# Measuring what matters: using claims data to evaluate healthcare outcomes and volume-outcome relationships

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**CHAPTER 7**

# Summary and General discussion

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## I. Use of claims data for research

### Context and background

With increasingly constrained healthcare budgets and limited personnel, efforts to improve quality, reduce costs and decrease the use of healthcare personnel are vital. This requires transparency of quality of care, especially for the most common procedures and conditions with high burdens of disease, high costs and high personnel demand. In the past decade, there is a trend to use National Quality Registries (NQRs) to monitor and benchmark patient outcomes thereby contributing to an improvement of quality of healthcare. In the Netherlands currently around 60 NQRs exist. For some 'common' diseases, such as prostate cancer or lumbar disk herniation, there is still no NQR. Several challenges for the development and use of NQRs exist. A major hurdle is 'double registration', where healthcare professionals register similar or identical data in electronic health records (EHRs) and in several registries, due to shortcomings in design and limited interoperability of individual digital systems. Therefore, it is not unexpected that many healthcare professionals say that this takes too much administrative time, takes away patient time and should be solved as soon as possible.[1] Other important challenges are issues around data transparency and security, as well as how to address underperforming institutions to aim for better results.[2]

In oncology, for example, the urgency is obvious. The forecast of the Netherlands Comprehensive Cancer Organization (Integraal Kankercentrum Nederland [IKNL]) states that the number of newly diagnosed cancer patients will increase from 118,000 in 2019 to 156,000 in 2032.[3] However, these additional patients will have to be treated with the same healthcare budget and with the same number of healthcare professionals.

Several national programs were started to overcome these challenges and to support the achievement of the goals of the Dutch Healthcare system in the near future. Every four years, a new national healthcare agreement is developed. In 2022 the Integral Healthcare Agreement (Integraal Zorgakkoord [IZA]) was agreed upon by all relevant stakeholders.

The Integral Healthcare Agreement (IZA) encompasses several subjects which are related to this thesis:

- **Appropriate care** is value- and evidence-based and involves shared-decision making between healthcare professionals and patients
  - Increased focus on outcome information which is relevant for patients and enables patients to choose their treatment and their healthcare institution
  - Outcomes will be transparent for 50% of the disease burden in 2025 (N.B. This goal was originally set in 2018 for 2023, but could not be achieved yet)

- Increase efforts to gain knowledge on the effectiveness of care (healthcare evaluation) and to de-implement care which is of low value

- **Centralization of care:** for complex oncological procedures, volume thresholds around 50-100 will become the standard

- **Electronic exchange of data** will become the standard, preferably via the Collect Once Use Many Times (COUMT) principle
  - Data needs to be available within 24 hours of registration for all healthcare professionals, regardless of the place where the patient is treated

Healthcare lags far behind other sectors in fully harnessing the potential of data and digital technology, missing the opportunity to increase quality of healthcare services, cost savings and efficient allocation of personnel. Given the increasing pressure on health systems and budgets, a digital transformation is urgently needed and a long overdue necessity.[4] For a long time, the guiding principle in medical informatics has been to use data only for the specific purpose for which it was collected.[5] Nowadays, challenges faced by the healthcare sector are immense, making it imperative to make optimal use of existing data for broader insights and improvements.[6]

### Clinical data versus trial data and pros and cons of claims data

Clinical data, sometimes referred to as real-world data, are data relating to patient health and/or the delivery of healthcare from routinely collected sources. Trial data are data which are specifically collected as part of a clinical study, such as a randomized clinical trial (RCT), aimed to address a specific question for a specific group of patients. Both clinical and trial data are important in addressing relevant questions across healthcare.[7] Clinical data can be used to generate insights in healthcare delivered outside the context of trials which are often conducted only in selected populations. Analysis of clinical data is thus extremely important, because <5% of the patients with for example cancer are enrolled in clinical trials, and these are not typically representative of the general population.[8] At the same time, clinical data often lack statistical robustness and are sensitive to biases. For example, (long-term) outcome data are not standardly collected in healthcare records and patients are selectively lost to follow-up (especially those who are not treated). In addition, as many clinical differences are inherently small, the only way to properly establish a causal relationship between treatment and outcome requires randomization of patients in order to avoid biases. In all, the combination between clinical data and trial data is necessary to gain sufficient insights in the quality of care.

Besides retrieving clinical data from medical records, which in itself is a challenge given the previously mentioned lack of interoperability between different systems, claims data are also an interesting source of relevant data.[9] These data are recorded for reimbursement purposes but also include information about for example diagnoses, interventions, pharmacy and medical aids. Claims data can thus include valuable information on healthcare delivery that enables research on differences in care delivery amongst providers, like hospitals' patient mix, procedural volumes, treatment patterns and outcomes of patients. Also, longitudinal research is possible with claims data. However, the main limitation of claims data is that they often lack important clinical, laboratory or patient information for specific research purposes.

Claims data are on the other hand a cost-efficient, often timely source of information that has the potential for answering research questions spanning the entire care continuum, in addition to complementing results from clinical trials. However, their use requires rigorous training of researchers, thoughtful study planning and implementation, and careful consideration of potential biases and interpretation of results. Only in this way claims data will be beneficial and generate evidence on how to improve the quality of care.

### Claims data are a gold mine: gold standard international example

In recent decades, claims data have become available as a source of so-called big data. These claims data often contain data on healthcare use over large populations. They are an excellent source of information for a plethora of use cases in healthcare. It has been suggested that claims databases may have considerable advantages compared to clinical and trial data in observing trends over longer periods of time, multiple institutions and calculating disease prevalence over large populations.[10] [11] In 1996, the Dartmouth Atlas of Healthcare pioneered the dissemination of policy-relevant population-based measurement and claims-based analysis that revealed both weaknesses and opportunities in the United States healthcare system by focusing on regional and hospital variation in utilization, quality and costs.[12] In two decades following the publication of the initial Dartmouth Atlas of Healthcare, the Dartmouth Institute has produced almost 50 additional reports.[13] One of their main observations was that *"Much of the variation in healthcare across areas is unwarranted."* Meaning, much of the observed variation was not based on patient need or informed demand, or on evidence regarding effectiveness.[14] Another main observation was that *"More healthcare might not be better."* The question 'is more care better?' was studied by investigating outcomes – primarily mortality –in regions with high capacity and high costs. Wennberg e.a. demonstrated that more healthcare is not necessarily better, and, in some instances, it was even worse.[15] [16] Medical overuse is still a major concern. The idea that more care leads to better outcomes is deeply engrained in the system.[17] The efforts trying to reduce medical overuse are frustrated by the prevailing lack of evidence for many everyday medical decisions.[18] Despite the availability of rich data, most Western countries have no routine surveillance of the geographic distribution of utilization, costs, and outcomes of healthcare, including trends in variation over time.[19]

### Claims data in the Netherlands

In 2008, the Dutch Council for Health Research (In Dutch: Raad voor Gezondheidsonderzoek [RGO]) made a recommendation to improve access to existing healthcare data for scientific purposes.[20] However, despite this advice, a report by the OECD in 2015 revealed that the Netherlands is still lagging behind in effectively (re-)utilizing routinely collected healthcare data for research purposes.[21] Subsequent studies, conducted three years later, confirmed that many of the required data are indeed registered, but regrettably often not used to their full potential for research purposes.[22] Numerous organizations including Vektis, Dutch Hospital Data, Nivel, the Dutch Institute for Clinical Auditing (DICA), Perined, PALGA among others, play a crucial role in preparing vast amounts of healthcare data for scientific research.[6] Vektis, responsible for health insurers' business intelligence, collects claims data from all health insurers and analyses data on costs and healthcare related topics, such as waiting times. Since 2020 limited sets of aggregated claims data with information about costs, are available through open data source.[23]

In the Netherlands a limited number of research papers using claims data has been published. Around 2010, way before the initiation of the research included in this thesis, several studies on practice variation were executed based on claims data.[24]

### Encountered barriers in working with claims data

Although the use of claims data has been proven to be of additional value for evaluating important aspects in healthcare, we identified several barriers in working with claims data in the Netherlands while conducting the research presented in this thesis.

*Governance barriers*

Health insurers process claims data of all Dutch citizens. These claims data are then stored in the data warehouse of Vektis. Health insurers can collaborate and ask Vektis to execute specific research using claims data, but only when permission of the boards of all health insurers is granted. Other parties have access to claims data of Vektis when permission of the boards of all health insurers is given and if this is paid for.[25] In recent years, only requests for research based on claims data with the purpose of scientific research for a few national programs (e.g. "Zinnige Zorg", SKMS Program, ZE&GG), have been accepted by health insurers.

