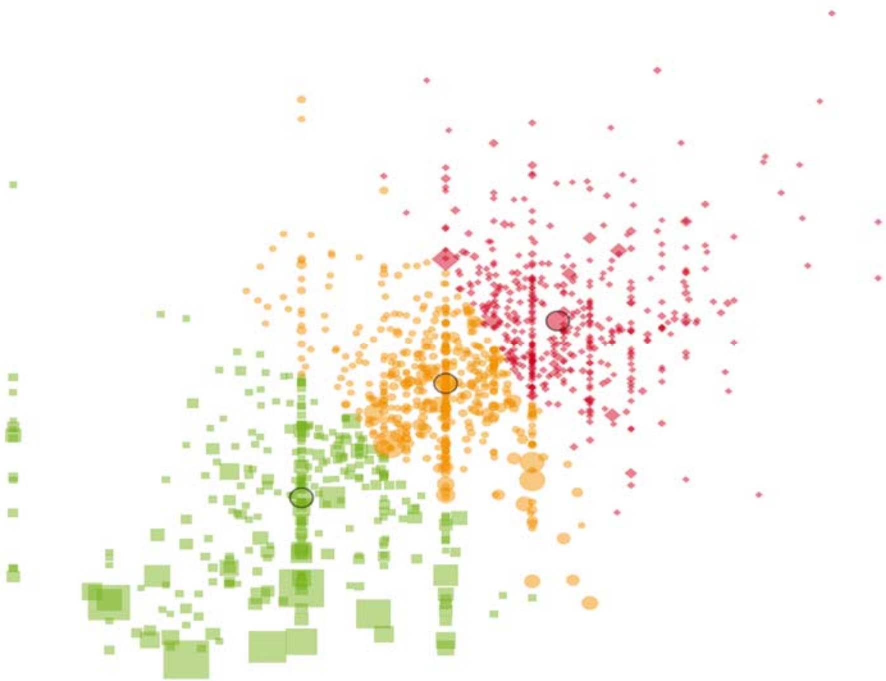
KCE REPORT 270C

Federaal Kenniscentrum voor de Gezondheidszorg
Centre Fédéral d'Expertise des Soins de Santé
Belgian Health Care Knowledge Centre

SHORT REPORT

CLUSTERING PATHOLOGY GROUPS ON HOSPITAL STAY SIMILARITY



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HEALTH SERVICES RESEARCH

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SHORT REPORT

CLUSTERING PATHOLOGY GROUPS ON HOSPITAL STAY SIMILARITY

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FOREWORD

In her Action Plan for the reform of the hospital payment system, the Minister defines three different payment systems for three distinct clusters of hospital stays. For the cluster of low-variable, low-complex, and standardisable routine care, a prospective payment system for the fees and the hospital stay is proposed. For highly complex, limited to non-standardisable care, a payment system that more closely reflects actual care is proposed. And for the cluster in between, a system that is in keeping with the current system.

And so KCE was asked to examine whether and how these three clusters can be delineated. It seems a rather technical question, and the calculations are indeed quite technical – so do not expect a simple story. Technicality in itself is not a problem – to develop an efficient, equitable and sustainable payment system, quite some study work is warranted. On the other hand, also the readability of the system is important to create sufficient support.

On top of the technical complexity comes the challenge to reconcile all these objectives, which is almost by definition impossible. How one defines and delineates the clusters is closely related to where one wants to put the risks and responsibilities. These are important choices, which obviously cannot be made by the KCE. The results of this study provide a first idea of where you approximately end up with a division into three clusters. Nobody expected this to be a cut-and-dried trichotomy – this report is no more or less than a step in a larger work in progress. A step in the right direction, we dare to hope.

Christian LÉONARD	Raf MERTENS
Deputy general director	General director

■ SHORT REPORT

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1. INTRODUCTION

1.1. Background

International trends in hospital payments

Expenditure on hospital services represents one of the largest shares of total healthcare spending. Therefore, in many cases an important aim of reforming hospital payment mechanisms is to achieve efficiency gains. Looking back on hospital payment reforms in the last decades, two characteristics of these reforms are similar in many developed countries.

First, since the 1990s, payments per case have become the main mechanism of reimbursing hospitals for acute inpatient care and more and more also for day care.[1, 2] Very often these payments per case are based on a variant of diagnosis-related groups (DRGs). In such system hospitals are paid a lump sum amount per case belonging to a certain DRG which consists of economically homogeneous and clinically meaningful groups of cases. Patients within one group should have homogeneous costs and clinically, cases allocated to one group should be distinguishable from other groups based on main diagnosis, severity, co-morbidity and/or treatment performed.[3] Statistically such groups are preferably as low-variant as possible. Outlier cases, usually measured in terms of cost or length of stay, attract additional payments. DRGs are also used to distribute the available regional or national hospital budget to individual hospitals, but this is mainly done in National Health Service systems.

Second, despite the fact that DRGs have been adopted in an increasingly large number of countries around the world, hospital payments consist of a sophisticated mix of different payment mechanisms. No single hospital payment system suffices to attain all possible objectives of hospital payments. Therefore, all countries are looking for the optimal mix of hospital payment systems which depends on the national context and on the objectives of the healthcare system. Ultimately, each provider payment system corresponds to a division of financial risk between the payer and the provider. Hence, the search for the optimal combination of hospital payment systems boils down to balancing the financial risk and associated incentives between payers and providers.

Lessons learned from international experience

A comparative analysis of the DRG hospital payment system in five countries revealed that the concrete design options of such system can make an important contribution to whether health system priorities, such as quality, efficiency or accessibility, are reached.[1] Concrete design characteristics include the classification system, the availability of high-quality and recent cost data and the period during which DRG payments are phased in.

Although all classification systems have the same purpose, i.e. case grouping, large differences were found between systems. Some countries developed a new classification system (e.g. England and the Netherlands). Others imported an updated version of the original DRG system and adapted it (e.g. France and Germany) because the cost structure of delivering acute care may vary considerably across countries, for example because of their level of technology or labour costs.[4] The Dutch system registers the complete process of care, from the initial consultation through the final check-up, in one group. In most countries outpatient care is not included.

To phase in DRG payments, a country can begin with a limited number of hospitals, a subset of hospital cases paid by DRGs, a subset of costs, shadow billing or a hospital-specific base rate which is gradually converted to a nationwide rate.[4]

Belgium followed the international trend but in a fragmented way

Belgium followed the international trend to base hospital payments on the case-mix of a hospital (see Box 1), but did this in a fragmented way.[3] Examples are the (partly) case-mix system for the hospital budget, called the ‘Budget of Financial Means’ (BFM – BMF), for a subset of hospital drugs and lump sum fees for clinical biology and medical imaging. Other lump sum payments, for example for non-surgical day care, are determined independently of the hospital case-mix.

Box 1 – APR-DRG classification system

Belgium imported the 3M **APR-DRG** (All Patient Refined-DRG) grouper to assign hospital stays to an APR-DRG. The basic DRG structure is extended by adding two sets of subclasses to each base APR-DRG, namely severity of illness (SOI) and risk of mortality (ROM).[3]

Patients are allocated to an APR-DRG-SOI group on the basis of principal diagnosis, secondary diagnoses and procedures, age and sex of the patient and, for some APR-DRGs (e.g. burns) type of discharge.

Severity of illness is defined as the extent of physiologic decompensation or organ system loss of function and introduces 4 categories for SOI: 1=minor, 2=moderate, 3=major, 4=extreme.

Risk of mortality is defined as the likelihood of dying in the admission, also classified as minor, moderate, major and extreme.

Hospital stays are classified into one of 320 base APR-DRGs (version 28), each with 4 SOI-classes, and two 'residual' APR-DRGs grouping hospital stays whose medical record abstracts contain clinically atypical or invalid information, thus rendering SOI classification irrelevant (APR-DRG 955 – Invalid principal diagnosis and 956 – Ungroupable stay). Hence, the **number of distinct groups** amounts to **1 282.**

Although medical and medical-technical services provided by medical specialists are mainly paid by fee-for-service, a limited number of lump sum fees have been introduced. Moreover, lump sum fees for clinical biology and medical imaging are partly determined by the hospital case-mix.

In 2002 the system of reference amounts was introduced to reduce variation in medical practice for a selection of frequent and less severe pathologies for which medical practice can be harmonized and standardised (see section 2.2 and Box 3).[5]

No compulsory collection of patient-level cost data for Belgian hospitals

One of the lessons learned from international experience is the importance of the availability of high-quality and recent cost data. Ideally, the amount per APR-DRG reflects actual costs because prices or reimbursement rates also reflect the historical bargaining power of providers or political negotiation. Unfortunately, the only patient-level cost data available in Belgian hospitals are from a few samples, collected on a voluntary basis.[3, 6, 7] There is no compulsory nationwide registration of patient-level cost data available.

Action Plan for a reform of the Belgian hospital payment system

In April 2015, the minister of Social Affairs and Public Health published a comprehensive plan to reform the Belgian hospital landscape.[8] The Action Plan proposes reforms on a wide variety of topics all related to how hospital care could be organised and financed. One of the central elements in the plan is the idea to classify hospital stays in three clusters and to apply a different payment system to each of the clusters. The plan explicitly mentions that the payment system applied to each cluster should be determined in terms of the financial risk sharing between the payer and the hospital and that the delineation between the clusters should be based on the predictability of the care process. Indeed, some hospital stays require a rather standard process of care while others have a much lower predictability of the care process and hence of resource use.

The following clusters are defined:

- The **first cluster** consists of hospital stays requiring a standard process of low-complexity care which varies little between patients and is called the 'low variability cluster'.

  For stays belonging to this first cluster, the Action Plan proposes to apply a prospectively determined amount per stay, irrespective of the care provided for each individual stay.
  The financial risk for care that is provided beyond the standard care process is borne by the hospital. The healthcare payer bears the financial risk for the number of cases.

- The **second cluster**, called the 'medium variability cluster', consists of hospital stays that are less predictable than those in the first cluster.
  The proposed payment system is very similar to the current system, where a national closed-ended budget is divided among individual hospitals on the basis of justified activities (see section 2). The predominant mode of payment for physicians remains fee for service. The financial risk is shared between the hospital and the payer.

- The **third cluster** consists of hospital stays for which the care process is not predictable and depends on the individual patient.
  The financial risk is mainly with the payer and hospitals are reimbursed for the care provided.

The Action Plan has opted for a gradual implementation of the three clusters and corresponding payment system, in terms of DRGs as well as in terms of budget items. For example, for DRGs in the low variability cluster a five-step implementation plan is envisaged. The plan proposes to start with only those DRGs and medical activities that are currently included in the system of reference amounts and to gradually extend the number of DRGs and medical activities. In still a later phase also drugs, day care and (part of) the hospital budget can be added to a lump sum payment system per case.

1.2. Scope and objectives

KCE was asked by the minister of Social Affairs and Public Health to develop a method for the delineation of the three clusters and to assess the feasibility of applying a prospectively determined amount per stay for stays assigned to the low variability cluster.

The scope of the study is limited to inpatient and day-care stays of general hospitals, except for the hospitals of a specialised nature that are no longer the competence of the federal authorities.

1.3. Methods

The methods used in this report are statistical in nature. For the first topic, cluster analysis was performed to classify pathology groups (APR-DRG-SOIs) into three clusters based on selected variables that are similar across hospital stays. For pathology groups classified into the low variability cluster by the cluster analysis, further analysis of the variability within groups was performed to identify groups eligible for a prospectively determined amount per stay.

The methods are detailed in subsequent sections.

Section 2 provides an overview of the sources of revenue of Belgian hospitals. Readers familiar with this topic can skip the section and continue with section 3 on the cluster analysis.

2. BACKGROUND ON HOSPITAL PAYMENT IN BELGIUM

In this section we provide a brief overview of how the different revenue sources for Belgian hospitals, including the revenue of the medical specialists, are calculated and paid for. We concentrate on the main revenue sources and on the systems and terminology needed for the remainder of the report.

The main revenue sources are the hospital budget (BFM – BMF), fees for medical specialists, a partial prospective and pathology-based payment system for pharmaceutical specialties and to a lesser extent, some lump sum payments for non-surgical day care. More detailed information can be found in Durant (2015)[9] and Van de Voorde et al. (2014)[5] and the references therein.

2.1. The Budget of Financial Means

Non-medical hospital services such as services for accommodation, accident and emergency services, and nursing activities provided during an inpatient stay or a surgical day stay are paid for by a budget. A national hospital budget, which is a closed-ended budget, is defined annually by Royal Decree. The BFM – BMF consists of three major parts: part A covers capital and investment costs (transferred to the federated authorities since the 6th State reform); part B covers operational costs; and part C covers some corrections (positive or negative) of budgets for past financial years. Parts A, B and C each consists of subparts of which B1 (common operational costs; 20.34% of total BFM – BMF in 2015) and B2 (clinical costs; 38.39% of total BFM – BMF in 2015) are the largest parts.

Calculation of the individual hospital budget

The distribution of the national hospital budget to the individual hospitals is based on a multifaceted calculation with a specific calculation method and parameters for each subpart. The calculation method for subpart B2 is explained in Box 2.[5]

Box 2 – The allocation of the B2-budget to individual hospitals

General principle

A national closed-ended budget for part B2 is allocated to individual hospitals on the basis of a point system by which the national budget is divided by the total number of B2-points 'earned' by all hospitals. This gives the monetary value of one B2-point. 'Justified activities' and the resulting number of 'justified beds', the number of operating theatres and the availability or not of an emergency department determine the number of basic points a hospital is entitled to. Supplementary points for certain services (C-, D-, and E-beds and the emergency department) can be attributed depending on activity and care profile (e.g. nursing intensity).

