

EXTENDED REPORT

Costs of rheumatoid arthritis in Germany: a micro-costing approach based on healthcare payer's data sources

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Objective: To develop a systematic set of German cost data in rheumatoid arthritis (RA) based solely on valid healthcare payer's cost data sources.

Methods: Retrospectively one year cost data of 338 patients with RA were generated and analysed. The cost data were derived from a major statutory health insurance plan ("Allgemeine Ortskrankenkasse Niedersachsen") and the regional physicians' association ("Kassenärztliche Vereinigung Niedersachsen"). The recently published matrix of cost domains in RA was applied to structure the analysis. Descriptive statistics were used to analyse the data.

Results: The total direct costs for the 338 patients during one year (third quarter 2000 to second quarter 2001) were €3815 per patient-year. RA related direct costs were €2312 per patient-year. Outpatient costs accounted for 73.7%, inpatient costs for 24.0%, and other disease related costs for 2.3% of RA related direct costs. Outpatients cost drivers were RA related drugs (€1019 per patient-year), physician visits (€323 per patient-year), diagnostic and therapeutic procedures and tests (€185 per patient-year), and devices and aids (€168 per patient-year). 98 patients were retired prematurely owing to RA related work disability and incurred costs of €8358 per retired patient-year. 96 patients were gainfully employed and incurred sick leave costs of €2835 per employed patient-year.

Conclusion: Micro-costing based on healthcare payer's data provides a relatively conservative albeit highly accurate estimate of costs in RA. Both RA related and non-RA related costs must be taken into account. In gainfully employed patients and in patients who receive RA related retirement payments productivity costs exceed direct costs.

Internationally available costing studies provide a heterogeneous view on costs related to rheumatoid arthritis (RA). The 10 costing studies examined in a recent survey¹ showed average direct costs of about €5000 per patient-year (ranging from €1610 to €9970). The main cost drivers within the direct cost domains also varied widely between the individual studies: inpatient costs (range €1130–6940 per patient-year), drug costs (range €220–1300 per patient-year), physician costs (range €350–1210 per patient-year), and costs for diagnostic and therapeutic procedures and tests (range €170–700 per patient-year). In the same review the ratios of direct costs/productivity costs were reviewed and showed a range from 1/3² to 3/1.³

According to a recently published literature review two major reasons may account for the heterogeneity of reported cost data⁴: (a) lack of a homogeneous core set of cost domains which should be covered by any health economic analysis and (b) differences in applied costing methodology. While the cost estimates in most of the internationally available publications are based on patient questionnaires,^{3–8} only a few studies have been published examining validity and reliability of patient derived cost data.⁹ In addition, the design of frequently applied questionnaires differs considerably in its major psychometric characteristics: length (3–113 items), recall period (between one week and one year), format (interview *v* self administered), response categories, cost units (monetary *v* physical), and cost domains covered.¹⁰

Our study, therefore, aimed at developing a systematic set of cost data in RA based solely on valid healthcare payer's cost data sources. In addition, we aimed at reducing further sources of bias by developing the costs, in both physical and monetary units, on a patient by patient micro-costing level.

PATIENTS AND METHODS

Our methodological approach was characterised by three elements: (a) only healthcare payer's data sources were used; (b) we focused on a time interval which was not biased by any intervention; and (c) the cost assessment was structured according to a recently published matrix for cost assessments in RA.¹¹

Perspective

In accordance with our major goal, which was to rely solely on healthcare payer's cost data, we decided to take the payer's perspective. In particular, we took the perspective of the major payers: the "Allgemeine Ortskrankenkasse Niedersachsen" (AOKN), the "Kassenärztliche Vereinigung Niedersachsen" (KVN), and the employer (for parts of the productivity costs). Taking a full societal perspective would necessarily have required reliance on additional patient derived data sources.

Patients and study design

The data for the cost analysis were developed in conjunction with a multicentre randomised controlled prospective trial assessing the effectiveness of clinical quality management in patients with RA.¹² The inclusion criteria for the trial were: fulfilment of RA diagnostic criteria,¹³ age >18 years, membership of AOKN, the patient had to be known to a rheumatologist (that is, at least one visit to this rheumatologist in the past was required), and written consent. Patients for this trial were recruited by 14 outpatient rheumatologists throughout the

Abbreviations: AOKN, Allgemeine Ortskrankenkasse Niedersachsen; DMARDs, disease modifying antirheumatic drugs; EBM, Uniform Value Scale; KVN, Kassenärztliche Vereinigung Niedersachsen; NSAIDs, non-steroidal anti-inflammatory drugs; RA, rheumatoid arthritis