*Legal barriers*

Due to the General Data Protection Regulation (GDPR, in Dutch: AVG) the access to patient data has been subject to strict regulations. The GDPR takes the position that the 'processing of data should be designed to serve mankind' (Recital 4). Whilst it does not spell out what exactly is meant by this, it indicates that a proportionate approach will be taken to the protection of personal data on the one hand, and use of the same data for the common good such as improving healthcare on the other hand. Thus, the protection of personal data is not absolute, but considered in relation to its function in society and balance with other fundamental rights in accordance with the principle of proportionality.[26]

A recent study highlighted significant variations in the interpretation of the GDPR among EU member states.[27] In some countries the concept of data solidarity prevails over individual data protection rights, whilst other countries place greater emphasis on safeguarding individual rights. The concept of data solidarity is comparable to other forms of solidarity within the health system: citizens pay insurance premium also when they are in good health; in a similar way, data solidarity is based on the idea that citizens allow that their health data is used for research even if the benefit is for other or future citizens.[28] Regrettably, the Netherlands has adopted an exceptionally strict interpretation of the GDPR, leading to obstacles in accessing patient data for scientific research.[29]

Legal restrictions also hamper the joining of patient data from different data sources for research purposes. However, recently new solutions have become available, such as a so-called secure Multiparty Computation (MPC) protocol. MPC is a collection of cryptographic techniques that allow several parties, each of which holds some private input, to evaluate a function on those inputs without disclosing any extra information on the input themselves, and without resorting to a trusted external party.[30] Thus, with MPC there is no violation of GDPR. MPC is a solution that is focused on specific research questions and might be an expensive tool for broader use.

In our last research **[Chapter 3]** on prostate cancer we encountered hindrance from this legal barrier. In accordance with the GDPR, original data were kept at Zilveren Kruis and we worked with their data analysts in order not to transfer data outside the company.

Due to the legal and governance barriers, it took 18 months to get access to the data for the research of urinary incontinence after radical prostatectomy **[Chapter 3].** A request for access to national data from Vektis was not granted. One insurance company, allowed our research team to work with their data. Collecting the data for this study only took them one day.

*Technical challenges*

We also encountered technical challenges in working with claims data. When attempting to determine whether patients were incontinent after radical prostatectomy using claims data, we found out that differences in reimbursement policy amongst health insurance labels led to a misinterpretation of the results **[Chapter 3]**. To avoid this bias, we excluded patients from the specific health insurance label with restrictions in reimbursement of incontinence pads.

## OUTCOMES: MEASURING OUTCOMES

| Goal | Category | Means | Challenges | Research questions |
|---|---|---|---|---|
| Improved healthcare outcomes and reduced costs | Structure | *Adequate* hospital volume thresholds | What is volume threshold per disease? | • Can secondary data be used to find a volume-outcome relationship for prostate cancer?<br>• What is the volume-outcome relation?<br>• Is a volume threshold enough to get better outcomes? |
| | | Signaling public health trends | Signaling 'harmful' practices quickly and cost-effective | • Can we use secondary data for current Dutch situation regarding opioid use and prescription?<br>• What are the trends in opioid use and prescription? |
| | Process | Optimizing inefficient processes | Administrative burden national quality registries | • Can Electronic Health Record data be used to reduce administrative burden for national quality registries through existing Clinical Information Models?<br>• What is the potential coverage of existing Clinical Information Models on national quality registries? |
| | Outcomes | Measuring outcomes per disease | Some major diseases still no national quality registry | • Can secondary data be used to measure outcomes for prostate cancer and lumbar disk herniation?<br>• What are the outcomes? |

## II. Healthcare outcomes based on claims data

### Why is measuring and transparency of outcomes of care relevant?

For prostate cancer and for lumbar disk herniation, no national quality registry (NQR) was available at the time of our research. So, there was no or very limited benchmarked feedback on their outcomes to surgeons and no transparency of outcomes to patients before initiation of the work in this thesis. In the Netherlands, patients have the legal right to be informed on request about clinical outcomes after interventions and about the differences in outcomes amongst providers in order to make an informed decision about a specific treatment and/or a specific healthcare provider.[31] Moreover, the absence of NQRs also hampers the ability of policy makers to make evidence-based decisions regarding large-scale transformations in healthcare delivery, which is a key objective of the 2022 Integral Healthcare Agreement (IZA).

Patients have the right to be informed about the quality and scientific robustness of care and withholding information on quality of care, is a violation of Dutch law and may lead to prosecution.[31] As long as designated institutions do not take their role and responsibility in making quality of care transparent, patients are not able to adequately and sufficiently inform themselves.

This thesis aims to contribute to the transparency of outcomes of care and support patients in their quest for relevant information. Studies on outcomes for lumbar disk herniation and prostate cancer were performed to evaluate the rate of unwanted outcomes and the variation in outcomes between hospitals.

### Can claims data be used to measure outcomes?

Most studies on incontinence after radical prostatectomy are based on patient questionnaires.[32 33] Claims data have been used successfully to determine prostate cancer treatment trends over time[34], to identify treatments received,[35] and to create prediction models for long-term survival.[36] In our work, we demonstrated that claims data can also be used to evaluate an important outcome measure namely urinary incontinence (UI) **[Chapter 1, 2]**. A recent study compared patient reported outcome measures (PROMs) for UI with UI outcomes based on claims data and concluded that UI outcomes based on PROMs and claims data are comparable and claims data slightly underestimate actual UI rates.[37] Our finding that a limited number of Dutch health insurance labels have other reimbursement policies resulting in very low UI based on claims data, might have caused a slight underestimation of UI rates in previous studies based on claims data.

We found average national UI rates after radical prostatectomy in the range of 26% (incontinence first study (2014-2015)) and 33% (incontinence second study (2016-2020)) and a large variation in outcomes between hospitals.

Also, studying outcomes for lumbar disk herniation seems possible with claims data. Re-operations and costs after lumbar disk herniation surgery have been studied using claims data before.[38] In this thesis **[Chapter 4]** we demonstrated that several unwanted outcomes after lumbar disk herniation surgery can be studied using claims data. The weighted mean of reoperations was 7.3%, nerve root block 6.7% and opioid use 15.6%. In total, 23.0% of patients with lumbar disk herniation had one or more undesirable outcomes after surgery and a large variation existed between the different hospitals for all outcome measures.





### Which outcomes to study and are claims data sufficient to study outcomes?

Three studies in this thesis evaluated outcomes of care based on claims data. The International Consortium for Health Outcomes Measurement (ICHOM) has standard sets of outcome parameters for healthcare interventions in several domains.[39] Based on claims data, we could study one outcome for prostate cancer (urinary incontinence) and three outcomes plus a combined outcome measure for lumbar disk herniation (reoperation, nerve root blocks, opioid use and combined outcome measure based on reoperation, nerve root block and opioid use).

For lumbar disk herniation for example, beneficial surgical outcomes that matter to patients, such as fast recovery and return to work, could not be evaluated, based on the available data. Also, outcome domains relevant to the patient as mentioned in the standard set of outcomes[40], such as the degree of pain experienced, quality of life as in physical and mental functioning, could not be investigated for the same reason. This means that studies based on claims data alone, are not sufficient to evaluate the total quality of care, and underscores the need for NQRs. Yet some important outcome measures can be studied based on claims data for a whole nation over several years with limited costs.

Other quality indicators can also be studied by using claims data. A Swiss study group determined 23 quality indicators with evidence-based criteria to measure quality of ambulatory primary care. All indicators were based on claims data.[41] In Japan a quality of care monitoring program was launched to assist hospitals with data on quality of cancer care that can be compared across other institutions. Thirteen process of care quality indicators were used, all based on claims data.[42]

### Recommendations for future research

First of all, we recommend to implement a national quality registry (NQR) for prostate cancer and for lumbar disk herniation in order to facilitate continuous monitoring, benchmarking and improvement of outcomes that matter to patients.

For prostate cancer surgery, six consecutive years of incontinence outcomes have been studied. However, to identify the effects of centralization of radical prostatectomy (RP) on other patient outcomes (e.g. erectile dysfunction) and oncological outcomes (e.g. positive surgical margins), additional research is needed. Also, research is required to analyze the outcomes per surgeon, identify best practices and implement these best practices nationwide in order to improve outcomes after RP. In addition, to evaluate the effects of centralization on the reduction of outcome variation of UI between hospitals, a follow-up study based on all claims data is recommended, or evaluation of UI in a NQR including PROMs. Future research is also recommended to more precisely determine an adequate volume threshold for RP, which might well be higher than 100 – 120 RP per hospital per year.

For lumbar disk herniation only outcomes of patients operated from July 2015 until June 2016 were studied. It is recommended to validate our previous research with recent data and to evaluate the trend in (variation of) outcomes on a local and national level. Furthermore, studies on other outcome domains relevant to patients (eg. pain, disability, quality of life) and on factors that predict and/or prevent postoperative complications are needed. In our research only patients with surgical interventions were included. Ideally, outcomes of patients with surgery should be compared with outcomes of patients treated with other therapeutic modalities or without any treatment. In this way, differences in outcomes of care will become clear for the same patient population choosing different treatment options.



Using claims data for this type of study presents a limitation, as it lacks information about the diagnosis from a general practitioner (GP). To gain a comprehensive understanding of patients who were not referred to a hospital, integration with data from other sources, such as databases from GPs, could enrich claims data for this purpose.

Furthermore, it is crucial to acknowledge the presence of selection bias, which can affect the validity of direct comparisons between patients who choose for surgery and those who do not. The decision-making process involved in selecting surgery or an alternative treatment is likely influenced by various factors, making it challenging to draw conclusions.

For diseases with an existing NQR usually there is a focus on short-term (around 1 year) outcomes. Adding claims data could be of additional value in measuring other and/or longer-term outcomes. For example, for patients with hip fracture claims data could answer questions about out-of-hospital mortality for people with or without operation, or questions about the amount of care patients need after the incident and what the associated costs of care are. For colon cancer, claims data could give insight into what happens to patients years after they received a stoma; how many stomas are removed, how many are kept?