Justified activities

Justified activities are based on the number and type of admissions during a reference year. A national average length of stay per APR-DRG-SOI is calculated, which is then applied to the case-mix of each hospital. Multiplying the national average length of stay per APR-DRG-SOI with the case-mix of a hospital gives the number of justified patient days for the hospital. Per department or group of departments, the number of justified patient days is divided by the 'normative occupancy rate' of the service (in general 80%).

Payment of the individual hospital budget

The payment of the individual hospital budget depends on the insurance status of the patient and on the payer.

For patients who are member of a Belgian sickness fund and for whom the hospital stay is reimbursed by the National Institute for Health and Disability Insurance (RIZIV – INAMI), the BFM – BMF is divided into a fixed and a variable part. The fixed part is paid on the basis of monthly advances (called 'provisional twelfths'). It includes (theoretically) 80% of the components B1 and B2 and 100% of all other parts. The remaining variable part includes (theoretically) 20% of components B1 and B2 and is paid according to the number of admissions (10% of the budget) and the number of nursing days (10% of the budget) for the general hospitals included in the analyses of this study. Hospitals receive a lump sum payment per admission and per diem; both lump sum amounts are hospital-specific. For the variable part hospitals have to submit an invoice to the sickness fund; for the fixed part no invoices are required.

For patients who are not enrolled into one of the sickness funds, or for stays without entitlement to reimbursement from the RIZIV – INAMI, hospitals have to submit an invoice for parts A, B and C to the paying authorities (e.g. Fund for Occupational Accidents, private insurance, public centre for social welfare (OCMW – CPAS), patients from abroad). Hospitals are paid a per diem price for these stays.

At this moment, the national BFM – BMF is distributed among individual hospitals on the basis of a diverse set of criteria and it is not possible to further allocate the hospital budget to an individual hospital stay.

2.2. Physician fees

Mainly fee-for-service payments

Physicians are mainly paid fee-for-service. Health insurance pays for medical services and some services provided by allied health professionals, based on a fee schedule, called 'nomenclature', which lists almost 9 000 unique covered services and their payment rates.

Lump sum fees for clinical biology and medical imaging[a]

Clinical biology

The medical activities for laboratory tests for hospitalised patients are reimbursed as follows:

- A lump sum fee per admission which is determined at the national level and consists of a basic lump sum and an additional lump sum (two tariffs) depending on certain characteristics of the clinical laboratory of the hospital (e.g. the number of staff, guarantee of continuity).
- A lump sum fee per day is hospital-specific and partially depends on case-mix data.

[a] Reproduced from Chapter 9 in Van de Voorde et al. (2014).[5]

- A fee-for service component which was reduced to 25% of the value for this service before the introduction of lump sum fees for the inpatient hospital sector.

The lump sum fees per admission and per day are both independent of whether or not tests were performed and of the number of those tests.

Medical imaging

The payment system for medical imaging consists since 1991 of a mix of lump sum fees and fee-for-service:

- A lump sum fee per admission or the so-called consultancy fee, determined at the national level (hospital independent amount).
- A second lump sum fee per admission determined by the hospital's case-mix and by the national average expenses for medical imaging per hospital stay.
- A reduced fee-for-service theoretically equals about 74% of the former value for the service.

The system of reference amounts

As already mentioned in the introduction, the system of reference amounts was introduced to standardise medical practice for a selection of frequent and less severe pathologies (see Box 3).

Box 3 – The system of reference amounts

Definition of a reference amount

The reference amount is a standard by which a hospital is compared, and is equal to the national average expenditure per APR-DRG-SOI (only SOI 1 and SOI 2) and per type of medical activity, raised by 10%. Three groups of medical activities are included

- clinical biology (with the exception of the lump sum fees);
- medical imaging (with the exception of the lump sum fees and magnetic resonance imaging (MRI) services);
- other technical activities (internal medicine, physiotherapy and various medico-technical services).

Selection of APR-DRGs

The reference amounts are only calculated for 31 APR-DRGs (20 surgical and 11 medical APR-DRGs but 8 APR-DRGs are split which brings the total number of groups to 39; numbers in 2016). It (initially) only concerned inpatient hospital stays but the system has been extended to day care.

Retrospective refunding

A two-step calculation is carried out to determine which hospitals have to refund money to the health insurance and the amount of the refund. Refunding is done retrospectively: there is a time lag of three years between the sanction and the year of registration.

2.3. Mixed payments for pharmaceutical specialties

On 1 July 2006 a prospective budget for most pharmaceutical specialties administered to patients hospitalised in an acute hospital was introduced. For these specialties, 25% of the reimbursement basis in 2006 is still reimbursed per product, approximately 75% by means of a lump sum amount per hospital stay.

Pharmaceutical specialties not integrated in the lump sum are reimbursed per product. These include specialties with a high relevance, taking into account therapeutic and social needs and the innovative character, or with a high cost. Other products excluded by law from the prospective budget are orphan drugs, cytostatic drugs, immunoglobulins and albumins, retroviral drugs, radioisotopes, etc. The list of excluded pharmaceuticals is updated monthly. Pharmaceuticals dispensed by the hospital pharmacy for non-hospitalised patients are not included in the prospective budget.[10]

Hospital-specific lump sums based on APR-DRGs

Hospitals receive a lump sum amount per stay, which is based on the hospital's case-mix and the national average reimbursement per APR-DRG and SOI. APR-DRGs 950 to 956 (residual APR-DRGs) are excluded. National average reimbursements are calculated annually for all hospital stays reimbursed by health insurance of the last available year (generally three years earlier). Outliers (defined on the basis of the length of stay by Q3 + 2*(Q3 – Q1), with Q=quartile)) are also suppressed. When taking account of the excluded pharmaceutical specialties (25%), outliers (9%), excluded APR-DRGs (2%) and 25% reimbursement per product, the lump sum per stay represents 48% of total reimbursements for pharmaceutical specialties.[9] On 1 July 2015 the lump sum amount per hospital varied from € 60.58 to € 145.84.[11]

2.4. Payments for day-care stays

Payments for day care depend on the type of day-care setting. Day-care activities can be grouped into day-care stays (comparable to an inpatient stay but without an overnight stay) and more ambulatory activities that make use of the hospital infrastructure. Hospitals receive lump sum payments for these ambulatory activities (e.g. plaster ward lump sum and groups 1 to 3 lump sums for chronic pain).

Day-care surgery

Payments for day-care surgery are included in the Budget of Financial Means (BFM). The general costs are included in part B1 of the BFM – BMF and costs specific to the day-surgery centre and its activity in the operating room are included in part B2.

Payments for activities in a day-care surgery centre concern two types of stays. A first type concerns interventions for which day-care surgery is considered to be justified. These interventions are recorded on List A. The procedures have to meet two additional criteria: involving an invasive surgical intervention and the number of the interventions performed in day care or in a policlinic are at least 60% of all interventions performed in ambulatory care.

For interventions on List B (inappropriate inpatient stays), hospitals receive exactly the same amount independent of the care setting, being inpatient or day care. For codes on List B the same criteria hold as for List A, except that the substitution level of the inpatient stays by day-care stays has to be at least 10% during a certain reference period. A stay is defined as an inappropriate inpatient stay if it meets all of the following criteria at the same time:

- it involves one of 32 selected APR-DRGs;
- it concerns an inpatient stay;
- it concerns a scheduled admission;
- the length of stay is at maximum three days;
- the stay has an SOI 1;
- the patient did not die during the stay;
- the stay has a mortality risk index of 1 (low);
- the patient is under 75 years of age.

The total number of justified stays in a day-care surgery centre is the sum of stays in the day-care surgery centre (List A) and the inappropriate inpatient stays (List B). For each justified stay the hospital is allotted a justified length of stay of 0.81 days.

Non-surgical day care

Payments for day-care activities can be classified into:

- Hospital-independent lump sums: plaster ward lump sum, group 1 to 7 lump sums for non-surgical day care, group 1 to 3 lump sums for chronic pain treatments and the lump sum for portal catheter manipulation. All have a fixed price.
- Hospital-dependent lump sums: maxi lump sum, priced according to the previously allocated B2 part of the hospital's BFM – BMF and haemodialysis lump sum. The interventions allowing hospitals to charge a mini lump sum (emergency bed occupation or medical surveillance after administering an intravenous infusion) were also priced according to the previously allocated B2 part of the hospital's BFM – BMF until 1 July 2014. Since that date, they are included in the B2-part of the BFM – BMF.[b]

The maxi lump sum is linked to a restricted number of nomenclature codes and covers procedures requiring general anaesthesia or for administering chemotherapeutic agents. Due to the hospital-specific character of the lump sums, large inter-hospital price variations exist for equivalent services.

In 2007 lump sums for 7 groups and 3 lump sums for chronic pain were introduced. They have a fixed price per lump sum and are linked to nominative lists of services.

3. DEFINING THREE CLUSTERS

In this section the selected cluster analysis method is described (section 3.2) and applied to the available data. The results are shown in section 3.3 and a discussion on the feasibility to use the three clusters as outlines for three different payment systems is provided in section 3.4. We start with a description of the available data.

3.1. What data is used?

As discussed in the introduction, at present no comprehensive patient-level cost data is available for at least a representative sample of Belgian hospitals. However, there are nationwide compulsory data collections available on a number of factors that might influence variability between hospital stays. Most of these variables should be considered approximations as they are gathered for other purposes than to study variability. The next subsections detail what data are currently available and how certain features of the data were dealt with.

3.1.1. Minimal Hospital Data (MZG – RHM)

All general hospitals are required to submit twice a year a large set of data on all inpatient and day-care hospital stays and emergency room contacts: the Minimal Hospital Data (MZG – RHM defined in a Royal Decree[12, 13]) which are transferred to the Federal Public Service (FPS) for Health, Food Chain Safety and Environment. Day-care stays include all surgical stays and non-surgical day-care stays for which one of the following lump sums can be charged: maxi lump sum, mini lump sum (up to July 2014), lump sums (3 groups) for chronic pain and one of the 7 groups of lump sums introduced in 2007; or are of a specific type (currently geriatric, paediatric, oncological). An APR-DRG is assigned to all inpatient stays and to all day-care stays.

At the time of this study, MZG – RHM data were available up to 2012, as used to calculate the hospital budget for 2015. Figure 1 shows the general components of the collected data[c]. The variables of use for this report are the clinical information provided by diagnoses, patient characteristics such

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b Since the most recent year of our data is 2012 (see section 3.1.3) the mini lump sums are included as separate lump sums.

c A detailed description including a list of datasets and variables is available from http://www.healthstat.be/web/register.xhtml?registerId=74 for MZG – RHM, http://www.healthstat.be/web/register.xhtml?registerId=921 for AZV – SHA and http://www.healthstat.be/web/register.xhtml?registerId=901 for ADH – HJA.

as age and gender, in hospital mortality and stay type information such as urgent or not, length of stay or if a stay is a readmission. We included these variables because they cover both patient and care setting characteristics which can contribute to variability in hospital stays. We were, however, limited to the variables available in the data to cover different aspects of patient and care setting characteristics. Also the grouping of hospital stays in pathology groups using APR-DRGs is pivotal for the analysis in this report.

3.1.2. Hospital Billing Data (AZV – SHA and ADH – HJA)

The Hospital Billing Data contains all reimbursements by the RIZIV – INAMI related to hospitals stays: fees charged by physicians and other healthcare providers, pharmaceuticals and implants, per admission and per diem lump sum payments, etc.

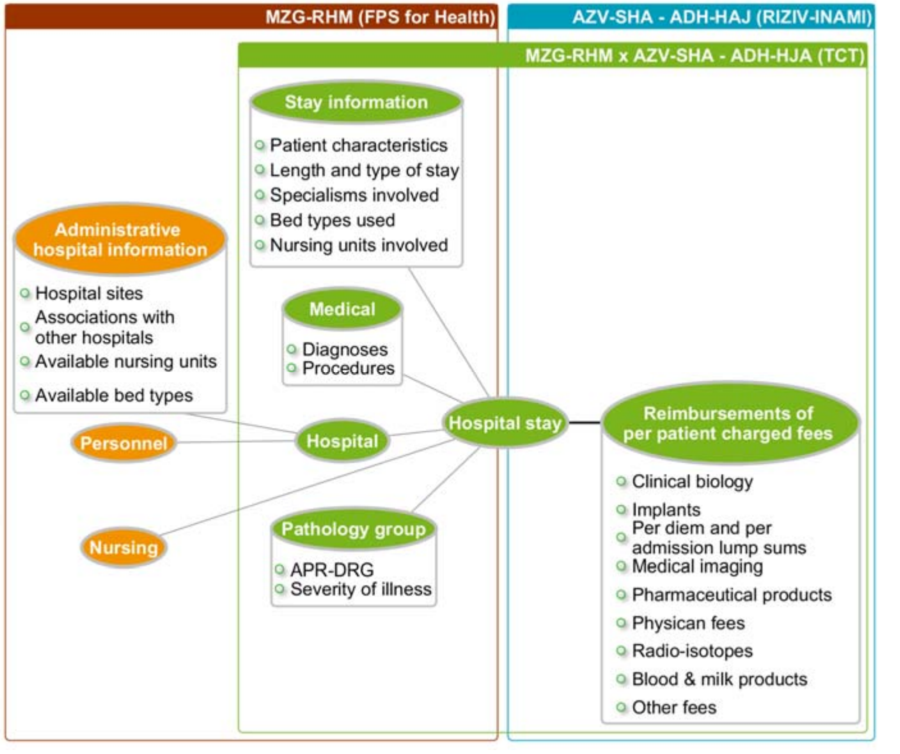
In practice, hospitals bill the patient's sickness fund for the provided services for the part covered by the health insurance on the basis of the RIZIV – INAMI nomenclature.