Table 1 Demographic, clinical, and occupational variables of the 340 patients with RA at the baseline of the clinical trial (the examined cost data focused on the one year before inclusion in the clinical trial; cost data for two patients were missing)

Demographic variables	
Female, No (%)	260 (76)
Age (years), mean (SD)	58.4 (11.8)
Clinical variables	
Disease duration (years), mean (SD)	8.4 (8.4)
No of swollen joints, mean (SD)	5.2 (6.1)
ESR (mm/1st h), mean (SD)	16.5 (15.4)
Rheumatoid factor positive, No (%)	215 (64)*
Erosive changes, No (%)	181 (60)†
Social variables	
Currently employed	96
Retired	184
Apprenticeship as highest educational level	144
University degree as highest educational level	4

*Data of three patients missing; †data of 40 patients missing.

region of Niedersachsen, Germany. To prevent any bias from study intervention (protocol driven costs) we decided to analyse the costs of the study group one year before inclusion in the trial. Hence, patients who satisfied the respective classification criteria for RA¹³ were (a) included in the clinical trial and (b) the respective patient identities were taken to analyse the costs retrospectively over the period of one year before the start of the trial (that is, third quarter 2000 to second quarter 2001). Table 1 shows the clinical characteristics of the study sample of 340 patients with RA.

Data sources and data transfer

A patient by patient micro-costing approach was performed.¹⁴ The cost data were derived from a major statutory health insurance plan, the AOKN. The AOKN covers the medical care for 2.317 million members in the region of Lower Saxony, which is one of 16 regional states in Germany.¹⁵ However, only the inpatient costs, costs for devices and aids, drug costs, and the productivity costs are available from the AOKN on a patient by patient basis. Payment of physicians for outpatient care is subject to a process involving two steps. Firstly, all sickness funds make total payments to the physicians' associations for the payment of all affiliated physicians. The total amount is negotiated as a capitation for each member or for each insured person. Secondly, the associations have to distribute this lump sum among their members according to a distinct point system: the Uniform Value Scale (EBM).¹⁶ All for remuneration approved medical services are listed in the EBM. Therefore all outpatient cost data in Germany are collected and managed by the physicians' associations. The transmission of those datasets for outpatient services from the physicians' associations to the sickness funds is prohibited by federal law, except for educational purposes within clinical trials. Hence, we also approached the regional physicians' association, KVN, and received information on all incurred outpatient healthcare use for our patients on a patient by patient basis. The translation of physical healthcare use units into monetary units was based on the EBM system (the monetary value of each EBM point was €0.04 and remained stable over the study time period). The data received from AOKN and KVN were matched in a single database. The matching was performed on a patient by patient basis using anonymous matching codes which were used for the transfer of the cost data from the two healthcare providers. The data transfer was performed quarterly and covered the period between July 2000 and June 2001.

Content of cost domains

Our analysis was structured according to the recently published matrix of cost domains in RA.¹¹ However, owing to

the perspective of the study (payer's perspective), we did not follow the matrix in every detail. The original matrix consists of 19 cost domains. In our analysis we did not separately elaborate the following domains: home remodelling, medical equipment, non-medical practitioner and alternative therapy, patient time, opportunity costs, and lost wages. The vast majority of payments for home remodelling, medical equipment, non-medical practitioner and alternative therapy are covered in Germany by the patients themselves. Assessment of these costs requires patient derived data. Furthermore, domains such as patient time, opportunity costs, and lost wages require methodologically advanced patient derived data, which were not the scope of this investigation. An overview of the contents and data sources of the remaining 13 domains is given in the appendix. The German retirement schemes (=pension funds) traditionally cover rehabilitation treatments which are aimed at delaying or preventing disease related work disability. We did not have access to data from the retirement schemes. Therefore this cost domain may be underrepresented. Patient co-payments are not part of the EBM based accounting system. Co-payments in Germany often occur for drug and inpatient costs. However, owing to the applied healthcare payer's perspective and the fact that patients with chronic conditions such as RA are excluded from any co-payment requirements, they were not covered in our analysis.