For several diseases no NQR is in place yet, for some such a registry has just been started. Yet, by using claims data for many diseases with existing international standard sets of outcomes, some outcomes may be analyzed through the use of claims data only. For example, for Inflammatory Bowel Disease, hospital and emergency room visits, complications of intervention and steroid use could be evaluated. Also, for multiple sclerosis, the use and effect of different medicines could be studied by using claims data. Numerous possibilities exist in all areas of healthcare. It is also recommended to add claims data to NQRs in order to evaluate longer-term outcomes of treatment decisions.

## STRUCTURE: HOSPITAL VOLUME THRESHOLDS

| Goal | Category | Means | Challenges | Research questions |
|---|---|---|---|---|
| Improved healthcare outcomes and reduced costs | Structure | *Adequate* hospital volume thresholds | What is volume threshold per disease? | • Can secondary data be used to find a volume-outcome relationship for prostate cancer?<br>• What is the volume-outcome relation?<br>• Is a volume threshold enough to get better outcomes? |
| | | Signaling public health trends | Signaling 'harmful' practices quickly and cost-effective | • Can we use secondary data for current Dutch situation regarding opioid use and prescription?<br>• What are the trends in opioid use and prescription? |
| | Process | Optimizing inefficient processes | Administrative burden national quality registries | • Can Electronic Health Record data be used to reduce administrative burden for national quality registries through existing Clinical Information Models?<br>• What is the potential coverage of existing Clinical Information Models on national quality registries? |
| | Outcomes | Measuring outcomes per disease | Some major diseases still no national quality registry | • Can secondary data be used to measure outcomes for prostate cancer and lumbar disk herniation?<br>• What are the outcomes? |

## III. Volume-outcome relationships based on claims data

### What is the history of volume-outcome studies?

For a number of decades there has been an interest in the volume-outcome relationship for surgical procedures. In many complex surgical procedures, the relationship between hospital volume and patient outcomes has been studied and the notion 'more is better' has been established for various procedures since the 1970s.[43 44 45] John Birkmeyer – one of the initial pioneers of outcomes research – published data in the New England Journal of Medicine 20 years ago demonstrating that both hospital and surgeon volume are a proxy for quality of surgical care for a number of complex cancer surgeries.[44 46] The number of publications that report on the relationship between the volume of high-risk surgical procedures and patient outcome continues to grow and most reviews tend to support the presence of a surgeon volume-outcome relationship.[47] Many recent studies have investigated the hospital volume-outcome relationship in surgery. In some cases, the results have prompted the centralization of surgical activity. However, the methodologies and interpretations differ markedly from one study to another. Levaillant et al. reviewed 403 studies covering 90 types of surgery and concluded that 86.6% of the studies found a statistically significant volume-outcome relationship, although the findings differed from one type of surgery to another and the types of outcome were highly diverse.[48] Evidence for these outcomes is based on retrospective data. Limited data exist on the actual effects on centralization of care. Wouters et al. audited the effect of centralizing esophageal resections for cancer and showed an actual improvement in outcome after the process of centralization of these procedures in hospitals shown to have more favorable outcomes (outcome-based referral).[49]

### What does literature say about volume-outcome for prostate cancer surgery?

Outcomes after major uro-oncological procedures, such as radical prostatectomy (RP), depend on various patient-, disease-, surgeon- and hospital-related factors. Systematic reviews on the association between volume and outcome after RP have reported that both higher hospital and higher surgeon volume improve RP outcomes such as UI[50], however the association varied between outcomes.[51] For example, mortality was more dependent on hospital factors, whereas urinary incontinence (UI) and length of hospital stay were more related to the individual surgeon. Other studies confirm that increased surgeon volume – but not hospital volume – was associated with improved outcomes regarding overall complications, in-hospital complications, length of stay and long-term incontinence.[50 52] In addition, not only volume in itself but also the time it takes to be sufficiently trained matters. Thompson et al. report that robot-assisted RP involves a long learning curve, and patients early in the learning curve may experience worse quality of life, including UI.[53] Therefore, it is recommended that the future Dutch NQR for prostate cancer will monitor and give feedback on outcomes on a per surgeon level.





### Can claims data be used to measure volume-outcome relationship?

In our studies **[Chapter 2 and 3]** we concluded that there is a relationship between hospital volume and urinary incontinence (UI)12-15 months after radical prostatectomy (RP). Over the years 2014 and 2015, patients operated in a hospital with ≥100 RP per year had a 30% lower risk on UI than patients operated in low volume (<100) hospitals. Over the years 2016-2020, patients operated in a hospital with >120 RP per year had a 52% lower risk on incontinence than patients operated in low volume hospitals (≤120).

A major push for the centralization of RP came from the results of our first nationwide study on UI after RP **[Chapter 2]**. The minimum volume threshold for RP in the Netherlands increased from 20 procedures annually until 2017, to 50 in 2018 and 100 from 2019 onwards. To the best of our knowledge, studies that have analyzed the actual effect of centralization of RP and UI were non-existent before our study **[Chapter 3]**. Limitations of our studies are that some variables for casemix-correction, such as type of surgery (open/laparoscopic/robot-assisted), body mass index, the performing surgeon, were not available in claims data. Future research could benefit from analyzing all Dutch patients from the Vektis database and combining outcome data with patient-specific characteristics from the Netherlands Cancer Registry (NKR). In addition, to evaluate the effects of centralization on the reduction of outcome variation of UI within and between hospitals, a follow-up study based on all claims data is recommended. Future studies should also focus on defining an optimum minimum volume threshold per hospital as well as per surgeon.

### Is a volume threshold enough to get better outcomes?

Even though the literature is unambiguous, many European countries have not yet implemented policies towards centralization of RP, although in some countries specialized prostate cancer centers with high patient volumes do exist.[54] From our study **[Chapter 3]** we concluded that two years of centralization of RP in hospitals with a minimum annual RP volume of more than 100, did not yet significantly improve urinary incontinence (UI) outcomes on a national level.

A Swedish population-based study concluded that the most important factor influencing heterogeneity of UI after RP was the surgeon's experience and this accounted for 42% of observed heterogeneity.[55]

This finding also raises questions on the Dutch process of centralization of RP care, where focus is on hospital RP volumes rather than on a per surgeon volume. Urologists travel with their patients to a high-volume hospital and there has been no to little increase in RP volume per surgeon as the number of urologists performing these procedures is constant over the years.

One could question whether an increase of the RP volume threshold in the Netherlands, has led to real or pseudo concentration of RP. Data of the National Transparency Register shows the number of urologists per hospital performing RP, this number is constant over the years since it was measured; 60 urologists performing RP in 2018 and 62 urologists in 2021.[56]

To date, there is no NQR for prostate cancer and thus functional outcomes such as UI or sexual dysfunction, are not yet measured.

An important factor that can influence the quality of surgical care is the availability of ongoing feedback about adverse outcomes to surgical teams and individual surgeons; such feedback may stimulate modifications of technique in an attempt to reduce adverse outcomes in the future.[57] Simunovic et al. compared outcomes of complex oncologic surgery in two regions in Canada and concluded that concentration of pancreatic cancer surgery was associated with improved outcomes only when this regionalization was accompanied with ongoing auditing of results.[58] Late events that are not life-threatening but have high impact on quality of life such as incontinence and impotence may be less readily apparent to the surgeons.

Our results suggest the need for monitoring the outcomes and continue the learning cycle in order to reduce the burden of suffering among patients undergoing surgery for prostate cancer **[Chapter 3]**.

In the Netherlands, the Dutch Healthcare Institute is responsible for agreements with healthcare providers on the registration and transparency of multiple sets of disease-specific quality indicators. The Healthcare Institute can develop quality measures if providers do not take responsibility themselves. However, in the specific case of prostate cancer, even though international standard sets of outcomes are available since over 10 years[59], there is still no obligation of measuring the most important outcomes for patients and making them transparent. In this regard, much can be learned from Nordic countries such as Sweden and Norway, where all hospitals are required to be transparent about healthcare outcomes per hospital since many years and where the information is easily accessible for all patients.[60]

The question also arises whether centralization leads to an overall reduction in healthcare costs. For RPs, a simple calculation illustrates potential cost savings due to a reduction of the use of incontinence pads. If one assumes that as a consequence of the centralization of RP, 200 patients per year no longer have to use incontinence pads with an average cost of 300 euro per year, this will lead to cost savings of 60,000 euros in the first year and 120,000 euros in the second year (existing cohort of 200 patients plus new cohort of 200 patients), etc. Thus, the cumulative savings in the first five years is around 900,000 euros. Assuming that patients have a life expectancy of 10 years after their prostatectomy, the current value of the total savings in ten years is 2.8 million euros.

### Volume thresholds as a stand-alone measure

Significant criticism remains for the centralization of care based on volume only. As volume is an imprecise measurement of quality, volume-based healthcare policy raises a potential risk that low-volume surgeons who provide excellent care are negatively impacted, just as high-volume surgeons who provide lower quality care are not identified. For example, the Leapfrog Group in the United States established a minimum hospital case volume of 13 for esophageal resection in a response to known improved outcomes in larger volume centers. They evaluated the variation in short-term outcomes amongst hospitals that met the volume criteria and found that although referral to high-volume centers has been an important advance for complex surgical procedures, there is still a substantial degree of variability in outcomes among hospitals.[61] They concluded that metrics such as process, individual surgeon volume, and risk-adjusted outcome measures may yield further opportunities for quality improvement that extend beyond hospital volume-based assessments.