A subset of the data available on these transactions is passed yearly from the sickness funds to the RIZIV – INAMI: Anonymous Hospital Stays (AZV – SHA) for inpatient stays and Anonymous Day-care Stays (ADH – HJA) for day-care stays. Figure 1 shows the general components of the collected data[c]. At the time of this study, data were available up to 2013.

3.1.3. Technical Cell data (TCT)

Each year, the Technical Cell links MZG – RHM with AZV – SHA and with ADH – HJA (see Figure 1).[14] The purpose of this linked data is twofold: to allow analysis on the relation between pathology and health insurance expenditure, and to support the development of financing and quality rules and policies. The KCE has legal access to these linked data[15] which are used in the analysis in this report. At the time of this study, we had access to linked data for 2008 to 2012.

Figure 1 – Components of data collections on inpatient and day-care hospital stays



Green ellipses: available for this report.

3.1.4. Analysis data set

3.1.4.1. Data set at start

The analysis data set is based on the linked TCT hospital stays for 2009 to 2012. The year 2008 was not used because version 28 of the APR-DRGs was not available. Table 1[d] shows the number of hospital stays per year that are linked. Over 98% of the inpatient hospital stays charged to the health insurance are linked to MZG – RHM. Almost 90% of all inpatient general hospital stays are linked with reimbursement data. The majority of the missing 10% is not charged to health insurance, but to other payers (social security (e.g. labour accidents), social welfare (OCMW – CPAS), or international conventions for foreign patients). These stays are not available in the reimbursement data. A similar reasoning accounts for the percentages of day-care stays. Here the lower percentages compared to inpatient stays are explained by emergency room contacts without admission, and renal dialysis, use of the plaster room and mini lump sum in the reimbursement data for which no corresponding MZG – RHM stay are available.

Table 1 – Summary statistics linked TCT data

	Inpatient			Day care		
Source	All	Retained	% retained	All	Retained	% retained
2009						
ADH-HJA				3 178 287	2 236 854	70.4%
AZV-SHA	1 748 618	1 723 317	98.6%			
MZG-RHM	1 924 166	1 723 317	89.6%	4 492 371	2 236 854	49.8%
2010						
ADH-HJA				3 203 114	2 287 714	71.4%
AZV-SHA	1 760 322	1 738 553	98.8%			
MZG-RHM	1 941 843	1 738 553	89.5%	4 664 490	2 287 714	49.0%
2011						
ADH-HJA				3 402 112	2 429 448	71.4%
AZV-SHA	1 776 976	1 747 172	98.3%			
MZG-RHM	1 949 873	1 747 172	89.6%	4 825 394	2 429 448	50.3%
2012						
ADH-HJA				3 536 798	2 495 714	70.6%
AZV-SHA	1 797 328	1 768 422	98.4%			
MZG-RHM	1 959 152	1 768 422	90.3%	4 920 647	2 495 714	50.7%

3.1.4.2. How to account for the BFM – BMF in a hospital stay?

As discussed in section 2.1, the hospital budget is not available at the level of an individual stay and at present, there is no validated method to reverse engineer the BFM – BMF to an amount per individual hospital stay. Furthermore, the lump sums per admission and per diem for the B1 and B2 part differ per hospital. This introduces variability in payment variables between hospital stays related to payment modality and much less to actual activity.

Instead, we use the length of stay, as registered in MZG – RHM, as a proxy for resource use as there are no real viable alternatives in the data. Length of stay is not a perfect replacement for allocating the hospital budget to an individual stay, but it is a much better approximation for resource use than the hospital lump sums per admission and per diem.[3]

[d] All data manipulation and analysis were performed with SAS software 9.4 and R 3.2.3

3.1.4.3. How to account for lump sums in a hospital stay?

Similar to the BFM – BMF lump sums per admission and per diem, the lump sum fees for clinical biology and medical imaging, and the lump sum payments for pharmaceutical products introduce variability between hospital stays that is not related to activity because they are charged for every hospital stay and are independent of actual use (details can be found in appendix section 1).

The partial fee-for-service payment for clinical biology, medical imaging and pharmaceutical products allows us to approximate the resource use by extrapolation of the fee-for-service part. For clinical biology and inpatient pharmaceutical products, the fee for service part was initially defined as 25% of the tariff. For medical imaging, the legal definition does not mention a specific percentage, but RIZIV – INAMI indicated it was initially defined as 73.83% of the tariff. The extrapolation factor equals 4 for clinical biology and inpatient pharmaceutical products, and 1.35 for medical imaging (the impact on reimbursement is shown in appendix section 2). Again, this is not a perfect, but a sufficient approximation for the purposes of the study.

3.1.4.4. Variables for the cluster analysis

The variables available for the cluster analysis are shown in Table 2. The purpose of the cluster analysis is to assess whether hospital stays (which are grouped in APR-DRG-SOIs) can be classified in three clusters on the basis of the variables in Table 2. Hence, the analysis classifies APR-DRG-SOIs in clusters only on statistical grounds.

Table 2 – Analysis variables

Variable	Unit	Description
Reimbursements	euro	▪ all reimbursements summed per hospital stay ▪ excluding BFM – BMF lump sums ▪ extrapolating fee for service of clinical biology, medical imaging, and pharmaceutical products
Length of stay	days	length of stay for inpatient hospital stays
Age	years	age on admission
Gender		male or female
Admission type		▪ unknown ▪ planned admission ▪ from daycare ▪ transfer back ▪ involuntary admission ▪ newborn ▪ urgent admission (recoded to one level from emergency room (ER), ambulance, mobile emergency group (MUG – SMUR), paramedical intervention team (PIT), urgent not passed through ER) ▪ long stay
Readmission		is the stay a readmission within the year within the same hospital?
Deceased		did the patient die during the stay?
ICD-9-CM chapter		principal diagnosis of the stay recoded to its chapter

The 3M APR-DRG grouper version 28 allocates each hospital stay to one of 322 possible APR-DRGs with a particular severity of illness (SOI).

For each of the APR-DRG-SOI combinations, a relative variability measure is calculated per variable (see Table 3) over two different year ranges: 2009–2011 and 2010–2012. A relative measure of variability is used, rather than a spread measure like the standard deviation or the interquartile range (IQR) because it is scaleless and facilitates comparing the variability of variables with a different unit. For ratio level variables, the selected relative variability measure is the quartile coefficient of dispersion (qcod); for nominal level variables the deviation from the modal frequency (dmf) was used.

The reason to use the stays in three years is to partly solve the problem of APR-DRG-SOIs having a relatively small number of stays per year. Furthermore, it reduces variability introduced by one-off events during a particular year. Two periods are used to be able to assess the stability of the clusters (see below). For each APR-DRG, summary statistics and the full distribution per SOI for each variable are available in the supplement to this report.

Table 3 – Relative variability measures

Variable	Level of measurement	Point estimator	Formula
Reimbursements Length of stay Age	Ratio	Quartile coefficient of dispersion (qcod)	$\frac{Q_3-Q_1}{Q_3+Q_1}$ with: · Q_1: 25$^{\text{th}}$ percentile · Q_3: 75$^{\text{th}}$ percentile
Gender Admission type Readmission Deceased ICD-9-CM chapter	Nominal	Deviation from the modal frequency (dmf)	$1-\frac{\sum_{i=1}^{K}(f_m-f_i)}{N(K-1)}$ with: · f_m: modal frequency · K: number of categories · f_i: frequency of i^{th} category · N: sum of all category frequencies

3.1.4.5. Exclusion of APR-DRG-SOIs

Some particular APR-DRGs concerning provisional registration and ambulatory contacts without a hospital admission are not relevant for inpatient and day-care hospital stay financing (see appendix section 3 for details).

Furthermore, despite using three year of stays, there are still a number of APR-DRG-SOI combinations with a very small number of stays. We excluded APR-DRG-SOIs with less than six stays over a three-year period (in any of the two periods used). The number is chosen to exclude as little as possible but to still have a bare minimum available to calculate the necessary statistics (see appendix section 3 for further details). Since no hard rules exist for a minimum number of stays, the choice of at least six stays is somewhat arbitrary.

The remaining APR-DRG-SOI combinations are grouped in the cluster analysis in the next section.

3.2. Cluster analysis method

3.2.1. What is a cluster analysis?

The aim of a cluster analysis is to group objects in such a way that the objects in the same group (cluster) are more similar to each other than to the objects in another group. These groups can have a hierarchical relationship (e.g. APR-DRGs are pathology groups which have hierarchical subgroups of different severity of illness). When the groups are not meant to be hierarchical, clustering is often called partitioning.[16] It is this type of clustering that is used in this report.

3.2.2. Choice of cluster method

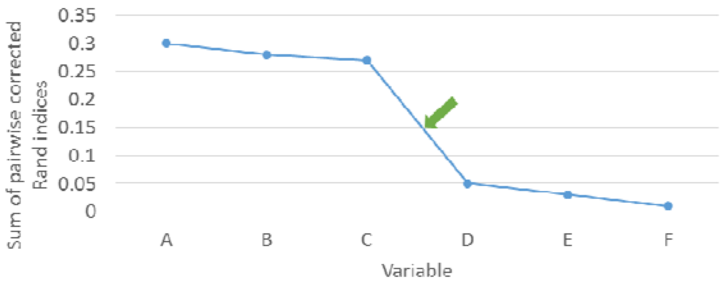
The *k*-medoids cluster method is a method to group multidimensional data into *k* clusters. A medoid is the data point that is the most 'central' within the cluster. We chose this method because it requires little assumptions on the distribution of the data, it is relatively insensitive to outliers[16], and it is readily available in statistical analysis software.

The attribution of data points to a cluster is done using an iterative algorithm. We chose the partitioning around medoids (PAM) algorithm for finding three clusters (for a description of how the algorithm works, see appendix section 4). As the relative variability measures qcod and dmf are at the ratio level, we used Euclidean distance as the distance measure for the PAM algorithm.

3.2.3. Which variables to include?

In the data set section (3.1.4.4) we discussed the variables available for the cluster analysis. The main reason to start with such an elaborate set of variables instead of concentrating only on resource use is that some of these variables, for example age and gender, make up-coding more difficult (see section 5.2.3). However, not all variables are necessarily useful or needed to find the three clusters best partitioning the data. To find the variables that best help discriminate the clusters, we used the algorithm of Heuristic Identification of Noisy Variables (HINoV).[17] The algorithm is described in appendix section 4.

The result of the HINoV algorithm is a curve. A sharp drop in the curve indicates which variables can be considered 'noisy' because they do not contribute much in determining the clusters (see e.g. the green arrow in the example below). These can be excluded (e.g. variables D to F in the example below).



3.2.4. Cluster validation

A good cluster is a cluster:

- for which data points are 'connected', i.e. they belong to the same cluster as their immediate neighbours;
- which is compact, i.e. data points form a homogeneous group; and
- which is well separated from other clusters, i.e. there are few to no data points in the 'space' between clusters.

For connectedness, the connectivity index is calculated and ranges from 0 to ∞. Lower values correspond with better connectivity and are considered as giving better clusters.

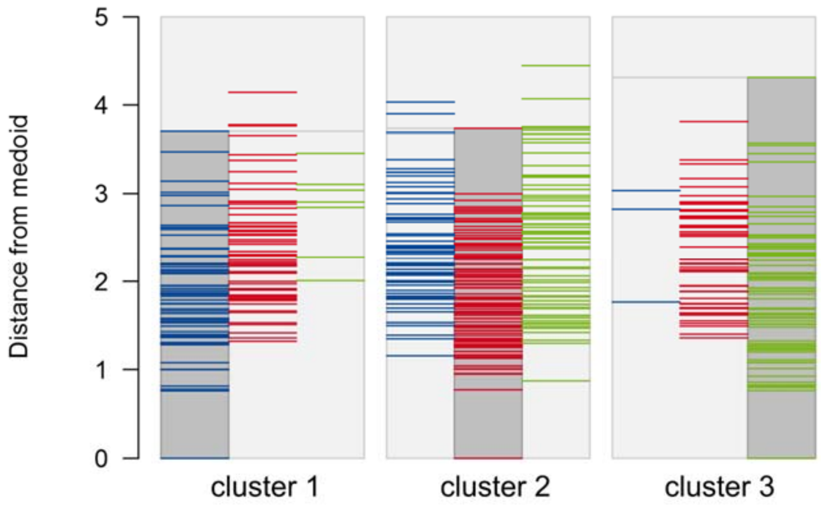
Compactness and separation are related: increasing the number of clusters tends to increase compactness, but tends to decrease separation. Both the Dunn index and the Silhouette Width (see below) are indices that evaluate compactness and separation in a single value. Silhouette Width ranges from -1 to 1, while the Dunn index ranges from 0 to ∞. For both indices, larger values correspond to more compact and better separated clusters.