RA related versus non-RA related direct costs

A major challenge was the discrimination of RA related and non-RA related costs. Physician visits were considered to be RA related when the respective ICD-10 code (International Classification of Diseases) included RA (M05 and M06). Transportation costs in conjunction with these visits were considered to be RA related. For outpatient surgery, non-physician service use, and devices and aids a list of RA related procedure codes was developed and costs were extracted from the database. The following drugs were considered to be RA related: disease modifying antirheumatic drugs (DMARDs), steroids, non-steroidal anti-inflammatory drugs (NSAIDs), drugs for osteoporosis, analgesics, and gastroprotective drugs. Antibiotics were listed separately but not included in the RA related drugs figure. A full list of ICD-10 based hospital diagnoses was developed. Beside RA (M05 and M06), all hospital admissions which were likely to be RA related were identified. For the two most important cost domains (drugs and hospital visits) non-RA related costs were extracted separately. All other non-RA related costs were calculated as a lump sum.

Productivity costs

This domain included the two components sick leave and work disability. Sick leave days of gainfully employed patients were derived from the AOKN data. Costs for sick leave for each gainfully employed patient were derived by the formula: "sick leave days × (yearly income/250)", with 250 reflecting the estimated number of working days per year in Germany. Yearly income was given within the AOKN data. In Germany, payments for any sick leave period which exceeds six weeks (that is, 42 days or 30 working days) is covered by the health insurance. Employers cover payments for any sick leave period of less than six weeks. Payments of the employer reach employee's gross wages, while payments from the sickness fund cover up to 80% of gross wages. Costing for work disability was based on the respective retirement codes given by the AOKN. These codes were used to discriminate between disease related retirement and age related retirement. The yearly income (that is, pension payments) of retired patients was given within the AOKN data. The income of all patients with disease related retirements was considered to constitute the total work disability costs. We could not discriminate between

Table 2 RA related direct costs (€) per patient-year by cost domains

Cost domain	Mean (SEM)	Percentage of direct costs	Median	Range
Visits to physicians	323.5 (9.3)	14.0	300	0–972
Outpatient surgery	3.9 (1.6)	0.2	0	0–352
Emergency room visits	0	0	0	0
Non-physician service use	2.4 (0.7)	0.1	0	0–135
Drugs	1019.3 (144.1)	44.1	382.7	0–28975
DMARDs	722.7 (138.6)	31.3	189	0–27949
Steroids	46.9 (3.7)	2.0	28	0–396
NSAIDs	83.7 (12.1)	3.6	15	0–2693
Osteoporosis drugs	73.3 (7.8)	3.2	19	0–890
Analgesics	21.7 (5.3)	0.9	0	0–1032
Gastroprotective drugs	71.1 (12.3)	3.1	0	0–1960
Diagnostic/therapeutic procedures and test	185.3 (5.7)	8.0	168.0	0–608
Imaging of bones and chest	27.2 (1.3)	1.2	24.2	0–132
Laboratory tests	140.1 (4.4)	6.1	126.9	0–462
Other procedures	18.0 (1.9)	0.8	7.7	0–328
Devices and aids	168.4 (34.9)	7.3	0	0–8712
Acute hospital facilities (without surgery)	276.1 (79.0)	11.9	0	0–19150
Acute hospital facilities (surgery)	215.1 (67.5)	9.3	0	0–15690
Non-acute hospital facilities	65.3 (27.9)	2.8	0	0–6544
Transportation	52.7 (10.9)	2.3	0	0–1921
Home healthcare services	0	0	0	0

DMARDs, disease modifying antirheumatic drugs; NSAIDs, non-steroidal anti-inflammatory drugs.

RA related work disability and work disability due to any other disease. Therefore we assumed that all disease related work disability was due to RA. The yearly income data used for the calculations covered the gross income of the employees and did not account for any additional expenditure by employers (contributions to social insurance covered by employers, etc).

Ethical approval and data protection

For the course of the study a contract was signed between the AOKN, KVN, and the Hannover Medical School. The study design was approved by the local ethics committee of the Hannover Medical School. Data transfer procedures and data protection measures were approved by the Social Ministry of Niedersachsen. The patients were informed separately about the contents of the clinical trial and the retrospective cost data collection and signed two separate informed consent forms.

Statistics

Data management was performed on Microsoft ACCESS software (version 8.0). For data analysis SPSS version 10.0 was used. For the purpose of the current study only descriptive statistics were applied.