This supports our suggestion that a hospital volume threshold should always be accompanied by measuring outcomes, increased audit and feedback through Quality Assurance Programs (QAPs) and higher per-surgeon volume thresholds **[Chapter 3]**.

### Centralization of care: one size does not fit all

Wouters et al. studied outcomes of care before and after the introduction of a centralization project of esophagectomies for cancer and found that outcomes improved after centralization. Along with a reduction in postoperative morbidity and length of stay, mortality fell from 12% to 4% and survival improved significantly.[49] Their study confirms that centralization of care for this type of surgery with high incidence of complications after surgery improves outcomes when patients were referred to the hospitals which showed superior outcomes in a regional audit.

However, as we concluded in our study **[Chapter 3]**, for some interventions, simply increasing volume standards may not immediately lead to better outcomes. Despite the centralization of RPs, a striking variation in outcomes after RP remained between all hospitals, even for those with relatively high volume **[Chapter 3]**. As outcomes after RP were not measured, referral to hospitals with the best outcomes could not take place. In contrast to esophagectomies, direct complications after RP are limited and patients usually only stay one night in hospital after surgery. In our study we found that five-year averages of UI per hospital varied from 19% to 85%. This wide variation in UI can hardly be explained by chance variation and must be due to real differences in quality of surgical care.

We hypothesize that when outcomes are not measured, huge differences in outcomes per hospital will persist.
In addition, we suggest that centralization based on volume seems insufficient to accomplish the expected improvement of quality of care. Centralization should be accompanied with continuous measurement of outcomes and quality of care improvement cycles.

Several studies examined routine outcome measurement for every patient with prostate cancer. One study investigated the integration of systematic outcome measurement into clinical practice. Compared with men followed with routine care, patients undergoing integrated quality of life assessments experienced greater recovery in sexual function scores at one year (52.2 vs 33.6; $p$<0.001) while no significant difference in urinary incontinence (UI) was found.[62] However, Cathcart et al. evaluated outcomes following implementation of a quality assurance program in the UK that included monthly peer review of individual surgeon performance They observed that patient-reported 3-months UI improved, both in terms of requirement for incontinence pads (43% before QAP and 33% after QAP; odds ratio (OR): 2.19, 95% confidence interval (CI) 1.08-4.46; $p$=0.02) and on International Consultation on Incontinence Questionnaire score (5.6 vs 4.2; OR: 0.82; 95% CI, 0.70–0.95; $p$ = 0.009).[57]

For surgery where the expertise of the surgeon is the main factor influencing outcomes, such as for localized prostate cancer, improved outcomes could potentially be achieved by measuring outcomes on a per-surgeon level, by identifying best practices and by centralizing care around the best performing surgeons. Additional studies are need to demonstrate that indeed centralizing care around the best performing RP surgeons improves outcomes on a national level.

For some NQRs it is possible to analyze on a per surgeon level, with additional analyses (e.g. Dutch Heart Registration), for many other NQRs, it is not. Discussion of these results in a safe hospital setting with colleagues is of course a precarious process. We suggest that for surgeries where the outcomes are mainly surgeon-driven this feature is added to the relevant NQRs.

## STRUCTURE: SIGNALING PUBLIC HEALTH TRENDS

| Goal | Category | Means | Challenges | Research questions |
|---|---|---|---|---|
| Improved healthcare outcomes and reduced costs | Structure | *Adequate* hospital volume thresholds | What is volume threshold per disease? | • Can secondary data be used to find a volume-outcome relationship for prostate cancer?<br>• What is the volume-outcome relation?<br>• Is a volume threshold enough to get better outcomes? |
| | | Signaling public health trends | Signaling 'harmful' practices quickly and cost-effective | • Can we use secondary data for current Dutch situation regarding opioid use and prescription?<br>• What are the trends in opioid use and prescription? |
| | Process | Optimizing inefficient processes | Administrative burden national quality registries | • Can Electronic Health Record data be used to reduce administrative burden for national quality registries through existing Clinical Information Models?<br>• What is the potential coverage of existing Clinical Information Models on national quality registries? |
| | Outcomes | Measuring outcomes per disease | Some major diseases still no national quality registry | • Can secondary data be used to measure outcomes for prostate cancer and lumbar disk herniation?<br>• What are the outcomes? |

## IV. Trends in opioid use and prescription

### An opioid crisis in the US

The US currently faces a serious opioid misuse epidemic that started with increased prescribing of oxycodone and the inclusion of pain as a fifth vital sign, eventually resulting in massive overdose mortality.[63] The current addiction crisis has destroyed a multitude of lives. In the US the sales of opioids quadrupled between 1999 and 2000[64], and at the same time, opioid-related mortality increased from 3 per 100,000 in 1999 to 7 per 100,000 in 2010[65] and to 15 per 100,000 in 2017.[66] In total 399,233 Americans died from an opioid overdose between 1999 and 2017.[66]

At the same time, various governmental agencies dedicated to solving this seemingly never-ending dilemma have not yet succeeded or delivered on their promises. Addictive behavioral seeking is a multi-faceted neurobiological and spiritually complicated phenomenon.[67]

### What are the main differences between the US and Dutch healthcare system regarding opioids?

In Europe, including the Netherlands, the medical use of opioids (mainly oxycodone) has also increased since 2009.[63] Universal healthcare has been a major factor in preventing an opioid crisis of US proportions in the Netherlands for several reasons. First, all Dutch citizens are required to have a health insurance and thus Dutch people do not have to choose between high-cost care or cheaper care such as, for example, a knee replacement or chronic pain management with opioid painkillers. Second, in the Dutch healthcare system, general practitioners (GPs) are important gatekeepers to specialist care, and they integrate all patient care. GPs thereby minimize fragmentation of care.[63] For example, 80% of opioids in the Netherlands are prescribed by a GP **[Chapter 5]**. In contrast, primary care physicians in the US account for only a third of all opioid prescriptions.[64] Third, in the Netherlands public marketing by pharmaceutical companies is not allowed.

### Is the use of opioids in Netherlands comparable to US or European countries?

Data from a report by the International Narcotics Control Board showed that in 2014-2016, the US had the highest number of Daily Defined Doses (DDDs) per million inhabitants, Germany was third in row, Belgium number seven and the Netherlands was number nine in the international row.[68] Recent research confirmed that the US is still the number one consumer of controlled substances, with 34,731 Daily Defined Doses (DDDs) of strong opioids per million inhabitants per day. In second place is Germany, in sixth place is Belgium. Canada is in 9th, Netherlands is in 10th, UK in 21st and France in 22nd place in the world.[69]

### Can claims data be used to measure trends in opioid use and prescription?

We demonstrate that with just one data source, claims data, relevant information for healthcare professionals and policymakers about opioid use and prescription can be acquired **[Chapter 5]**.

For each Dutch citizen we selected claims data for all opioids, except codeine and buprenorphine, for the period 2010-2017. A total of 3,655,265 different insured persons used opioids during the research period. The yearly number of opioid users increased from 650,864 in 2010 to 1,010,474 in 2017 **[Chapter 5]**. This increase was mainly driven by an increase in oxycodone prescriptions. Chenaf et al. studied opioid use based on claims data in the French population and also found that opioid prescriptions at least doubled in the period 2004 until 2017 and that oxycodone use increased particularly.[70] We found that elderly and female patients most frequently used opioids. These findings are also in line with international literature.[71] The ratio of short- versus long-term opioid users remained steady during the research period, with opioids being used for four months or longer in 21% of cases. General practitioners prescribed the largest share of opioids, but a growing number of prescriptions originated from medical specialists **[Chapter 5]**.

Compared to use of claims data only, more insight was gained by performing a multi-source database study. Kalkman et al used a combination of national registries to explore opioid prescriptions and several proxies for misuse, including addiction, hospitalizations, and mortality.[63] Their study demonstrates how much insight can be gained with multi-source databases, even without connecting data sources. Their findings clearly show an increase in opioid prescriptions being paralleled by an increase in multiple proxies for opioid misuse. Compared with the US however, the use and misuse of prescription opioids and opioid-related mortality were still very low.

### Future research on signaling health trends

Claims data can be used to explore trends on a national level for a plethora of healthcare domains. For example, a recent nationwide study on chemotherapy use and intensive care unit (ICU) admission in the last three months before death in patients with cancer of the stomach or esophagus was also based on claims data only.[72] The study found that chemotherapy use and ICU admission shortly before death were relatively infrequent in the Netherlands. Chemotherapy was used less often in hospitals that treat many patients compared to hospitals that treat fewer patients.

Comparable studies could be executed on the use of expensive drugs in the last months of life, for example for several oncological conditions.