Aside from numerical indices, clusters are often best validated visually as well. A stripes graph plots, per cluster, the distance of data points closest to the centre (medoid) of the cluster (not all data points are necessarily shown, depending on their distance to the centre of the cluster).[18] For example, Figure 2 shows a validation plot for data with three distinct clusters. Each panel represents a cluster. A data point (e.g. an APR-DRG-SOI) is drawn as a horizontal line (a 'stripe'). In the figure, the blue lines correspond to data points assigned to cluster 1, red lines those assigned to cluster 2, and green lines those assigned to cluster 3. The closer a line is to the horizontal axis, the closer the data point lies to the centre of the cluster. The panel for cluster one shows that the data points that are closest to the centre of cluster 1 are actually all data points assigned to cluster 1 (blue lines). A green line (a data point assigned to cluster 3) is also visible but is farther away than the blue lines, indicative of good cluster separation. Similarly, the panel on the right for cluster 3 has the green lines (data points assigned to cluster 3) closest to the centre of cluster 3. Red lines (data points assigned to cluster 2) and blue lines (data points assigned to cluster 1) lie further away than the green lines, again indicative of good cluster separation.

Figure 3 shows an example of data without a cluster structure. Further validation plots are discussed in appendix section 5.

Figure 2 – Stripes plot example: data with distinct three clusters

Figure 3 – Stripes plot example: random data without distinct clusters



3.2.5. *Cross-border cases*

The PAM algorithm used to assign APR-DRG-SOIs to a cluster described in section 3.2.2 does not always produce an overall optimal solution. In theory, to find the best solution all possible partitions should be calculated and assessed. In practice, even with a relatively small number of data points[e], this is unfeasible.[16]

As an extra validation step, we assess if data points have been assigned to the 'wrong' cluster based on the silhouette width. Table 4 summarises the classification used. A negative silhouette width means that on average, a data point is closer to the members of another cluster than to the members of its own cluster.

Table 4 – Silhouette width definitions

Silhouette width	Description
$s_i > 0$	the data point *i* is considered well matched to its cluster
$s_i = 0$	the data point *i* is on the border of two clusters
$s_i < 0$	the data point *i* is possibly better matched to another cluster

3.3. Cluster analysis results

3.3.1. *Variable selection with HINoV*

The HINoV algorithm found the variability in length of stay and stay reimbursement as the variables that contribute most to define the clusters for inpatient stays (Figure 4).

For day-care stays, it depends on the period of data used (Figure 5). For the period 2009–2011, the first drop in the curve occurs after variability in reimbursement, readmission, and age (although the largest drop occurs further on the curve). For the period 2010–2012, the drop is clearer after the variables variability in reimbursement and readmission. Because both variability in reimbursement and readmission occur in both periods and very clear in 2010–2012, we used these variables in the cluster analysis for day-care stays.

e For example, if all 322 APR-DRG combinations need to be clustered in three clusters, then there are 7.2×10^{152} possible partitions (based on $\frac{1}{g!}\sum_{m=1}^{g}(-1)^{g-m}\binom{g}{m}m^n$ with n the number of points to cluster and g the number of clusters[19]). In this study, a maximum of 1 288 APR-DRG-SOI combinations need to be clustered in three groups, but the number of possible partitions exceeds 1.8×10^{308} (the largest number representable on the analysis machine).

Figure 4 – HINoV plot inpatient for 2009-2011 and 2010-2012 periods

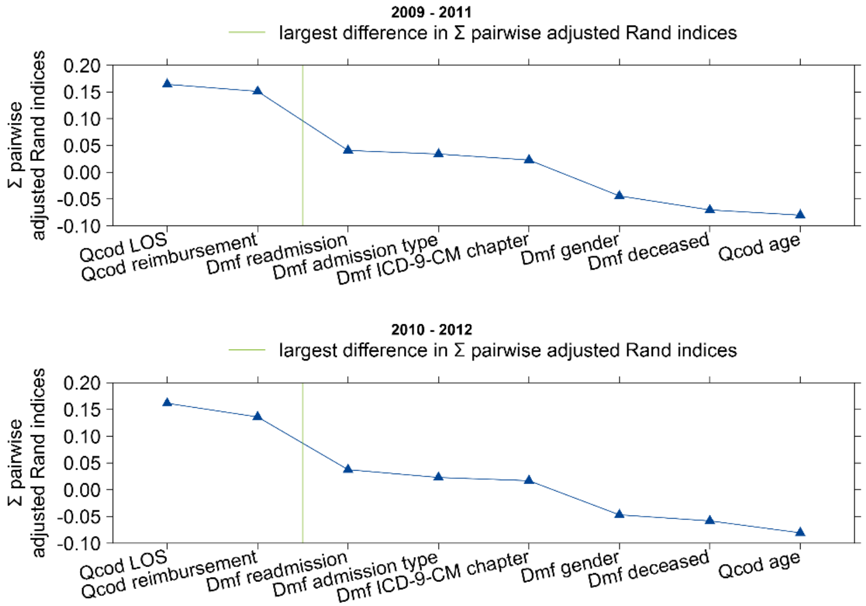
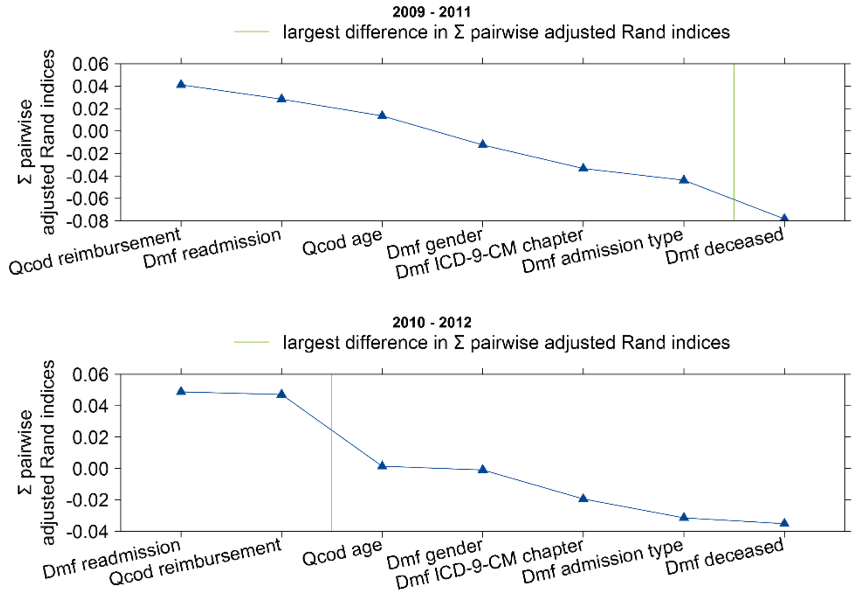


Figure 5 – HINoV plot day care for 2009-2011 and 2010-2012 periods



3.3.2. Description of the three clusters

Expressed in proportion of the total number of stays and total reimbursement amounts, the inpatient cluster with the lowest variability in reimbursement and length of stay is the largest cluster, while being the smallest when looking at the proportion of the total length of stay (Table 5). For day-care stays, the medium variability cluster is the largest with over half of the stays, while the lower variability cluster is the largest in the proportion of total amount reimbursed (Table 6). The list of APR-DRG-SOIs in each cluster can be found in appendix section 6.

Table 5 – Summary statistics inpatient clusters

Cluster	# APR-DRG-SOI	Stays		Reimbursement		Length of stay	
		N	%	€	%	days	%
2009-2011							
low	293	2 215 461	43.37%	4 134 719 872	45.08%	11 232 721	27.66%
medium	497	1 798 260	35.20%	3 158 983 278	34.45%	17 048 549	41.98%
high	445	1 095 077	21.44%	1 832 379 248	19.98%	11 468 928	28.24%
2010-2012							
low	317	2 311 177	44.83%	4 328 738 857	46.46%	11 648 147	28.71%
medium	505	1 745 340	33.86%	3 089 622 179	33.16%	16 530 485	40.74%
high	413	1 098 655	21.31%	1 853 265 769	19.89%	11 535 103	28.43%

Table 6 – Summary statistics day-care clusters

Cluster	# APR-DRG-SOI	Stays		Reimbursement	
		N	%	€	%
2009-2011					
low	173	1 421 094	28.45%	1 346 088 330	35.06%
medium	265	2 574 354	51.55%	1 132 016 205	29.48%
high	268	998 913	20.00%	572 361 161	14.91%
2010-2012					
low	183	1 522 680	29.07%	1 461 344 844	35.70%
medium	250	2 479 139	47.34%	1 092 877 951	26.70%
high	273	1 235 523	23.59%	690 652 310	16.87%

Figure 6 shows per APR-DRG-SOI (the coloured dots) the variability in reimbursement (vertical axis) and simultaneously the variability in length of stay (the horizontal axis). The symbol size is indicative of the size of the APR-DRG-SOI in terms of proportion of total reimbursement. APR-DRG-SOIs located in left lower corner have low variability both in reimbursement and length of stay. APR-DRG-SOIs in the top right corner have high variability both in reimbursement and length of stay. The colour of the dots corresponds to the cluster they were assigned to.

The variability per APR-DRG-SOI of both reimbursement and length of stay for inpatient stays, clearly increases from the low variability cluster to the high variability cluster (Figure 6). However, not every APR-DRG-SOI in cluster medium has a higher variability in reimbursement or length of stay than the APR-DRG-SOIs in cluster low. The same is true for cluster high. In other words, some APR-DRG-SOIs fall in cluster high because they have high variability in reimbursement but only moderate variability in length of stay, while some APR-DRG-SOIs in cluster medium have a higher length of stay variability.

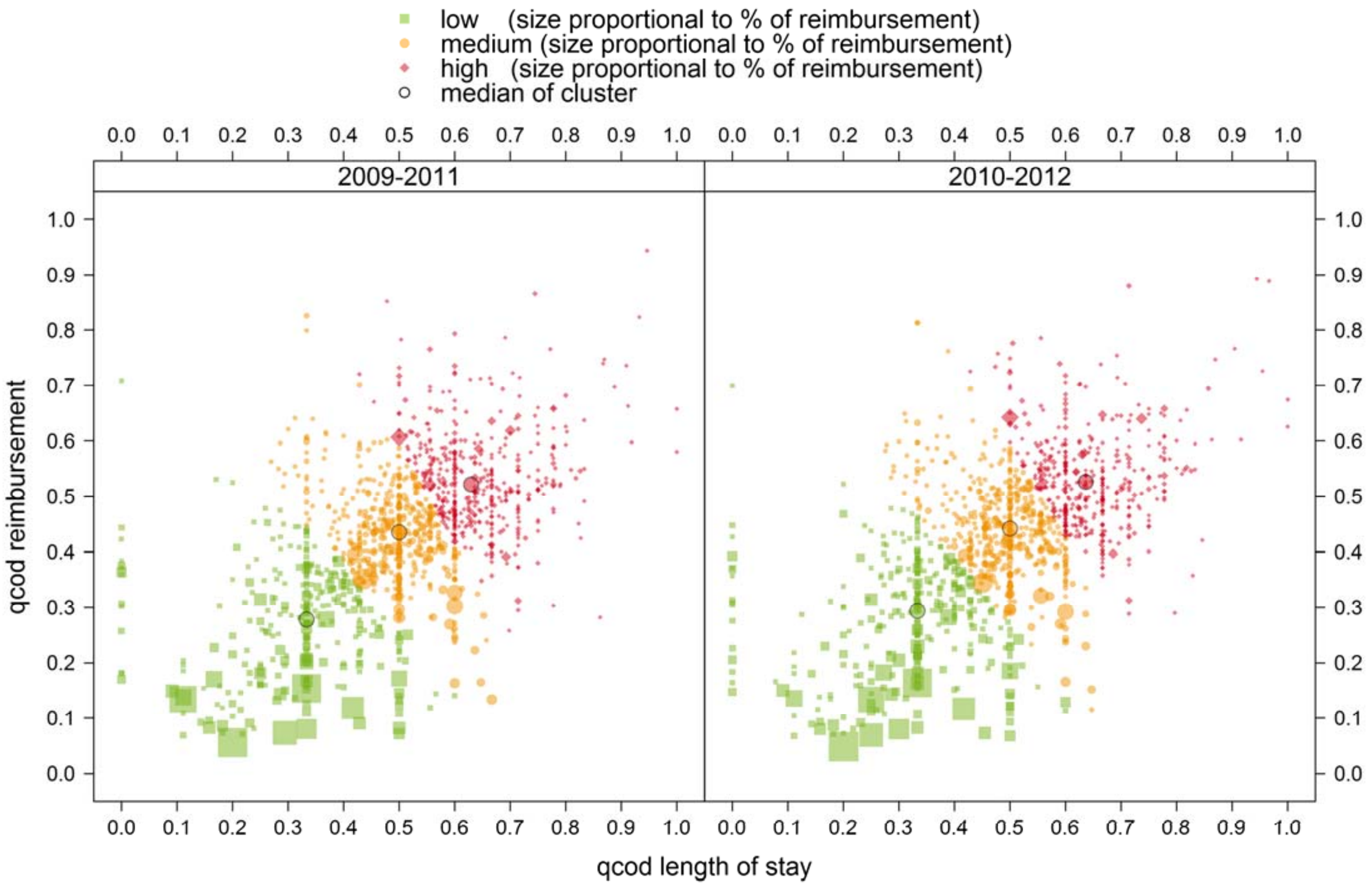
The picture is very different for day-care stays. Here the partitioning into three clusters is clearly determined by the variability in readmissions (Figure 7). The variability in readmissions increases from cluster low to cluster high, but this is not the case for variability in reimbursement, which is quite the opposite.