RESULTS

Clinical data were available for 340 patients. Cost data were available for 338 patients. The two missing patients were covered by the AOK of another state (Nordrhein-Westfalen) and therefore not accessible. The total direct costs for the 338 patients during the one year period (third quarter 2000 to second quarter 2001) was €3815 per patient-year (SEM €267). RA related direct costs were €2312 per patient-year (60.6% of the total direct costs). Further disaggregation of direct cost domains showed outpatient costs of €1703 per patient-year (73.7% of the RA related direct costs), inpatient costs of €556 per patient-year (24.0% of the RA related direct costs), and other disease related costs of €53 per patient-year (2.3% of the RA related direct costs). Table 2 shows the disaggregated RA related direct cost figures and table 4 the corresponding physical units.

Within the direct outpatient cost domains drug costs were by far the most important cost driver. Total drug costs for the study sample were €1739 per patient-year. RA related drug costs accounted for 58.6% of the total drug costs—that is,

€1019 per patient-year (44.1% of the RA related direct costs). Antibiotics were not included in this figure. They accounted for €2.4 per patient-year of the non-RA related drugs. Within the observed year 311 patients received any kind of DMARD treatment. A separate analysis for each of the four quarters (that is, Q3'00, Q4'00, Q1'01, Q2'01) was conducted. Over the four quarters the number of patients receiving methotrexate ranged from 177–186, sulfasalazine 30–34, (hydroxy-) chloroquine 28–50, gold 0–1, cyclosporin 12–15, azathioprine 4–7. However, as shown in fig 1 we found a sharp increase in DMARD costs during the year owing to the market penetration of infliximab (approval August 1999) and etanercept (approval February 2000). In Q3'00 4 patients received treatment with one of these biological drugs, in Q4'00 the number had increased to 6 patients, in Q1'01 to 7 patients, and in Q2'01 to 10 patients. Considering a yearly treatment cost of up to €20 000 per patient-year¹ the trend shown in fig 1 can be explained by the few additional patients being treated with the new biological agents.

Physician visits accounted for €323 per patient-year. Further disaggregation was performed according to the three

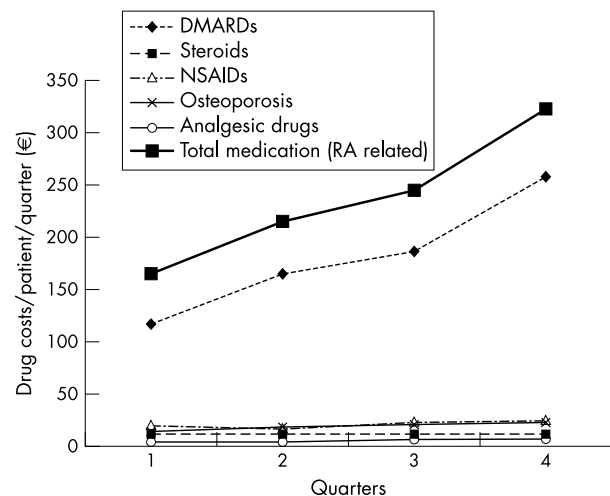


Figure 1 Development of RA related drug costs (without gastroprotective drugs) over the course of one year.

Table 3 Productivity costs (€) per patient-year by cost domains

Cost domain	Mean (SEM)	Median	Range
Sick leave*	2835 (470)	780	0–22858
Work disability payment†	8358 (357)	8006	0–16775

*Related to the 96 patients who were gainfully employed; †related to the 98 patients who received disease related work disability payments.

contributing physician groups: general practitioners accounted for €219 per patient-year (67.8% of the physician costs), rheumatologists for €80 per patient-year (24.8% of the physician costs), and specialists other than rheumatologists for €24 per patient-year (7.4% of the physician costs).

Total RA related inpatient costs were €556 per patient-year, which may be further disaggregated into acute non-surgical hospital facilities (49.6% of the inpatient costs), acute surgical hospital facilities (38.7% of the inpatient costs), and non-acute hospital facilities (11.7% of the inpatient costs). However, RA related inpatient costs only accounted for 50.0% of the total inpatient costs which were €1111 per patient-year. Altogether, 25 hospital stays (total of 393 inpatient days) occurred because of RA (ICD-10 M05 and M06). Another 28 hospital stays were considered to be RA related (two cases of anaemia, four cases of respiratory infections, six cases of arthrosis, nine cases of other RA related symptoms such as cervical disc disorders, acquired deformity of fingers and toes, synovitis, and bursitis, five cases of fractures of lower and upper limbs, one case of osteoporosis, and one case of poisoning by drugs). There was no reported case of hospital admission due to gastrointestinal complaints.