## PROCESS: OPTIMIZING INEFFICIENT PROCESSES

| Goal | Category | Means | Challenges | Research questions |
|---|---|---|---|---|
| Improved healthcare outcomes and reduced costs | Structure | *Adequate* hospital volume thresholds | What is volume threshold per disease? | • Can secondary data be used to find a volume-outcome relationship for prostate cancer?<br>• What is the volume-outcome relation?<br>• Is a volume threshold enough to get better outcomes? |
| | | Signaling public health trends | Signaling 'harmful' practices quickly and cost-effective | • Can we use secondary data for current Dutch situation regarding opioid use and prescription?<br>• What are the trends in opioid use and prescription? |
| | Process | Optimizing inefficient processes | Administrative burden national quality registries | • Can Electronic Health Record data be used to reduce administrative burden for national quality registries through existing Clinical Information Models?<br>• What is the potential coverage of existing Clinical Information Models on national quality registries? |
| | Outcomes | Measuring outcomes per disease | Some major diseases still no national quality registry | • Can secondary data be used to measure outcomes for prostate cancer and lumbar disk herniation?<br>• What are the outcomes? |

## V. Using existing data for national quality registries

### The administrative burden of national quality registries

As stated before, centralization based on volume only seems insufficient to accomplish immediate improvement in quality of care. Centralization should be accompanied with continuous measurement of outcomes and quality improvement cycles and more time might be required to establish effect on a national level. NQRs are the perfect tools for these measurements, however they still have one big disadvantage: Having to perform double registrations due to shortcomings in digital systems is perceived as a barrier for NQRs.[73] To date, there is very limited research on how the administrative burden for NQRs can be reduced on a national level.

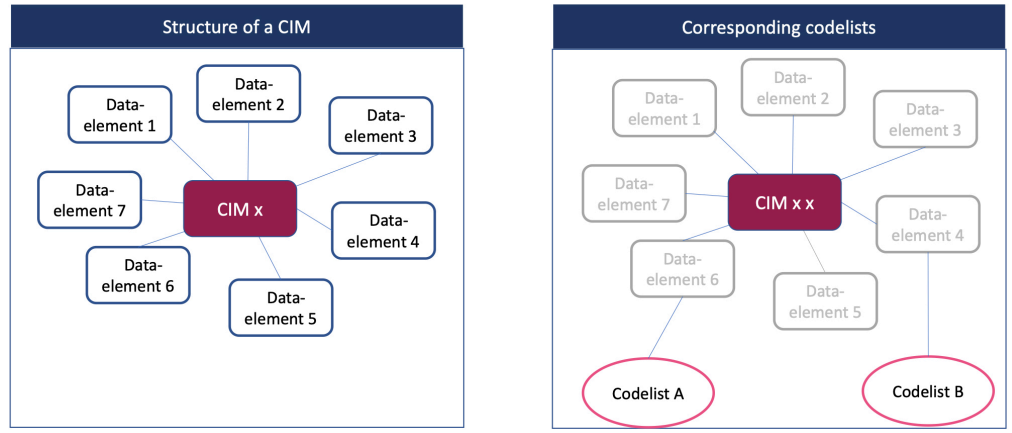
In a recent study, Zegers et al evaluated time spent on quality administration for three large hospitals and five different departments and care trajectories and found that the average Dutch healthcare professional spends 52.3 minutes a day on administration in the context of accountability of the quality of care both in electronic health records (EHRs) and other databases.[74] These quality data are requested by government bodies, accreditation institutes, insurers, professional associations, patient organizations and hospital boards. The average number of quality measures per department is 91, with 1,380 underlying variables. Only 25% of these data is required for quality improvement.

The administrative burden on the clinical level may not only reflect operational inefficiencies, but also failures in governance at macro- and meso level.[75] The impossibility of exchanging data between hospitals with different EHR systems and the administrative burden of registration both should be more firmly on the policy agenda. Where Zegers et al. do plea for less quality registries, a limited set of core indicators and a better use of information and communication technologies to reduce these workloads, we demonstrate another possibility, without losing the full potential of the impact of data from NQRs to use in quality improvement cycles.

### What is a clinical information model and how can it be used?

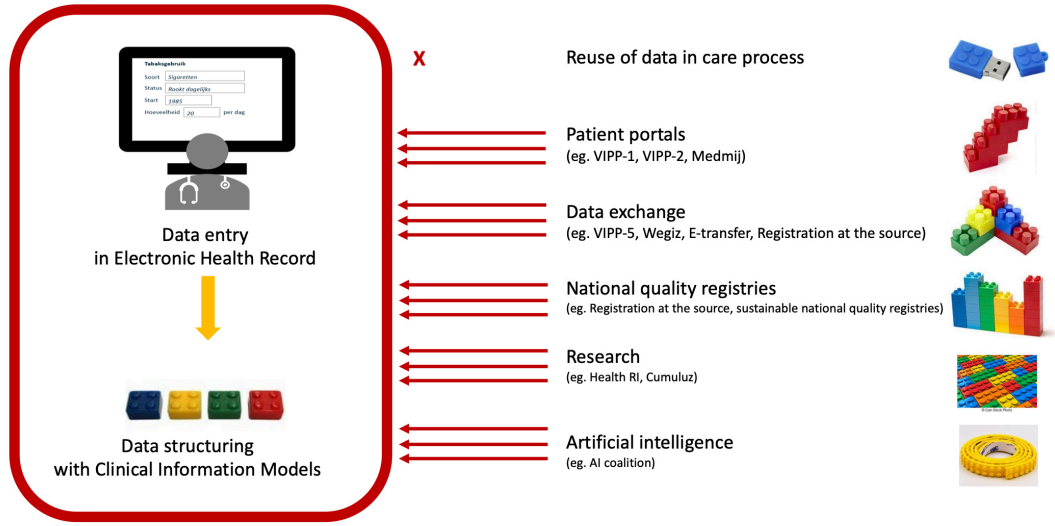
Clinical information models (CIMs) can be seen as building blocks collecting different data elements. They are needed for multiple reuse of data and were first introduced in the Netherlands around 2010. Figure 1 describes the structure of a clinical information model (CIM).

**Figure 1** Structure of a clinical information model




CIMS can be used for many different purposes (figure 2). At the moment, Dutch programs for all these purposes each have their requests for adaptation of specific CIMs and/or the overall CIM-structure (figure 2).[76]

**Figure 2** Purposes for use of data from electronic health records structured with clinical information Models and examples of Dutch national programs



## Can existing clinical information models be used for capturing data elements for NQRs?

The potential of using existing CIMs (also called clinical building blocks) in EHR systems for data collection for national quality registries (NQRs) is high. The average percentage of data elements for NQRs that can be captured from EHR systems by using existing CIMs is 83% **[Chapter 6]**. To our knowledge, this is the first study which matches data required for NQRs with CIMs. Matching of these data elements is the first step in exploring the potential. Implementing CIMs in hospitals and reusing the EHR-data for NQRs will be the next step.

Unfortunately, there is very limited international scientific literature on the subject of the potential and the implementation of CIMs. This may be due to the fact that hospitals and/or regions design and implement their own solutions for data reuse and do not translate this into a scientific contribution.

## Future perspectives

In theory EHR data can be used to reduce the administrative burden for NQRs as we demonstrated a high potential coverage of data elements of NQRs with existing CIMs [**Chapter 6**]). Yet, this is only possible when CIMs are implemented nationwide in EHRs and in systems of NQRs.

In order to use EHR data structured with CIMs for NQRs, several implementation steps need to be taken, such as:

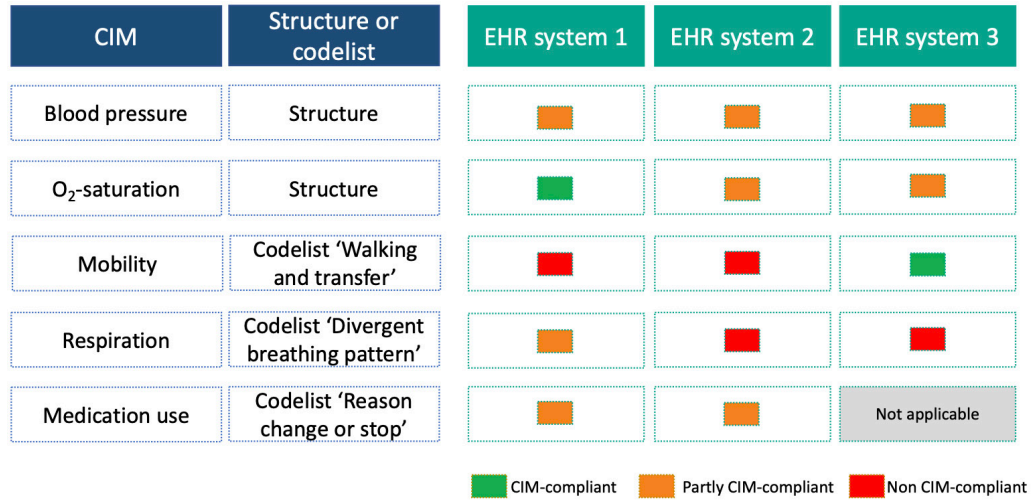
1) Compliance to CIM-structures and codelists for EHR-systems and NQRs
2) Focus of different national programs should proceed from perspective of single reuse of data to multiple reuse of data (Collect Once Use Many Times (COUMT))
3) Healthcare professionals should make a transition to more structured and standardized documentation

Each of these steps will be explained/ illustrated below.

Ad 1) Compliance to CIM-structures and codelists

To support adequate implementation of CIMs, we checked a few examples on the level of compliance across different EHR-systems for some CIM structures and corresponding codelists (figure 3).[77]

**Figure 3** Level of compliance to clinical information models (CIMs) of three electronic health record (EHR) systems for five CIMs




This analysis demonstrates that to date, the main EHR-systems seem not yet to be compliant with the current CIM-structure, and corresponding codelists.