The correspondence between the periods depends on the cluster (Table 7). Cluster low has a relatively high correspondence. The clusters medium and high have less correspondence even given the overlap of two years, in particular in day-care stays.

Table 7 – Cluster correspondence between 2009-2011 and 2010-2012

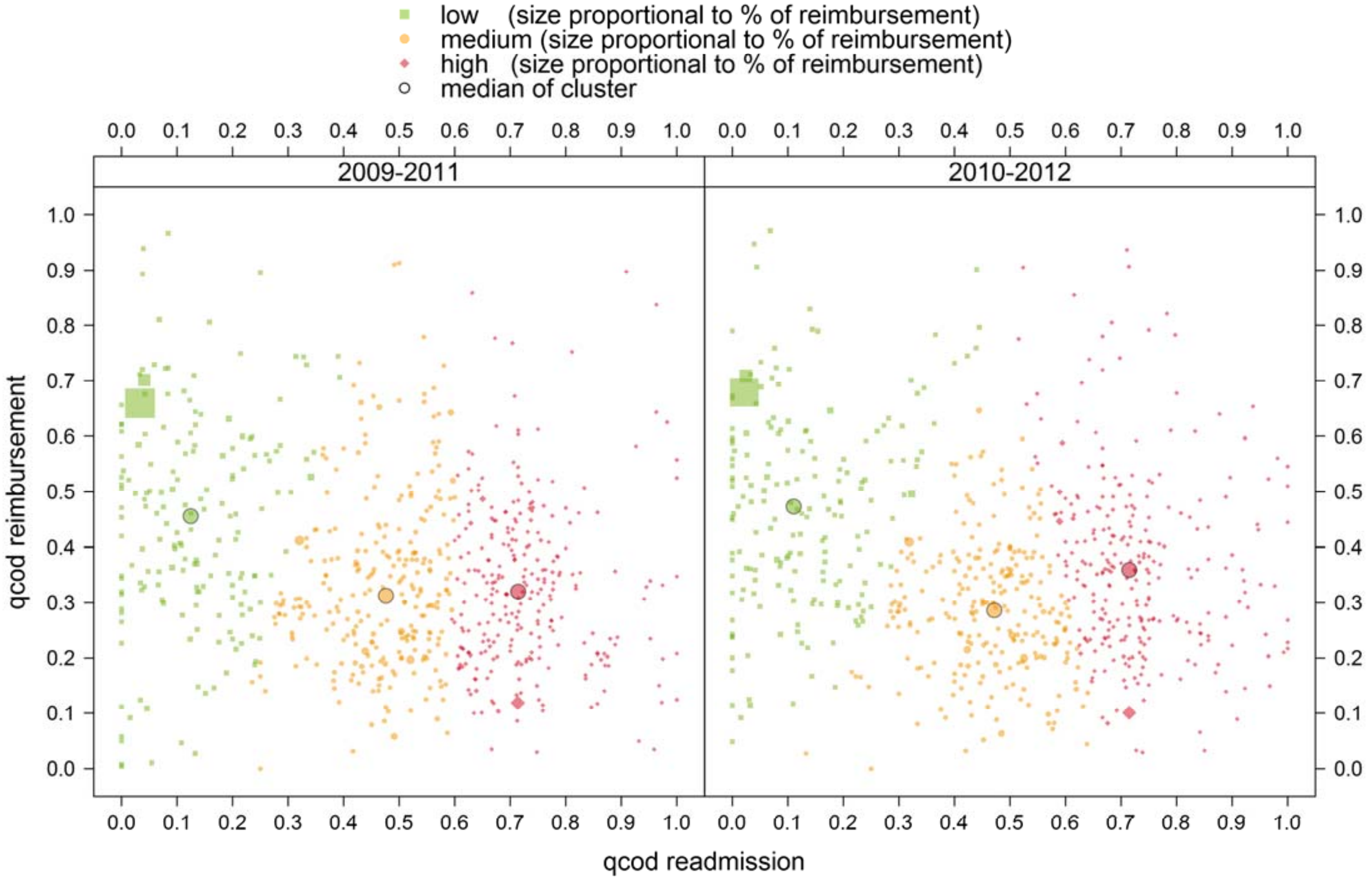
	2010-2012							
	low		medium		high		no stays	
2009-2011	N	% of row	N	% of row	N	% of row		
Inpatient								
low	**278**	**94.88%**	15	5.12%				
medium	35	7.04%	**432**	**86.92%**	30	6.04%		
high	4	0.90%	58	13.03%	**383**	**86.07%**		
Day care								
low	**158**	**91.33%**	10	5.78%	3	1.73%	2	1.16%
medium	21	7.92%	**200**	**75.47%**	44	16.60%		
high	2	0.75%	40	14.93%	**226**	**84.33%**		
no stays	2	100%						

Figure 6 – Variability per APR-DRG-SOI for inpatient stays



Symbol size is proportional to the percentage of total reimbursement an APR-DRG-SOI represents.

Figure 7 – Variability per APR-DRG-SOI for day-care stays



Symbol size is proportional to the percentage of total reimbursement an APR-DRG-SOI represents.

3.3.3. *Validation of the three clusters*

The clusters for the inpatient stays show better connectivity (how well data points belong to the same cluster as their immediate neighbours) when based on the stays in the 2009–2011 period than in the 2010–2012 period (Table 8). The opposite is true for the day-care stays. Both type of stays are very similar on the compactness and separation measures.

Table 8 – Cluster validation indices

Period	Connectivity	Dunn	Silhouette Width
Inpatient			
2009-2011	83.314	0.006	0.325
2010-2012	99.727	0.006	0.323
Day care			
2009-2011	78.281	0.009	0.330
2010-2012	73.381	0.008	0.347

The stripes plots in Figure 8 and Figure 9 strongly suggest that the clusters are not well separated. For example, in Figure 8 compare the green stripes (cluster low data points) with the orange stripes (cluster medium data points). If the clusters were well separated, all orange stripes should be higher than the green stripes as is the case in Figure 2.

Figure 8 – Stripes plot inpatient stays

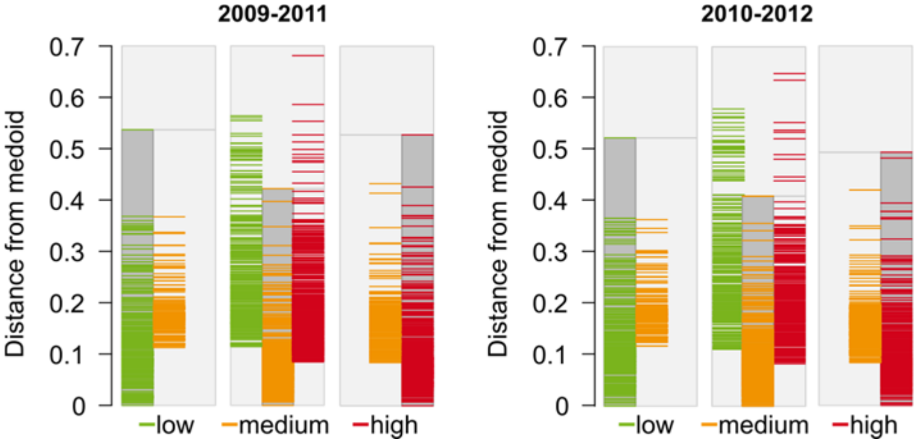
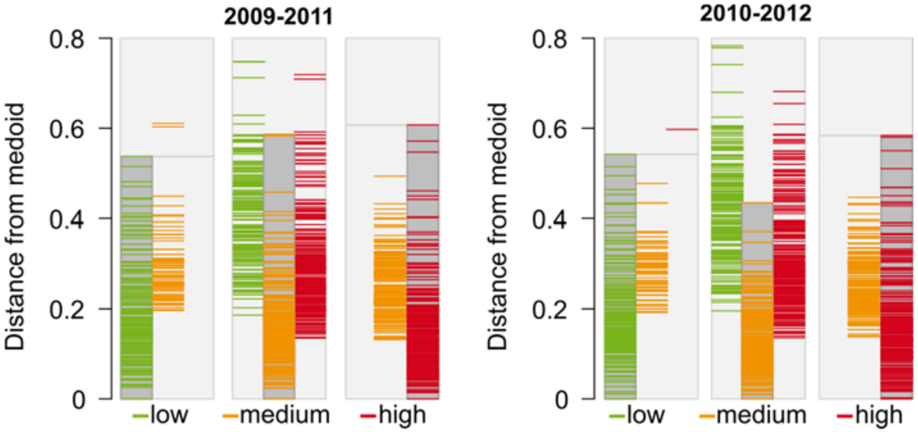


Figure 9 – Stripes plot day-care stays



As mentioned above, in some cases APR-DRG-SOIs appear to be closer to the centre of a different cluster than the one they were assigned to (cross-border cases, see section 3.2.5). This is the case in 5.6% in both periods of inpatient APR-DRG-SOIs and in 1.6% (2009-2011) and 3.7% (2010-2012) of day-care APR-DRG-SOIs (see appendix section 7).

3.4. Can the clusters be used as outlines for three different payment systems?

The short answer is 'not without additional considerations'. The cluster analysis shows that three clusters can be defined, but they are not well separated. In other words, if one had to draw the cluster borders on Figure 6 or Figure 7 manually, it would not be self-evident, as there are no 'natural gaps' between the clusters. The validation of the clusters (section 3.2.4) confirms this: a three cluster solution exists, is relatively compact and connected, but not well separated. This means the division into three clusters is imposed on the data rather than discovered in the data.

The intended purpose of delineating the clusters is to assign groups of hospital stays to a payment system. The above analysis shows that the clusters can be used as input for such an assignment, but they are not sufficient.

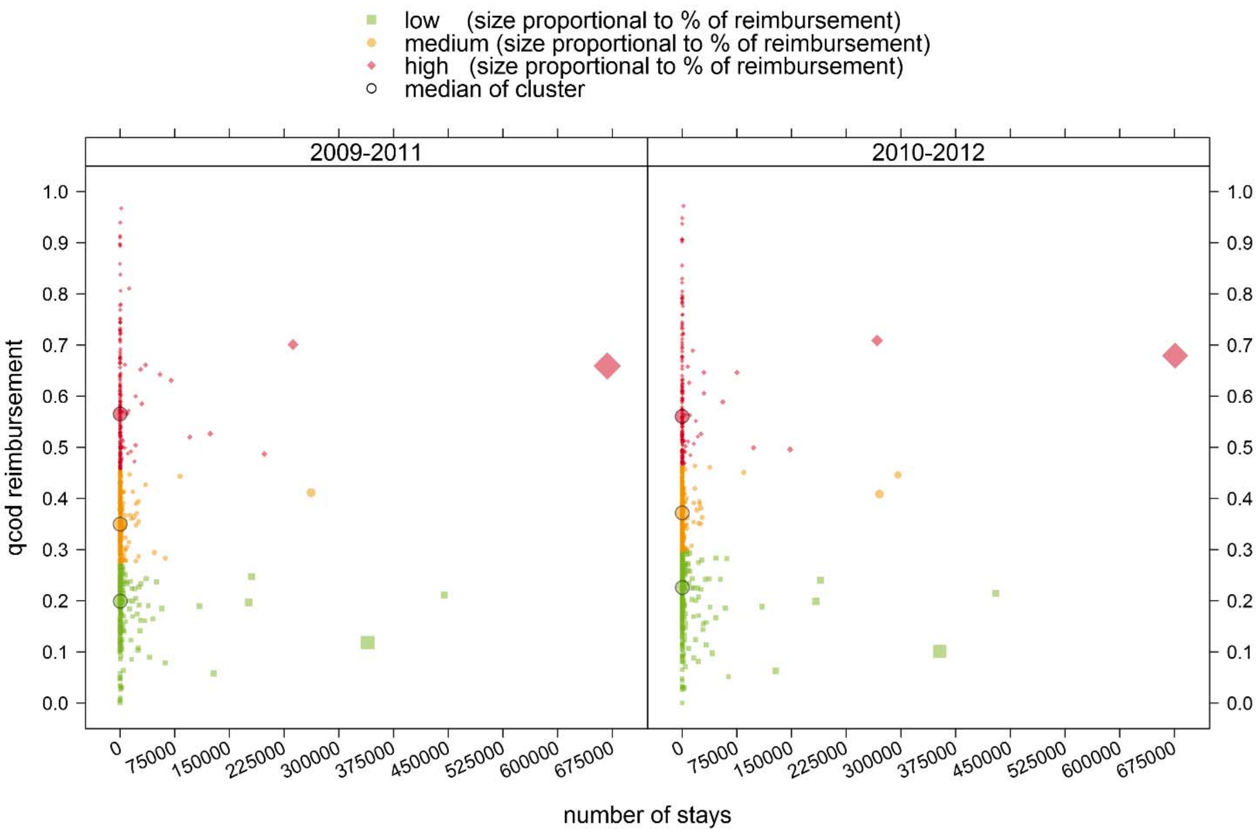
In other words, the observed differences in variability using the variables at hand represent rather a continuum, and further statistical analysis and clinical expertise are needed to assess whether a particular APR-DRG-SOI classified in one of the three clusters is eligible for use with the corresponding payment system of that cluster, as proposed in the Action Plan of the minister.