The costs for the other direct cost domains are given in table 2. We could not identify any costs for emergency room visits and home healthcare services. As stated in the appendix (table 5) this might reflect the fact that emergency room admissions due to RA are rather rare in Germany and that the few occurring RA related emergency room visits might be included in the other outpatient cost domains.

Non-RA related direct costs accounted for 39.4% of the total direct costs (that is, €1503). As the two major cost drivers we identified non-RA related drugs (€720), including antibiotics, and non-RA related hospital episodes (€555) with diseases of the circulatory system (23 inpatient stays) and neoplasms (16 inpatient stays) being the most common diagnoses.

Table 3 shows the disaggregated RA related productivity cost figures and table 4 the physical units. One hundred and eighty four patients were retired and received respective payments. Ninety eight of these patients were retired prematurely owing to RA related work disability. The average work disability cost for this sample was €8358 per patient-year (SEM 357). Ninety six of our patients were considered to be gainfully employed—that is, they did not receive any retirement pension and had a salary of >€0. The average annual sick leave costs for these 96 patients were €2835 per patient-year (SEM 470). The average number of sick leave days for each gainfully employed patient was 56 per patient-year (SEM 9) and 35 gainfully employed patients did not have a single day of sick leave. Twenty five gainfully employed patients exceeded the threshold of six weeks of sick leave per sick leave period (that is, 42 days or 30 working days). For those patients the sickness fund (AOKN) made sick leave payments. Altogether, the AOKN refunded 39.7% of all sick leave payments with the employers covering the remaining 60.3%.

DISCUSSION

Our study showed total yearly direct costs in a well treated RA cohort of €3815 per patient-year with €2312 per patient-year (60.6%) directly related to RA. Drug costs were by far the dominating RA related direct cost domain (44.1% of direct costs) with a sharp upward trend since the introduction of the new biological agents. Productivity costs exceed direct costs in gainfully employed patients (€2835) and in patients with RA related retirement (€8358).

The costing studies examined in a recent survey¹ showed an average of RA related direct costs of about €5000 per patient-year. Our total RA related direct cost data (€2312 per patient-year) are lower than this figure. However, several issues limit the comparability of our data with those of the other cost of illness studies:

Table 4 RA related direct and productivity costs in physical units (only cost domains with costs of > €0)

Cost domain	Physical units
Visits to physicians	<ul style="list-style-type: none"> Total of 4477 visits to general practitioners, Total of 3555 visits to rheumatologists, Total of 841 visits to other specialists (related to RA)
Outpatient surgery	Total of 25 outpatient surgical procedures
Non-physician service use	Total of 179 non-physician service visits
Drugs	Number of patients receiving respective treatment:
DMARDs	311
Steroids	255
NSAIDs	232
Osteoporosis drugs	189
Analgesics	106
Gastroprotective drugs	249
Diagnostic/therapeutic procedures and test	Total of number of procedures:
Imaging of bones and chest	420
Laboratory tests	20829
Other procedures	458
Devices and aids	Total of number of prescriptions: 255
Acute and non-acute hospital facilities (without surgery)	Total number of inpatient days: 430
Hospital facilities (surgery)	Total number of inpatient days: 266
Transportation	Total number of trips: 703
Sick leave	<ul style="list-style-type: none"> 96 Patients were gainfully employed. They incurred a total of 5395 sick leave days
Work disability	<ul style="list-style-type: none"> At the beginning of the year 98 patients were retired prematurely owing to work disability, at the end of the year it was 99 patients

- Most studies do not clearly define the perspective taken (societal *v* payer's perspective, etc), which necessarily limits comparability of the results
- Differences in demographic and clinical characteristics as well as differences between international healthcare systems lead to a high variance in the outcome of costing studies
- We aimed to clearly discriminate RA related from non-RA related direct costs. Similar to the methodological approach of Lanes *et al.*,¹⁷ we therefore created lists of drugs, procedures, and types of encounters that were likely to have been indicated for RA. Taking this approach, we found that only 60.6% of total direct costs were related to RA. Additional costs of €1503 per patient-year did not fall within the RA related cost categories, with non-RA drugs accounting for €720 per patient-year and non-RA hospital stays accounting for €555 per patient-year. The relevance of these non-RA related costs has been emphasised by Gabriel *et al* and Girard *et al.*^{18, 19} They reported that patients with RA incurred significantly more costs not only for musculo-skeletal disease care but also for the care in numerous other conditions. From a payer's perspective this seems of importance as there is increasing evidence that in patients with chronic conditions such as RA the propensity to claim medical services is generally higher even when those services are not related to the underlying chronic disease.