A more detailed analysis for one codelist clarified even more what the current situation is. We previously studied compliance to the codelist 'Tobacco use status' of the data element 'Tobacco use status' of the CIM 'Tobacco use'. We found that three different EHR-systems use three different sets of data elements. In total only two out of seven codes were implemented compliant to the codelist in three EHR systems, and only one of the EHR-systems was fully compliant with the codelist (figure 4).[76]

**Figure 4** Example of compliance to clinical information model (CIM) on detailed level for codelist 'Tobacco use status' for CIM 'Tobacco use' for three Electronic Health Record Systems

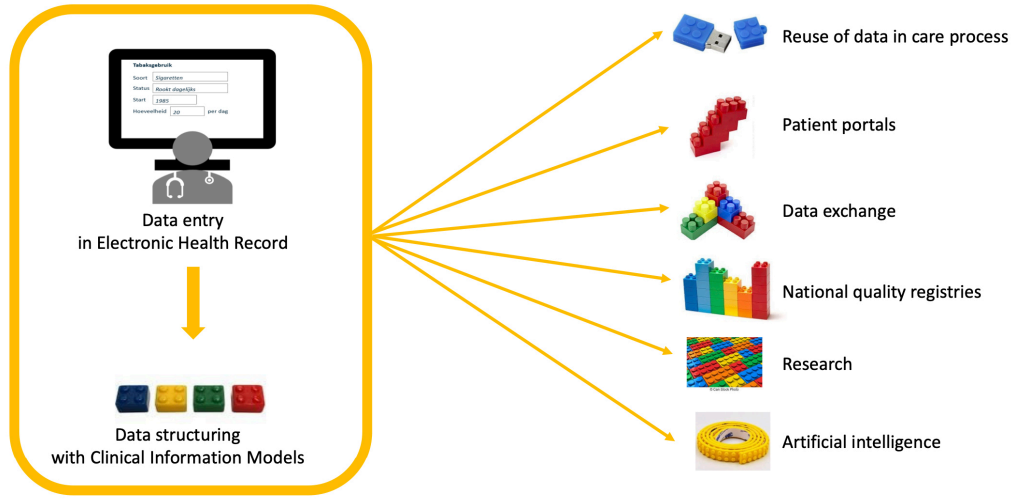

*Analysis based on data of three hospitals with three different EHR-systems*

Another example of content standardization is the CIM 'Operations' with the related codelist 'Operations thesaurus'. To date, this codelist is implemented in only a few hospitals in the Netherlands. Thus, the implementation of one of the five most important CIMs should go hand in hand with a national implementation of this related codelist. Content standardization is key priority in the Netherlands and requires national governance.

Ad 2) Shift of focus from single to multiple reuse of data

Data is a major asset that should be considered as strategic for any clinical organization and essential for every healthcare professional. Reuse of clinical data is crucial for healthcare quality, management, reduced costs, population health management and effective clinical research. However, most research demonstrates that possible advantages of clinical data reuse still lay in our future.[78] In the Netherlands many national programs currently focus on single reuse of data for a specific purpose, which might contribute to the current hick-ups in national implementation of CIMs. A common goal for multiple reuse of data following the COUMT paradigm, might also substantially contribute to the alignment and cooperation of the different national programs (figure 5). Working together with all programs towards a national goal, may optically slow down results of a single program, but is likely to eventually lead to improved outcomes and reduced costs for all programs.

**Figure 5** Proposed shift of focus from goal per national program to common goal and multiple reuse of data




Without content standardization and a shift of focus to multiple reuse, following the Collect Once Use Many Times (COUMT) principle is impossible and exchange of data will remain limited to hospitals using the same EHR system. In the Netherlands, many regions have hospitals using different EHR systems, therefore data exchange is hampered.

Ad 3) Transition to more structured and standardized documentation

The primary purpose of clinical documentation is to support high-quality patient care. The results of a retrospective multicenter study showed that structured documentation is associated with higher quality documentation, with a 20% increase in documentation quality measured on a 0–100 scale.[79]

There could be a concern that as data reuse becomes more important, healthcare providers are required to capture even more data while providing care. This, in turn, might increase the administrative burden. This should be avoided at any cost, as healthcare providers are unlikely to accept a documentation method that adds a significant burden to their workload.[80] Efforts should be made to implement structured documentation methods within EHRs to enable data reuse while reducing the administrative burden.

The pandemic opened up many windows of opportunity for positive reforms[81], and now may be the time to address this important digital transition in healthcare in a fundamental way on an (inter)national level.

## VI. Conclusions

The overall aim of this thesis was to contribute to the body of knowledge whether it is possible and useful to measure and improve quality of healthcare by using secondary data, such as claims data. This thesis shows that claims data can indeed be used to measure outcomes of care, to evaluate quality of care by quality improvement cycles and to evaluate trends in healthcare on a national and local level. Even volume-outcome relationships for certain procedures can be studied by using claims data.

A wide variety of patient outcomes is seen in hospitals for lower disk hernia surgery and radical prostatectomy (RP). For RP there is a clear volume-outcome (urinary incontinence (UI)) relationship, yet even within high-volume group of hospitals there is a wide variation in outcomes. Patients operated in hospitals that increased the volume of RPs over time, had a 29% lower risk of UI than patients operated in hospitals that remained of low volume (≤120 RP per year). Patients operated in hospitals that remained high volume (>120 RP per year), had a 52% lower risk of UI than patients operated in hospitals that remained of low volume.

Volume thresholds without measuring outcomes seems to be insufficient to improve quality of care within a few years after increasing the volume threshold. Measuring of outcomes is necessary on a national, hospital and sometimes even per surgeon level.

Centralization of care is not a one size fits all. For procedures in which the expertise of the surgeon is one of the main determinants of outcome, such as for RP, centralization should be accompanied with proceeding specialization, expressed in the number of procedures performed per surgeon. So far, centralization of RP has taken place in the Netherlands, yet the same number of urologists performed these RPs.

National quality registries are a great source of information for registering healthcare outcomes and improving quality, however the perceived and actual administrative burden is high. Reusing data from Electronic Health Records, structured with clinical information models (CIMs) has a high potential for reuse of data: 83% of required data for more than 30 national quality registries can be based on existing CIMs.

The knowledge that stems from this thesis, can be transferred to other areas and other diseases, and in this way contribute to improving outcomes for patients. Transparency of hospital-specific outcome information is a prerequisite for the continuous process of quality improvement and it is a legal right for patients to be informed about differences in outcomes per hospital.





### Recommendations

The Dutch Integral Healthcare Agreement (Intregraal Zorg Akkoord [IZA]) has several ambitious goals for the coming years. Based on this thesis, several recommendations are made which will support these IZA goals and benefit patients:

Appropriate care:

- Development and implementation of NQRs, that include standard sets of outcomes that matter to patients, at least for those conditions with significant health burden and/or societal impact such as prostate cancer and lumbar disk herniation.
- Reconsider the strict interpretation of the GDPR and make claims data available for scientific research, more specifically the study of outcomes of care
- Make use of existing data, such as claims data to evaluate outcomes of care for more procedures in order to reduce the administrative burden for healthcare professionals.

Centralization of care:

- Centralization of specific care can indeed increase the quality of care. When adopting centralization however, this should always be based on a scientific analysis of its effects. Centralization should not be a goal in itself, the goal is to improve outcomes.
- When volume thresholds are installed, it should be accompanied with measuring of outcomes, and not as a stand-alone measure to improve and/or indicate quality of care.
- Centralization of care should be adapted to the specific procedure; procedures with high complexity in surgery only (such as radical prostatectomy), should be centralized around the best surgeons; (procedures with high complexity and high risk after the procedure, should be centralized around the best teams).

Electronic exchange of data:

- The five most used clinical information models (CIMs) should be implemented in all healthcare domains in the Netherlands while following the COUMT-paradigm. The code- and value lists (such as the Operations Thesaurus) related to these five CIMs should also be implemented nationwide. Implementation could start in hospitals and NQRs.
- Adherence to (inter)national codelists is a sine qua non for national implementation of CIMs and reuse of data
- All national programs for data reuse should be in alignment with the COUMT paradigm, more specifically a focus on multiple reuse of data for different purposes.

## References

1 Sparring V, Granström E, Andreen Sachs M, Brommels M, Nyström ME. One size fits none - a qualitative study investigating nine national quality registries' conditions for use in quality improvement, research and interaction with patients. BMC Health Serv Res. 2018 Oct 20;18(1):802.

2 Rakhorst HA, Mureau MAM, Cooter RD, McNeil J, van Hooff M, van der Hulst R, Hommes J, et al. The new opt-out Dutch National Breast Implant Registry - Lessons learnt from the road to implementation. J Plast Reconstr Aesthet Surg. 2017 Oct;70(10):1354-1360.

3 IKNL. Cancer in 2032. https://iknl.nl/kanker-in-2032.

4 OECD. 2019. Health in the 21st Century: Putting data to work for stronger Health Systems. Available at: https://www.oecd-ilibrary.org/sites/e3b23f8e-en/index.html?itemId=/content/publication/e3b23f8e-en. Last visited June 22nd, 2023.