This is true in particular for the day-care stays as the cluster structure with data available in this analysis is strongly influenced by the variability in readmissions. The variability in reimbursement is larger in the low variability cluster than in the other clusters, although the overall variability based on all variables in the low variability cluster is lower than in the other clusters.

This begs the question if the clusters for day-care stays might not be better defined using only payment variables, similar to the inpatient clusters. For inpatient stays, the variables contributing most to defining the clusters (see section 3.2.3), reimbursement and length of stay as partial approximation of the BFM – BMF, are payment variables in nature. For day-care stays, this would mean using reimbursement as the only variable in defining the clusters. The detailed results of such an alternative analysis are available in appendix section 8. Figure 10 shows how APR-DRG-SOIs are then assigned to three clusters. The validation of the clusters has a similar pattern to the solution with variability in reimbursement and readmission: a three cluster solution exists, is relatively compact and connected, but not well separated.

As mentioned before, cluster analysis is a statistical technique to group, in our case, APR-DRG-SOIs in three clusters on the basis of selected variables. For day-care stays, variability in readmissions strongly influences the cluster structure. However, it should be kept in mind that the variable 'readmission' that was used in the cluster analysis is defined as follows: a readmission within the year within the same hospital. This definition does not make any difference between a planned (for example for chemotherapy) and an unplanned readmission. Hence, variability in readmissions might be due to a variety of reasons, some of which are related to the patient (e.g. age, comorbidities, or treatment characteristics, for example for chemotherapy) and others to the hospital (e.g. admission policy). It is, however, a policy decision whether and how payments should be adjusted for readmissions.

Figure 10 – Variability per APR-DRG-SOI for day-care stays (reimbursement only)



Symbol size is proportional to the percentage of total reimbursement an APR-DRG-SOI represents.

4. ASSESSING APR-DRGs FOR A LUMP SUM PAYMENT PER STAY

4.1. Scope

The Action Plan proposes a lump sum payment per stay for groups of hospital stays that are sufficiently similar in resource use and possibly also in other variables. The plan proposes a stepped approach to implementation, but the final aim is to have a single lump sum payment per stay. This section addresses the second topic of this report: how to identify APR-DRG-SOIs that are eligible for a lump sum payment per stay?

The APR-DRG-SOI as unit of analysis

The scope for this research question is strictly delimited by the following points. Firstly, we look at APR-DRG-SOIs as they are currently available in the MZG – RHM that are linked to reimbursement data. Similarity between hospital stays is thus operationalised as the (lack of) variability in resource use and other variables within the current classification system of APR-DRG-SOIs. Hence, in the present analysis, we do not look at the possibility to reduce variability by splitting APR-DRG-SOIs in more homogeneous groups.

Variability in current resource use

Secondly, we consider the variability as it exists in the data today. We make no judgement whether low or high variability is justified or not in terms of the care that was provided. We will return to these issues in the discussion (see section 5).

The idea put forward in the minister's plan of reform is to initially provide a lump sum for hospital stays with similar resource use at present. The underlying assumption is that there are patient groups with pathologies for which the required care and hence the resource use is predictable and varies little from one patient to another. This also implies that, in practice, there should not be much variation between hospitals for these stays.

Up until now, the variability has been looked at at the level of APR-DRG-SOIs. Returning to the results of section 3, we found that although APR-DRG-SOIs in the low variability cluster have the lowest variability in resource use compared to those in the medium and high variability clusters, there is of course a range of variability: reimbursement variability of qcod ranges from 0.06 to 0.71, and from 0 to 0.6 for length of stay variability (see Figure 6 and Figure 7).

To select APR-DRG-SOIs eligible for a lump sum payment per stay, APR-DRG-SOIs with the lowest overall variability in resource use are most appropriate. As argued above, standardised resource use across hospital stays implies that variation in resource use is limited within and between hospitals. If, in addition to a low overall APR-DRG-SOI variability, the variability is low between hospitals, resource use within the APR-DRG-SOI can be considered standardised.

The analysis in the next section will look at variability within APR-DRG-SOIs in the low variability cluster and, in addition, to how this variability differs between hospitals. The methods proposed in this analysis can help identify APR-DRG-SOIs that, in addition to relatively similar resource use across hospital stays, also have similar resource use between hospitals. It also provides a method to identify APR-DRG-SOIs that should be studied further before introducing a lump sum per stay for them.

4.2. Visualising variability of APR-DRG-SOIs in the low variability cluster

4.2.1. *Finding patterns of low within and between hospital variability*

To compare variability between hospital stays within a hospital with the variability of this variability between hospitals[f], we plotted per variable the relative variability measures listed in Table 3 per APR-DRG and per SOI (see the supplement to this report).

Figure 11 shows patterns of different within hospital variability and variability between hospitals. The vertical blue line provides the variability for the particular APR-DRG-SOI. Each blue dot is the relative variability within a particular hospital. For example in top left panel, the data point at the top is a hospital with about 7 500 stays and a quartile coefficient of dispersion (qcod) of 0.13, indicating a low variability between stays within the hospital. All data points in the top left panel are vertically ‘stacked’, indicating a low variability between hospitals: almost all hospitals have a qcod between 0.05 and 0.16. The top right panel shows a similar situation for between hospital variability, but shows a high variability within hospital stays: a qcod between 0.8 and 1.

To identify APR-DRG-SOIs that are eligible for a lump sum per stay, the pattern to look for is the pattern depicted in the top left panel of Figure 11: low within and between hospital variability. For inpatient stays, this means that this pattern needs to be found both for reimbursement and for length of stay. For day-care stays, this pattern needs to be found for reimbursement.

We do not define a hard threshold for low within and between variability. Any threshold would be arbitrarily: similar to the discussion on p-values[20], values just below or above the threshold do not differ markedly in variability but would lead to a different decision.

The supplement to this report contains the graphs presented in Figure 11 for all APR-DRGs.

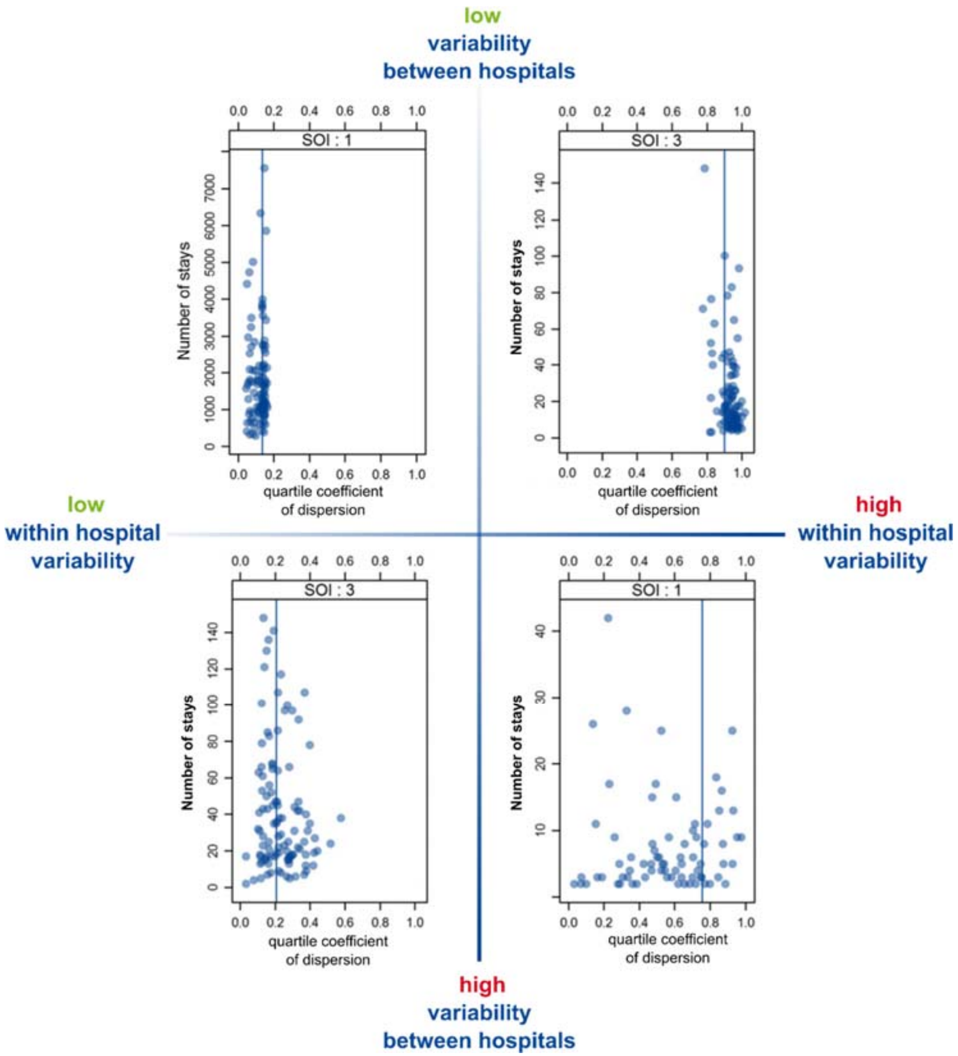
[f] For readability, we will use ‘variability between hospitals’ as an abbreviation of ‘variability between hospitals of the variability within hospitals’ for the remainder of the text.

4.2.2. *Visualising variability on the original scale of the variable*

Given low within and between relative variability, the next step is to consider the distribution per hospital on the original scale. The reason to look at this distribution is because the same relative variability between hospitals can correspond to two very different ranges on the original scale. For example, two hospitals can have a similar relative variability in reimbursement, but one hospital might charge on average twice as much for a stay as the other hospital.

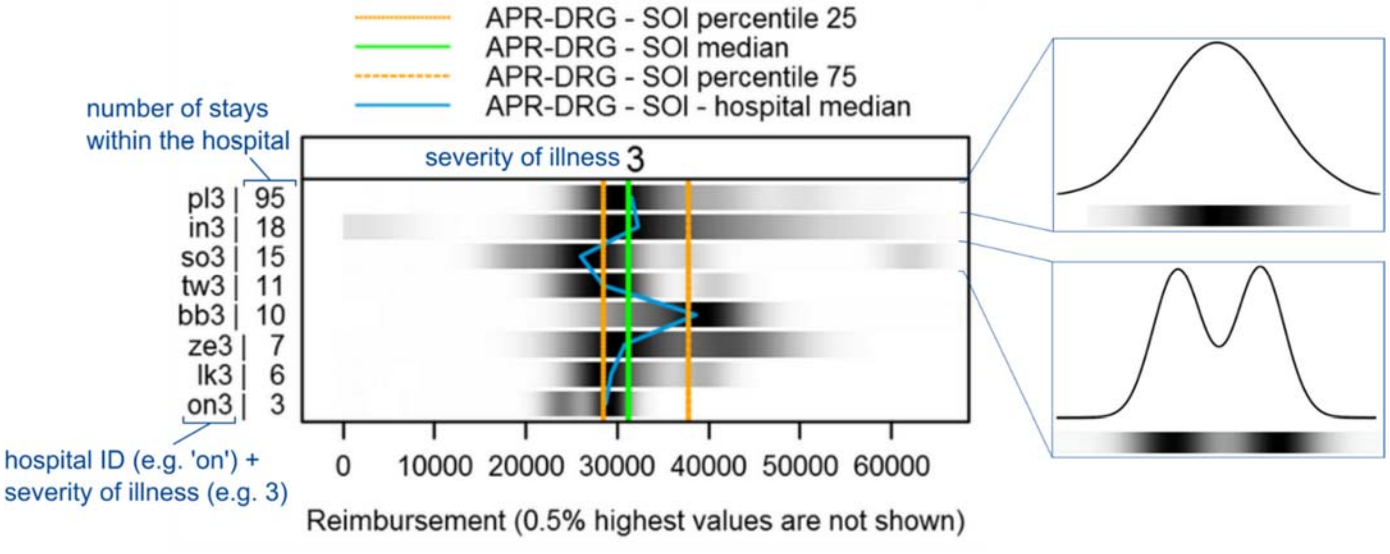
For each APR-DRG per SOI, we visualise the variability for each of the available variables (see section 3.1.4.4) per hospital for the data in the period 2010-2012, e.g. euro for reimbursement or days for length of stays. The distribution is shown by plotting the kernel density estimation. Figure 12 shows an annotated example for an imaginary APR-DRG-SOI of such a plot for a ratio level variable (reimbursement). The horizontal grey coloured bars show the distribution of the stays per hospital. As shown in the inset in the figure, this is a compressed visualisation of a kernel density estimation. The vertical coloured lines show summary statistics of the APR-DRG-SOI over all hospitals. The supplement to this report contains the results for all APR-DRGs.

Figure 11 – Patterns of relative variability



One point = variability in one hospital

Figure 12 – Example of plot showing variability on original ratio scale



4.3. An example: APR-DRG 301 – Hip joint replacement

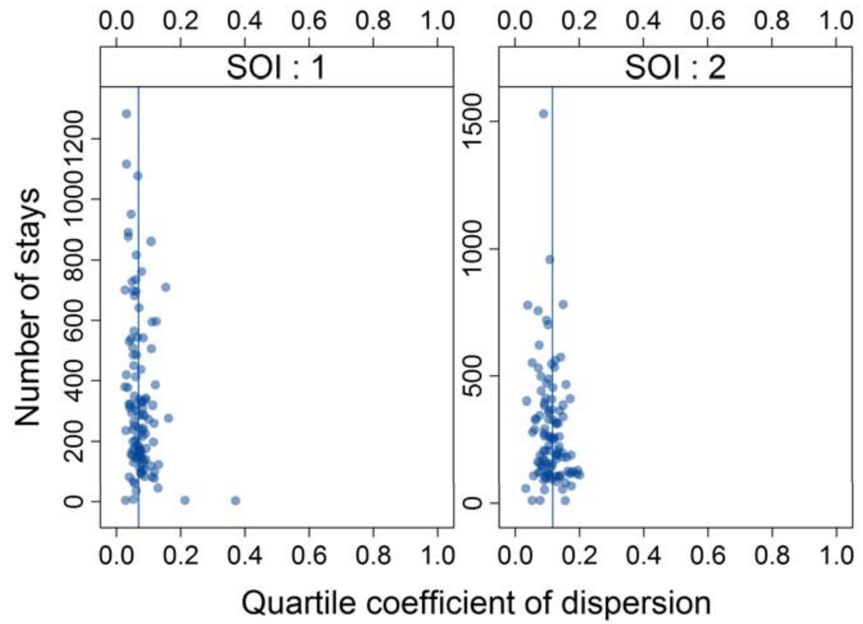
To illustrate the method described above, we provide the example of inpatient APR-DRG 301 – hip joint replacement. SOI 1 and 2 of this APR-DRG are in the low variability cluster for inpatient stays (see appendix section 6). The variability in reimbursement is one of the lowest within the low variability cluster (qcod ranges from 0.05 to 0.7; see qcod for APR-DRG 301 in Table 9). The variability in length of stay of SOI 1 is also amongst the lowest of the low variability cluster (qcod ranges from 0 to 0.6; see qcod for APR-DRG 301 in Table 9). The variability in SOI 2 is situated in the middle of the low variability cluster.

Table 9 – Summary statistics APR-DRG 301 for SOI 1 and 2 between 2010 and 2012

SOI	n	Q1	median	Q3	mean	sd	qcod
Reimbursement							
1	36 696	3 412	3 636	3 917	3 732	785	0.07
2	30 569	3 562	3 869	4 503	4 223	1 417	0.12
Length of stay							
1	36 696	6	8	10	10	10	0.25
2	30 569	7	9	17	15	15	0.42

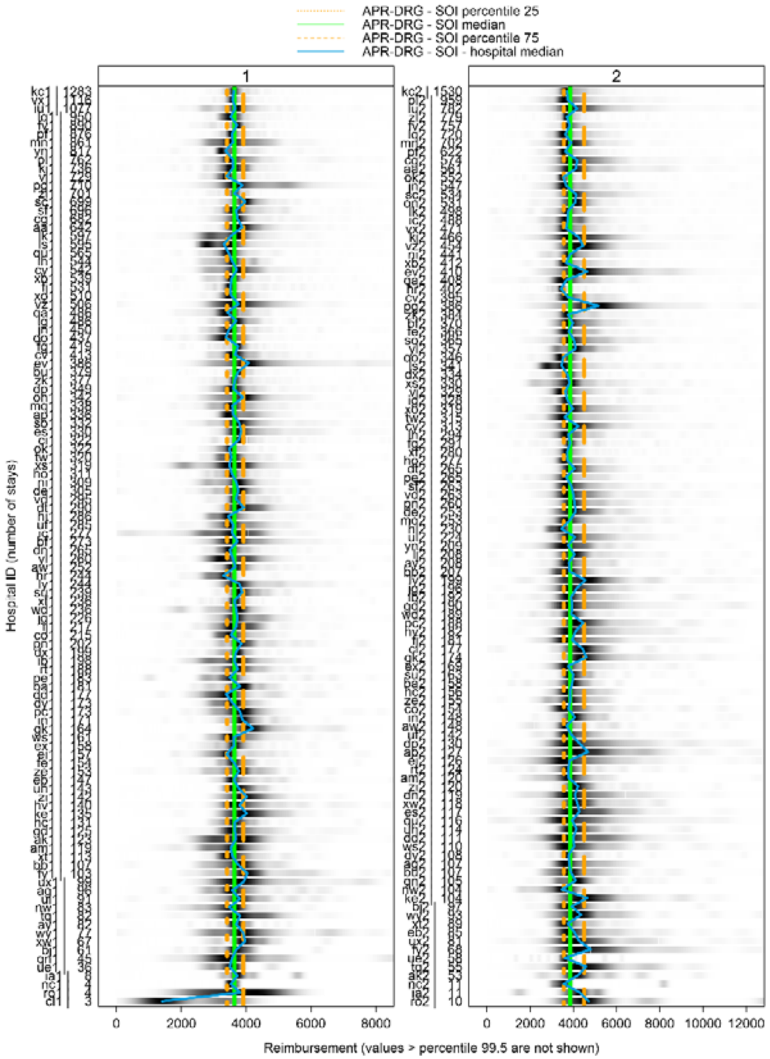
Based on the variability of the APR-DRG-SOI, both SOI 1 and SOI 2 are plausible candidates for a lump sum per admission. As explained above, we additionally looked at the variability within the APR-DRG-SOI between hospitals. Figure 13 shows the relative variability in reimbursement, expressed in terms of the qcod, for each hospital in the period 2010 – 2012. For SOI 1 and 2, there is low within hospital variability and low variability between hospitals and both correspond to the top left pattern shown in Figure 11: the reimbursement for hospital stays within a hospital is relatively similar with a range of 0.03 to 0.16 for SOI 1; 0.03 to 0.2 for SOI 2. In SOI 1, two hospitals have a higher variability, but this is due to the very low number of stays in these hospitals.

Figure 13 – Qcod per hospital for reimbursement in APR-DRG 301 for SOI 1 and 2 between 2010 and 2012



Given the low relative variability, the next step is to consider the distribution of reimbursement per hospital on the original scale in euro. The reason to look at this distribution is because the same relative variability between hospitals can correspond to two very different price ranges. The hospital median reimbursement (blue line in Figure 14) shows this is not the case: almost all hospitals' medians fall between the 25th and 75th percentile (IQR) of the overall APR-DRG-SOI. This IQR (€ 444 for SOI 1 and € 790 for SOI 2) is also relatively small compared to the median reimbursement (€ 3 471 for SOI 1 and € 3 650 for SOI 2).

Figure 14 – Reimbursement per hospital for APR-DRG 301 SOI 1 and 2 between 2010 and 2012



A similar analysis for length of stay, as an approximation for the BFM – BMF, is shown in Figure 15 and Figure 16. The variability in length of stay is larger than for reimbursement. In SOI 1, the within hospital variability is small, but the variability between hospitals is larger: the qcod ranges from 0.11 to 0.46. Three hospitals with relatively few stays have an even higher variability. For SOI 2, both between and within hospital variability is larger: qcod ranges from 0.11 to 0.69.

This analysis shows that the low variability in APR-DRG 301 for SOI 1 and SOI 2 for reimbursement makes them eligible for a lump sum per stay. However, the larger variability between hospitals in length of stay warrants further analysis on the reasons for this variability.

Similar graphs and statistics for each APR-DRG-SOI for inpatient and day-care stays are available in the supplement to this report. A list of APR-DRG-SOIs identified with a low within hospital variability and low variability between hospitals pattern for reimbursement and length of stay (for inpatient stays only) in the data available for this study, can be found in appendix section 9.

Figure 15 – Qcod per hospital for length of stay in APR-DRG 301 for SOI 1 and 2 between 2010 and 2012

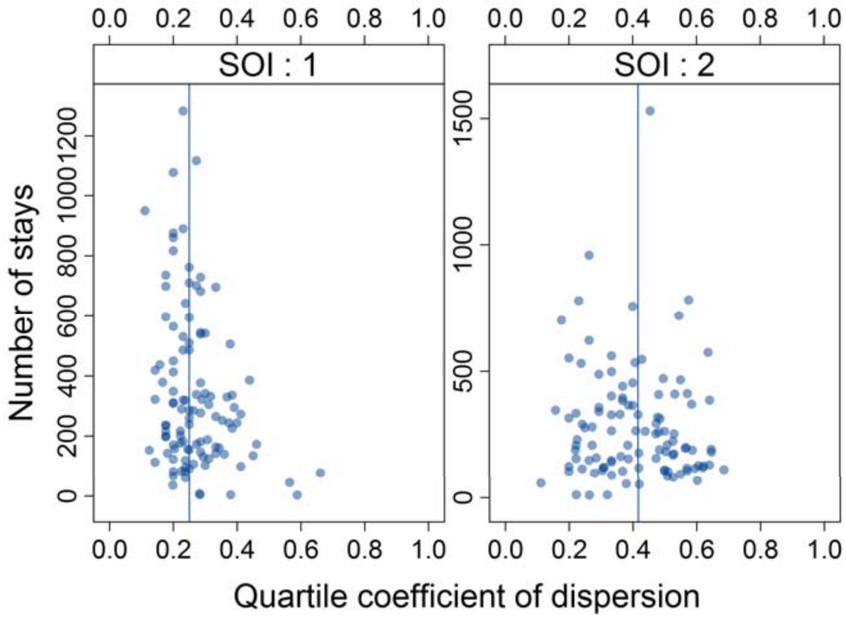
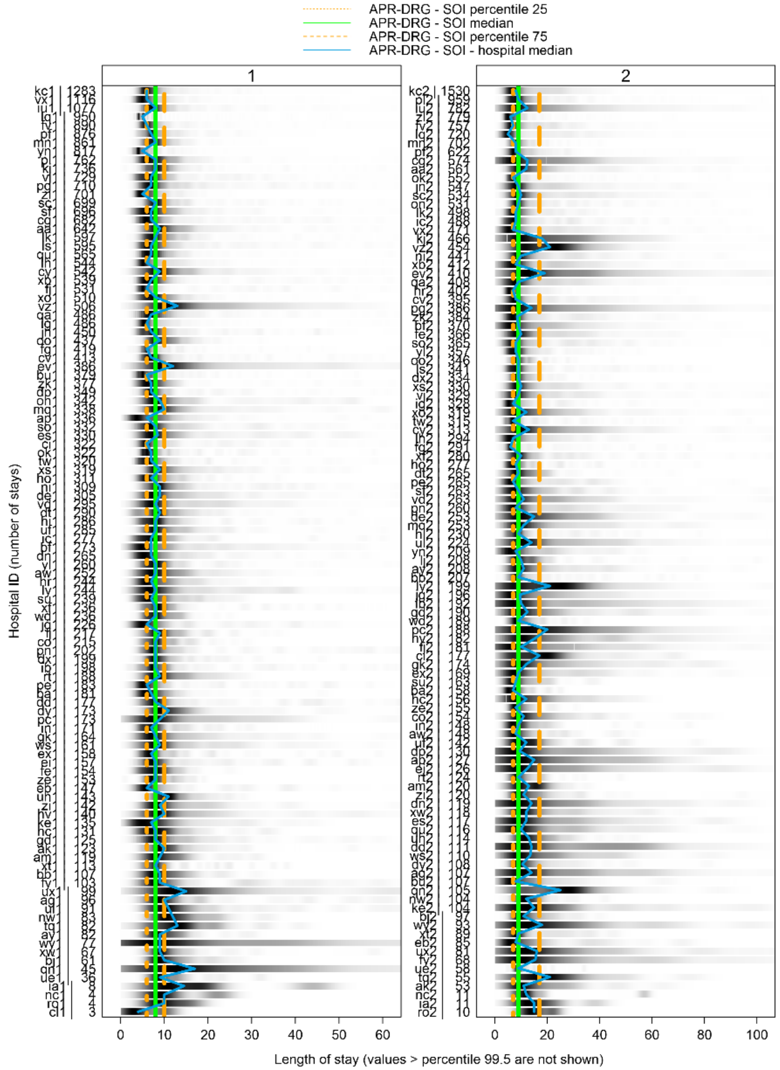


Figure 16 – Length of stay per hospital for APR-DRG 301 SOI 1 and 2 between 2010 and 2012



5. DISCUSSION AND CONCLUSION

The analyses in this report have tried to answer two questions. First, is it possible to assign hospital stays in pathology groups to three clusters, each of similar variability in a number of variables? Second, how to identify APR-DRG-SOIs that are eligible for a lump sum payment per stay?

5.1. Three clusters

5.1.1. Conclusion

The variability within APR-DRG-SOIs in the available variables allows to divide the data. However, these clusters are not well separated. In other words, there is no clear distinction or 'gap' in variability between the three clusters, and the clusters are more 'imposed upon' the data rather than 'found in' the data. As such, the clusters can serve as a first step but further analysis is needed in which the aims and particularities of the payment system to be used for the corresponding APR-DRG-SOI are taken into account.

5.1.2. Data improvements for future analysis

The analyses in this report could be improved if certain limitations of the data are overcome in the future. First, as discussed in the introduction, the available data concern prices paid for healthcare. Given that these prices are part of a complex negotiation process in Belgium, their link to the cost of healthcare is not direct. Ideally, the analysis should be redone when sufficiently comprehensive cost data become available to Belgian public authorities.