5 De Lusignan S, Mimnagh C. Breaking the first law of informatics: the Quality and Outcomes Framework (QOF) in the dock. J Innov Health Inform 2006;14(3):153-6.

6 Verheij R. 2021. Het datalandschap als voedselbos voor een lerend zorgsysteem. Available at: https://pure.uvt.nl/ws/files/60566865/TiU_Rede_Robert_Verhey.pdf. Last visited June 22, 2023.

7 US Food and Drug Administration (FDA). Real World Evidence. Accessed March 28, 2023 fda.gov/sience-and-research-special-topics/real-world-evidence.

8 Murthy VH, Krumholz HM, Gross CP. Participation in cancer clinical trials: race-, sex-, and age-based disparities. JAMA. 2004 Jun 9;291(22):2720-6.

9 Penberthy LT, Rivera DR, Lund JL, Bruno MA, Meyer AM. An overview of real-world data sources for oncology and considerations for research. CA Cancer J Clin. 2022 May;72(3):287-300.

10 Mues KE, Liede A, Liu J et al. Use of the Medicare database in epidemiologic and health services research: a valuable source of real-world evidence on the older and disabled populations in the US. Clin Epidemiol 2017;9:267-77.

11 Motheral BR, Fairman KA. The use of claims databases for outcomes research: rationale, challenges, and strategies. Clin Ther 1997;19:346-66.

12 Bronner, K.K., Goodman, D.C. The Dartmouth Atlas of Health Care – bringing health care analyses to health systems, policymakers, and the public. Res Health Serv Reg 1, 6 (2022).

13 The Dartmouth Atlas Project. Research Articles [cited 2023 March 27]. Available from: https://www.dartmouthatlas.org/research-articles/.

14 Wennberg JE, Gittelsohn A. Small area variations in health care delivery: a population-based health information system can guide planning and regulatory decision-making. Science. 1973;182(4117):1102–1108.

15 Wennberg JE, Freeman JL, Shelton RM, Bubolz TA. Hospital use and mortality among Medicare beneficiaries in Boston and New Haven. N Engl J Med. 1989 Oct 26;321(17):1168-73.

16 Fisher ES, Welch HG. Avoiding the unintended consequences of growth in medical care: how might more be worse? JAMA. 1999 Feb 3;281(5):446-53.

17 Mandrola J, Cifu A, Prasad V, Foy A. The case for being a medical conservative. Am J Med. 2019;132(8):900-1.
18 Kampman JM, Turgman O, van der Ven WH, Hermanides J, Sperna Weiland NH, Hollmann MW, et al. Randomized controlled trials insufficiently focus on reducing medical overuse. Eur J Epidemiol. 2023 Jun 19.
19 Westert GP, Groenewoud S, Wennberg JE, Gerard C, DaSilva P, Atsma F, et al. Medical practice variation: public reporting a first necessary step to spark change. Int J Qual Health Care. 2018 Nov 1;30(9):731-735.
20 Raad voor Gezondheidsonderzoek. Van gegevens verzekerd. Kennis over volksgezondheid in Nederland nu en in de toekomst. Den Haag;2008.
21 OECD. Health data Governance, Privacy, Monitoring and Research, OECD Health Policy Studies. Paris: OECD Publishing; 2015.
22 Verheij R, Witvliet C, Jansen T, Hooiveld M, van Hilten O. Hergebruik van routine zorgdata voor beleid en wetenschap: hoe het nog beter kan. Nivel/CBS. Utrecht;2019.
23 https://www.vektis.nl/open-data. Last visited June 22nd, 2023.
24 Vektis. Report, kwaliteit van de geleverde zorg rond electieve zorg, 2011. Available at: https://docplayer.nl/13656287-Kwaliteit-van-de-geleverde-zorg-rond-electieve-zorg-in-2010-beperkte-update-van-de-analyse-over-2009.html. Last visited July 11th, 2023.
25 Nivel. Hergebruik van routine zorgdata voor beleid en wetenschap: hoe het nog beter kan. 2019. Available at: https://www.nivel.nl/nl/publicatie/hergebruik-van-routine-zorgdata-voor-beleid-en-wetenschap-hoe-het-nog-beter-kan#:~:text=De%20OECD%20roept%20in%20dat,data%20te%20hergebruiken%20voor%20onderzoek. Last visited June 22nd, 2023.
26 Chico V. The impact of the General Data Protection Regulation on health research. Br Med Bull. 2018 Dec 1;128(1):109-118.
27 Hansen J, Wilson P, Verhoeven E, Kroneman M, Kirwan M, Verheij R, et al. Assessment of the EU Member States' rules on health data in the light of GDPR. Specific Contract No SC 2019 70 02 in the context of the Single Framework Contract Chafea/2018/Health/03. Brussels; 2021.
28 Ministry of Health Welfare and Sports. Data laten werk voor gezondheid. Den Haag: 2018.
29. Algra P. Consultatieronde Uitvoeringswet Algemene Verordening gegevensbescherming. Reactie Zorgverzekeraars Nederland. Available at: https://www.internetconsultatie.nl/uitvoeringswetavg/reactie/cc44f53f-00ed-44da-bf88-2f5f3f8fcf19. Last visited June 17th, 2023.
30 Spini G, Mancini E, Attema T, Abspoel M, de Gier J, Fehr S, et al. New Approach to Privacy-Preserving Clinical Decision Support Systems for HIV Treatment. J Med Syst. 2022 Oct 20;46(12):84.
31 Burgerlijk Wetboek artikel 7:448 ; Wet kwaliteit, klachten en geschillen zorg artikel 10: 1; Kamerstukken II 2010/11, 32402, 7, p. 56.
32 Auffenberg GB, Qi J, Dunn RL, Linsell S, Kim T, Miller DC, et al. Evaluation of Patient- and Surgeon-Specific Variations in Patient-Reported Urinary Outcomes 3 Months After Radical Prostatectomy From a Statewide Improvement Collaborative. JAMA Surg. 2021 Mar 1;156(3):e206359.
33 Baunacke M, Schmidt ML, Thomas C, Groeben C, Borkowetz A, Koch R, et al. Long-term functional outcomes after robotic vs. retropubic radical prostatectomy in routine care: a 6-year follow-up of a large German health services research study. World J Urol. 2020 Jul;38(7):1701-1709.
34 Cary KC, Punnen S, Odisho AY, Litwin MS, Saigal CS, Cooperberg MR; NIDDK Urologic Diseases in America Project. Nationally representative trends and geographic variation in treatment of localized prostate cancer: the Urologic Diseases in America project. Prostate Cancer Prostatic Dis. 2015 Jun;18(2):149-54.
35 Cheng Y, Zhuo L, Pan Y, Wang S, Zong J, Sun W, et al. Treatment patterns of prostate cancer with bone metastasis in Beijing: A real-world study using data from an administrative claims database. Pharmacoepidemiol Drug Saf. 2019 Nov;28(11):1501-1509.
36 Riviere P, Tokeshi C, Hou J, Nalawade V, Sarkar R, Paravati AJ, et al. Claims-Based Approach to Predict Cause-Specific Survival in Men With Prostate Cancer. JCO Clin Cancer Inform. 2019 Mar;3:1-7.
37 Baas D, Reitsma J, Gerwen van L, Vleghaar J, Gehlen J, Ziedses des Plantes CMP et al. Validation of claims data for absorbing pads as a measure for urinary incontinence after radical prostatectomy. Cancers. 2023 Dec 7;15(24):5740.
38 Sherman J, Cauthen J, Schoenberg D, Burns M, Reaven NL, Griffith SL. Economic impact of improving outcomes of lumbar discectomy. Spine J. 2010 Feb;10(2):108-16.
39 https://www.ichom.org/patient-centered-outcome-measures/#standard-sets Accessed March 28, 2023.
40 Clement RC, Welander A, Stowell C, Cha TD, Chen JL, Davies M, et al. A proposed set of metrics for standardized outcome reporting in the management of low back pain. Acta Orthop. 2015;86(5):523-33.
41 Blozik E, Reich O, Rapold R, Scherer M; Swiss Quality Indicator for Primary Care (SQIPRICA) Working Group. Evidence-based indicators for the measurement of quality of primary care using health insurance claims data in Switzerland: results of a pragmatic consensus process. BMC Health Serv Res. 2018 Sep 27;18(1):743.
42 Iwamoto M, Nakamura F, Higashi T. Monitoring and evaluating the quality of cancer care in Japan using administrative claims data. Cancer Sci. 2016 Jan;107(1):68-75.
43 Luft HS, Bunker JP, Enthoven AC. Should operations be regionalized? The empirical relation between surgical volume and mortality. N Engl J Med. 1979 Dec 20;301(25):1364-9.
44 Birkmeyer JD, Siewers AE, Finlayson EV, Stukel TA, Lucas FL, Batista I, et al. Hospital volume and surgical mortality in the United States. N Engl J Med. 2002 Apr 11;346(15):1128-37.
45 Chowdhury MM, Dagash H, Pierro A. A systematic review of the impact of volume of surgery and specialization on patient outcome. Br J Surg. 2007 Feb;94(2):145-61.
46 Birkmeyer JD, Stukel TA, Siewers AE, Goodney PP, Wennberg DE, Lucas FL. Surgeon volume and operative mortality in the United States. N Engl J Med. 2003 Nov 27;349(22):2117-27.

60 Norwegian prostate cancer registry. Results available at https://www.skde.no/kvalitetsregistre/prostata/sykehus/?level=H&selected_row=prostata_fri_reseksjonsmargin&chart_type=bar. Accessed February 20th, 2023.
61 Varghese TK Jr, Wood DE, Farjah F, Oelschlager BK, Symons RG, MacLeod KE, et al. Variation in esophagectomy outcomes in hospitals meeting Leapfrog volume outcome standards. Ann Thorac Surg. 2011 Apr;91(4):1003-9; discussion 1009-10.
62 Gilbert SM, Dunn RL, Wittmann D, Montgomery JS, Hollingsworth JM, Miller DC, et al. Quality of life and satisfaction among prostate cancer patients followed in a dedicated survivorship clinic. Cancer. 2015 May 1;121(9):1484-91.
63 Kalkman GA, Kramers C, van Dongen RT, van den Brink W, Schellekens A. Trends in use and misuse of opioids in the Netherlands: a retrospective, multi-source database study. Lancet Public Health. 2019 Oct;4(10):e498-e505.
64 Guy GP Jr, Zhang K, Bohm MK, Losby J, Lewis B, Young R, et al. Vital Signs: Changes in Opioid Prescribing in the United States, 2006-2015. MMWR Morb Mortal Wkly Rep. 2017 Jul 7;66(26):697-704.
65 Rudd RA, Aleshire N, Zibbell JE, Gladden RM. Increases in Drug and Opioid Overdose Deaths--United States, 2000-2014. MMWR Morb Mortal Wkly Rep. 2016 Jan 1;64(50-51):1378-82.
66 Scholl L, Seth P, Kariisa M, Wilson N, Baldwin G. Drug and Opioid-Involved Overdose Deaths - United States, 2013-2017. MMWR Morb Mortal Wkly Rep. 2018 Jan 4;67(5152):1419-1427.
67 Blum K, Bowirrat A, Gomez LL, Downs BW, Bagchi D, Barh D, et al. Why haven't we solved the addiction crisis? J Neurol Sci. 2022 Nov 15;442:120404.
68 International Narcotics Control Board. Narcotics Drugs 2017. Estimated world requirements for 2018. New York: United Nations, 2017:230-6. Available at: https://www.incb.org/documents/Narcotic-Drugs/Technical-Publications/2017/Narcotic_drugs_technical_publication_2017.pdf. Last accessed July 12th, 2023.
69 International Narcotics Control Board. Narcotics Drugs 2023. Estimated world requirements for 2022. New York: United Nations, 2022:255-6. Available at: https://www.incb.org/documents/Narcotic-Drugs/Technical-Publications/2022/Narcotic_Drugs_Technical_Publication_2022.pdf.
70 Chenaf C, Kaboré JL, Delorme J, Pereira B, Mulliez A, Zenut M, et al. Prescription opioid analgesic use in France: Trends and impact on morbidity-mortality. Eur J Pain. 2019 Jan;23(1):124-134.
71 Campbell CI, Weisner C, Leresche L, Ray GT, Saunders K, Sullivan MD, et al. Age and gender trends in long-term opioid analgesic use for noncancer pain. Am J Public Health. 2010 Dec;100(12):2541-7.
72 Besseling J, Reitsma J, Van Erkelens JA, Schepens MHJ, Siroen MPC, Ziedses des Plantes CMP, et al. Use of Palliative Chemotherapy and ICU Admissions in Gastric and Esophageal Cancer Patients in the Last Phase of Life: A Nationwide Observational Study. Cancers (Basel). 2021 Jan 5;13(1):145.



47 Morche J, Mathes T, Pieper D. Relationship between surgeon volume and outcomes: a systematic review of systematic reviews. Syst Rev. 2016 Nov 29;5(1):204.
48 Levaillant M, Marcilly R, Levaillant L, Michel P, Hamel-Broza JF, Vallet B, Lamer A. Assessing the hospital volume-outcome relationship in surgery: a scoping review. BMC Med Res Methodol. 2021 Oct 9;21(1):204.
49 Wouters MW, Karim-Kos HE, le Cessie S, Wijnhoven BP, Stassen LP, Steup WH, et al. Centralization of esophageal cancer surgery: does it improve clinical outcome? Ann Surg Oncol. 2009 Jul;16(7):1789-98.
50 Leow JJ, Leong EK, Serrell EC, Chang SL, Gruen RL, Png KS, et al. Systematic Review of the Volume-Outcome Relationship for Radical Prostatectomy. Eur Urol Focus. 2018 Dec;4(6):775-789.
51 Gershman B, Meier SK, Jeffery MM, Moreira DM, Tollefson MK, Kim SP, et al. Redefining and Contextualizing the Hospital Volume-Outcome Relationship for Robot-Assisted Radical Prostatectomy: Implications for Centralization of Care. J Urol. 2017 Jul;198(1):92-99.
52 Begg CB, Riedel ER, Bach PB, Kattan MW, Schrag D, Warren JL, et al. Variations in morbidity after radical prostatectomy. N Engl J Med. 2002 Apr 11;346(15):1138-44.
53 Thompson JE, Egger S, Böhm M, Haynes AM, Matthews J, Rasiah K, et al. Superior quality of life and improved surgical margins are achievable with robotic radical prostatectomy after a long learning curve: a prospective single-surgeon study of 1552 consecutive cases. Eur Urol. 2014 Mar;65(3):521-31.
54 Van den Broeck T, Oprea-Lager D, Moris L, Kailavasan M, Briers E, Cornford P, et al. A Systematic Review of the Impact of Surgeon and Hospital Caseload Volume on Oncological and Nononcological Outcomes After Radical Prostatectomy for Nonmetastatic Prostate Cancer. Eur Urol. 2021 Nov;80(5):531-545.
55 Nyberg M, Sjoberg DD, Carlsson SV, Wilderäng U, Carlsson S, Stranne J, et al. Surgeon heterogeneity significantly affects functional and oncological outcomes after radical prostatectomy in the Swedish LAPPRO trial. BJU Int. 2021 Mar;127(3):361-368.
56 Health Institute Netherlands. Prostate carcinoma indicators. Available at: https://www.zorginzicht.nl/kwaliteitsinstrumenten/prostaatcarcinoom-indicatoren. Accessed February 1, 2023.
57 Cathcart P, Sridhara A, Ramachandran N, Briggs T, Nathan S, Kelly J. Achieving Quality Assurance of Prostate Cancer Surgery During Reorganisation of Cancer Services. Eur Urol. 2015 Jul;68(1):22-9.
58 Simunovic M, Urbach D, Major D, Sutradhar R, Baxter N, To T, Brown A, et al. Assessing the volume-outcome hypothesis and region-level quality improvement interventions: pancreas cancer surgery in two Canadian Provinces. Ann Surg Oncol. 2010 Oct;17(10):2537-44.
59 Martin NE, Massey L, Stowell C, Bangma C, Briganti A, Bill-Axelson A, et al. Defining a standard set of patient-centered outcomes for men with localized prostate cancer. Eur Urol. 2015 Mar;67(3):460-7.

73 Sparring V, Granström E, Andreen Sachs M, Brommels M, Nyström ME. One size fits none - a qualitative study investigating nine national quality registries' conditions for use in quality improvement, research and interaction with patients. BMC Health Serv Res. 2018 Oct 20;18(1):802.
74 Zegers M, Veenstra GL, Gerritsen G, Verhage R, van der Hoeven HJG, Welker GA. Perceived Burden Due to Registrations for Quality Monitoring and Improvement in Hospitals: A Mixed Methods Study. Int J Health Policy Manag. 2022 Feb 1;11(2):183-196.
75 Jeurissen PP, Klazinga N, Hagenaars L. Complex Governance Does Increase Both the Real and Perceived Registration Burden: The Case of the Netherlands Comment on "Perceived Burden Due to Registrations for Quality Monitoring and Improvement in Hospitals: A Mixed Methods Study". Int J Health Policy Manag. 2022 Apr 1;11(4):533-535.
76 Verkenningsteam. Rapportage. Een duurzaam informatiestelsel vereist veel meer dan zib-compliancy. 2021. Available at: https://www.informatieberaadzorg.nl/publicaties/vergaderstukken/2021/10/11/4.c-rapportage-fms. Last accessed at July 12th, 2023.
77 Sustainable National Quality Registries (Verduurzamen Kwaliteitsregistraties). Federation of Dutch Medical Specialists. Interim-report March 2021.
78 Meystre SM, Lovis C, Bürkle T, Tognola G, Budrionis A, Lehmann CU. Clinical Data Reuse or Secondary Use: Current Status and Potential Future Progress. Yearb Med Inform. 2017 Aug;26(1):38-52.
79 Ebbers T, Kool RB, Smeele LE, Dirven R, den Besten CA, Karssemakers LHE, et al. The Impact of Structured and Standardized Documentation on Documentation Quality; a Multicenter, Retrospective Study. J Med Syst. 2022 May 27;46(7):46.
80 Berg M. Implementing information systems in health care organizations: myths and challenges. Int J Med Inform. 2001;64(2–3):143–156.
81 Auener S, Kroon D, Wackers E, Dulmen SV, Jeurissen P. COVID-19: A Window of Opportunity for Positive Healthcare Reforms. Int J Health Policy Manag. 2020 Oct 1;9(10):419-422.