Second, the approximation of the BFM – BMF part by length of stay was necessary because, at present, there is no validated method to reverse engineer the BFM – BMF to an amount per individual hospital stay. Length of stay should be replaced in the cluster and variability analysis by the actual part of the BFM – BMF attributable to an individual hospital stay, in the absence of cost data. The choice of which parts of the BFM – BMF should be integrated into one single payment per stay is a policy decision, but the literature and international experience can offer some guidance.[1, 2, 5]

Third, we used APR-DRG-SOI as the unit of a pathology group. There are good reasons for that. They are internationally used in some form or other in countries that have case-mix payment systems.[1, 3] More importantly, they are used in Belgium to determine a substantial part of current hospital payments. As such, they are available in data accessible to Belgian public authorities and comprise all hospital stays in general hospitals. However, one major limitation for this report is that the currently available version 28 is based on ICD-9-CM[21] diagnoses and procedures classification. The data in the MZG – RHM from 2015 onwards, however, is based on version 31, using ICD-10-BE, a Belgian modification of ICD-10-CM[22] and ICD-10-PCS[23]. Once this change is stable, the current analysis should be performed on this version.

5.2. APR-DRG-SOIs eligible for a lump sum per stay

5.2.1. Conclusion

The method presented in section 4 can help identify APR-DRG-SOIs that have similar resource use overall, and in addition, have at present similar resource use between hospitals. These APR-DRG-SOIs are identified on the basis of empirically identified variability patterns.

5.2.2. Next steps toward a lump sum per stay

Further statistical and clinical analyses are needed

Cases within the same APR-DRG should be economically and clinically similar. The imported 3M grouper contains APR-DRGs for which both economical and clinical similarity were tested with foreign data, reflecting foreign practice. Hence, the applicability of a lump sum payment per APR-DRG should be evaluated with Belgian data, taking account of practice patterns and resource use in Belgian hospitals.

The current study provides a first but necessary step in defining hospital stays that are eligible for a lump sum payment per stay. The cluster and variability analysis allow to identify APR-DRGs that show a low variability in resource use, both within and between hospitals.

APR-DRGs that show the lowest variability within hospitals in the selected variables but have a larger variability between hospitals (see bottom left pattern of Figure 11), are the next candidates for further analysis. Statistical analysis as well as clinical expertise are needed to identify possible causes of between-hospital variability in resource use.

A methodology should be developed how clinical experts are to be involved in the selection process of APR-DRGs eligible for a lump sum payment per hospital stay. For example, a preliminary analysis by two physicians of the FPS Health and of the RIZIV – INAMI has been performed for APR-DRG 301 SOI 1 and 2. Based on an analysis of the ICD-9-CM diagnosis and procedures, and on the RIZIV – INAMI nomenclature codes, they identified the following tentative clinical subgroups: total versus partial hip replacement, hip replacement related to fractures versus related to other causes, hip replacement with or without complications. Statistical analysis of the variability in resource use within these subgroups, such as the analyses proposed in this report, should reveal whether they qualify for a lump sum payment. The homogeneity analysis performed in KCE Report 121 also provides inspiration for further analysis.[3]

Ideally, the identification of (subgroups of) APR-DRGs eligible for a lump sum payment builds on the following data elements:

- diagnosis, both primary and secondary (including comorbidity information);
- procedural codes in ICD-9-CM (ICD-10-BE in the near future);
- detailed RIZIV – INAMI nomenclature.

A second source of information are clinical practice guidelines. The decision trees often used in these guidelines could point to clinical or treatment subgroups. To validate subgroups identified from the previous two sources, clinical experts in the field are a third source. Such procedure should be applied in a systematic way for each APR-DRG.

Gradual introduction

The Action Plan proposes a gradual introduction of a lump sum payment per stay with 'gradual' referring to the number of APR-DRGs as well as to the 'scope of resource use': (selection of) fees, non-surgical day-care lump sums, pharmaceuticals, etc. To integrate the BFM – BMF still a lot of work has to be done, be it in terms of collection of cost data or reverse engineering from hospital budget (and which parts?) to an amount per stay.

In this report variability in resource use was operationalised as variability in reimbursements or length of stay. Ideally, the resource use items for which a lump sum per stay is determined should be the same as the items for which the variability was analysed.

Hence, for the moment no lump sum payment per stay can be determined for the BFM – BMF part. When cost data or the results of a reverse engineering exercise become available, the analyses should be redone on the elements to be included in the lump sum. Since length of stay is only a proxy for resource use, it could be the case that APR-DRGs that are now grouped in the low variability cluster, will end up in one of the other clusters or vice versa. It could also be the case that an APR-DRG which is classified in the low variability cluster with a very low variability on the basis of reimbursements and length of stay, remains in the low variability cluster in the new analysis but with a relatively large variability between hospitals. Hence, it is perfectly possible that a decision on the basis of the current analysis to apply a lump sum payment per stay (without the BFM – BMF part) should be changed afterwards if the BFM – BMF part is included.

The 62 APR-DRG-SOIs (only SOI1 and 2 of 31 APR-DRGs) in the system of reference amounts represent frequent and less severe pathologies and were chosen to standardise medical practice. In the cluster and variability analysis for inpatient stays, 37 of the 62 APR-DRG-SOIs (59.7%) are in the low variability cluster. For day-care stays, 36 of the 60 APR-DRGs (58.1%) with a sufficient number of stays fall in the low variability cluster (see appendix section 10 for details).

Low variability but complex care

The list of APR-DRG-SOIs in each cluster can be found in appendix section 6. Some of the APR-DRG-SOIs in the low variability cluster involve complex care. An example is APR-DRG 001 SOI 2 and 3 referring to a liver transplant. Other APR-DRG-SOIs in the low variability cluster involve frequent and less severe pathologies, such as some of the APR-DRGs in the reference amounts. Hence, the low variability cluster is a mix of standard and complex care, but their common characteristic is that the care process entails a comparable resource use within and (in many cases also) across hospitals.

Coding incentives

In the Action Plan the choice has been made to apply three different payment mechanisms depending on the variability in resource use, with more financial risk for the hospital for stays in the low variability cluster. This means that there might be an incentive to code a hospital stay in the medium and high variability cluster because for these stays the financial risk is shared between the payer and the hospital or is mainly for the payer. Up-coding is a risk in all DRG-type payment systems, but the more so in the 'three-layer' payment system proposed in the Action Plan, because the financial risk in the three layers is different.

Hence, for APR-DRG-SOIs found eligible for a lump sum payment, clinical experts will have to assess whether the hospital stay can easily be up-coded to fall in the medium or high variability cluster.

Whether the same tariff should be applied for different SOI-levels (for example for SOI 1 and 2) or for inpatient and day-care stays or not, should be assessed in the same way. For example, it might be advisable to consider the same lump sum amount for both SOI 1 and 2, if SOI 2 is only different from SOI 1 because of one specific additional diagnosis.

There is a risk that up-coding incentives will increase under a system of payments per APR-DRG. Since this is difficult and labour intensive to audit, it will be important to monitor practice variations followed by targeted audits in hospitals that jump out compared with benchmarks.

Calculation of lump sum amounts

For the calculation of the actual amount of lump sum payments, a number of policy choices have to be made first.

A first choice concerns the available budget. In case it is decided that the payment reform for the selected groups has to be introduced in a budget neutral way (assuming the number of stays remains constant), this has some implications for the calculation of the lump sum amounts. Taking the mean over all stays, for example, will keep the budget the same, given the same number of stays. Other possible measures are the median or trimmed mean which require post-hoc corrections to enforce budget neutrality.[3]

Instead of defining lump sum amounts on average reimbursements or costs, one could also price the lump sums in such a way that they incentivise and adequately reimburse care that is high quality and cost effective. In the English DRG system, Best Practice Tariffs (BPT) have been introduced for that reason. BPTs have different aims, designed to either:

- change the setting of care, for example from inpatient to day care, or from day care to outpatient procedure;
- streamline the pathway of care, or
- increase the provision of high-quality care based on the best evidence available.[1]

Closely related is the decision of how to deal with outliers: should some stays be considered as outlier stays or not? Although this may appear a statistical problem, it is also a policy choice of who bares the risk of exceptionally high expenditures or gains from exceptionally low expenditures if they are included. And how should outliers be paid for when excluded? Of course, it concerns low variability APR-DRG-SOIs where, by definition, outliers should be exceptional. Although they are rare, they do exist, as is evidenced e.g. in Figure 14 and in the graphs in the supplement to this report.

5.2.3. Implementation issues

How to identify the APR-DRG-SOI of the patient?

At present, the APR-DRG-SOI of a hospital stay is available between six to twelve months after discharge at the FPS for Health, Food Chain Safety and Environment. For a lump sum per APR-DRG-SOI, some system should be put in place to allow the hospital to calculate or receive the APR-DRG-SOI and to invoice the stay within a similar period as the other RIZIV – INAMI nomenclature. An alternative way could e.g. to identify the APR-DRGs on the basis of RIZIV – INAMI nomenclature codes.

Keep a (small) fee-for-service payment to calculate future lump sum amounts?

To keep track of actual use, it could be envisaged to keep a (small) fee-for-service payment. This will allow adjustment of the lump sum amounts in case the activity profiles change. This mixed payment system is currently applied to e.g. pharmaceuticals. Keeping track of what happens has some additional advantages, among others:

- the possibility to define quality indicators or Best Practice Tariffs;
- the current system of co-payments and supplements can be maintained;
- it allows monitoring of DRG-coding.

Of course, major drawbacks of keeping a (small) fee-for-service payment are the registration costs for hospitals and the double invoice system (fee-for-service and lump sums).

5.3. General conclusion

The Action Plan of the minister clearly states that three different clusters of hospital stays will be defined, based on variability between these stays. It also states that part of hospital activity will be reimbursed by a prospectively determined amount per case belonging to a certain APR-DRG. Only stays requiring a standard process of care which varies little between patients qualify for this type of reimbursement. The current methodological report provides a first but necessary step in the grouping and selection of these stays.

Which results of this report are immediately applicable and for which aspects are more statistical and clinical analyses needed? The above analyses have shown that three clusters are imposed on the data rather than found in the data. The analyses also show that it is possible to identify APR-DRG-SOIs that show a low variability in resource use, both within hospital variability and variability between hospitals. Given current available data (e.g. no cost data; no hospital budget per stay) resource use can be defined in terms of fees for medical activities included in the system of reference amounts as proposed in the Action Plan. However, already now an extension is possible to include all activities that are reimbursed by RIZIV – INAMI nomenclature. Whatever decision is taken, it should be kept in mind that ideally the resource use items for which a lump sum per stay is determined should be the same as the items for which the variability has been analysed.

The gradual introduction as proposed in the Action Plan also relates to the selection of APR-DRGs. The plan proposes to start with only those APR-DRGs that are currently included in the system of reference amounts. However, not all stays that show a low variability in resource use, are included in the system of reference amounts and not all APR-DRGs in the system of reference amounts have a low variability in resource use when taking into account all activities. Most important is that the final selection of APR-DRGs to start with avoids possible up-coding incentives as much as possible.

Of course, limiting the lump sum payment system only to APR-DRGs for which variability in resource use is already very low will not induce significant efficiency gains. It will, however, increase the transparency of the payment system compared with the current BFM – BMF. If the lump sum payments also have the intention to increase efficiency, also APR-DRGs with a low variability within hospitals but with a larger variability between hospitals should be included in the system. For these APR-DRGs, a methodology should be developed involving statistical and clinical experts.

The availability of patient-level cost data is essential to improve the reliability of the analyses and to assure fair reimbursement on the basis of lump sum payments.

RECOMMENDATIONS[g]

To the Minister of Social Affairs and Public Health

The proposed cluster analysis is only a first approximation; before it can be translated into an operational payment mechanism of hospital stays, some additional steps are needed:

- **The cluster analysis should be performed again on the basis of cost data per stay. The steps to accomplish this are:**
  - **Development of a cost accounting model for the collection of cost data per stay in a sufficiently large and representative sample of hospitals;**
  - **Development of a reverse engineering method to assign the different elements of the BFM to an individual stay, in the absence of a cost accounting model.**
- **For the selection of stays that are eligible for a fixed amount per admission at least the following steps should be taken:**
  - **Determe the RIZIV – INAMI reimbursements for which an amount per admission will be introduced. The variability analysis should be applied to the eventually included RIZIV – INAMI reimbursements.**
  - **Determe which APR-DRG-SOIs are eligible for an amount per admission. For APR-DRG-SOIs with the lowest variability in RIZIV – INAMI reimbursements within and between hospitals, the variability analysis is sufficient. For APR-DRG-SOIs with low variability in RIZIV – INAMI reimbursements within hospitals but with a higher variability between hospitals, further statistical analysis and clinical input are required. For this a method need sto be developed.**
  - **Determine if the same amount is appropriate for SOI 1 and 2.**
  - **Determine if the same amount is appropriate for inpatient and day-care stays.**

To the RIZIV – INAMI and the FPS Public Health, Safety of the Food Chain, and Environment

- **To minimize the risk of upcoding, ongoing auditing and monitoring of coding, both statistically and in the field, is advisable.**
- **To determine the APR-DRG-SOI of a stay within a reasonable time, a procedure should be made available to the hospitals.**

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[g] The KCE has sole responsibility for the recommendations.

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COLOPHON

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Other reported interests:	All consulted experts and stakeholders were selected because of their involvement in the topic of this report. Therefore, by definition, each of them might have a certain degree of conflict of interest to the main topic of this report.
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