The distribution of RA related direct costs (that is, the relative weight of individual direct cost domains compared with the others) shows a high proportion of RA related drug costs (44.1% of RA related direct costs). In comparison with other published studies^{3, 8} this seems relatively high. Two reasons may account for this. Firstly, our patients were identified by consultant rheumatologists—that is, were very likely to receive appropriate RA care with intensive DMARD treatment. This view is supported by the findings of Lanes *et al.*¹⁷ They applied a comparable strict selection process and reported drugs to account for \$1342 per patient-year (that is, 62.1% of direct costs in RA). Secondly, as shown in fig 1 there is a clear upward trend in the drug costs over the four quarters, which is mainly due to the introduction of the new biological agents. Owing to the limited time horizon (one year) of our study we did not aim at evaluating potential increases in drug costs against potential long term cost savings (reduction of hospital admissions, productivity costs, etc).

The level of productivity costs reported and the ratio of productivity costs/direct costs differ considerably in the internationally available trials. At one extreme the Canadian costing study³ reports a ratio of productivity costs/direct costs of 1/3. Gainfully employed patients represented ~20% and patients with RA related disability represented ~14% of their population. At the other extreme the Swedish costing study² estimated potential working capacity by using the average labour costs for the respective age group and the subsequent decrease in working capacity due to RA in each of their patients and reported a ratio of productivity costs/direct costs of 3/1. Our analysis aimed at reporting productivity costs which were actually incurred. Real annual income, number of sick leave days, and retirement status of patients were available. Productivity costs were calculated based on these variables, which showed sick leave payments of €2835 per gainfully employed patient-year, and RA related retirement payments of €8358 per RA related retired patient-year. The results were compared with our results from another cohort of patients with RA.³ In that study sick leave costs were €5898 per patient-year and retirement payments were €1946 per patient-year. The difference from our current results is probably due to two factors: (a) whereas our earlier results⁵ focused on patients within the first three years after onset of disease, the current study sample had an average disease

duration of 8.4 years. As suggested in the earlier publication⁵ the composition of productivity costs changes over time. In early RA sick leave costs are the dominant productivity cost component, whereas in advanced disease stages disability payments become more important; (b) a more aggregated costing approach to estimating productivity costs per sick leave day in the earlier study⁵ produced a higher estimate than the values actually observed in the current sample (that is, €71.8 *v* €50.4 per sick leave day).

The strength of our methodological approach is based on a unique access to real incurred cost data. This approach is very helpful for identifying healthcare use from a payer's perspective, but it may not be possible to access a similar set of data in other countries. A further limitation in the generalisability of our micro-costing approach is the selection of the study sample. The identification of patients was performed by consultant rheumatologists—that is, all patients were receiving rheumatologist care. We did not examine patients solely receiving general practitioner care. According to a recently published American study the specialisation of a respective care provider (rheumatologist *v* generalist) should not have a major impact on incurred costs.²⁰ However, it remains to be clarified whether this also true in Germany. A second selection criterion was that all patients had to be insured by the same health insurance scheme, the AOKN. We did not include patients covered by other insurance plans, or patients in the higher income strata who may be members of one of the private health insurance schemes. As indicated by the relatively low level of education (only four patients out of 338 had a university degree) it is likely that the selected patients represent the lower social strata. This might have biased the results towards an overestimation of direct costs.²¹ Finally, it has to be mentioned that the region of Niedersachsen has a relatively high number of consultant rheumatologists and that other German regions may have different patterns of care and costs.

To examine some of these uncertainties further analyses are planned. In particular, cost data from a sample of 1000 patients with RA treated only by general practitioners is currently being generated and will be compared with the present cohort. In addition, a comprehensive set of patient derived data is being developed and the outcome of the micro-costing approach will be compared with the patient derived cost estimates in the future.

Our results provide a comprehensive insight into cost of illness of RA in Germany. It is important to consider both RA related and non-RA related costs. Drug costs are the dominant direct component with an increase due to the introduction of biological agents. In gainfully employed patients and in patients with RA related retirement payment productivity costs exceed direct costs. Micro-costing based on healthcare payer's cost data seems to provide a relatively conservative albeit highly accurate estimate of costs in RA.

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Appendix

Table 5 shows the contents of the cost domains and the respective data source.

Table 5 Content of cost domains and respective data source

Cost domains	Contents and remarks	Data source*
1. Healthcare costs direct		
<i>1.1. Outpatient costs</i>		
1.1.1. Visits to physicians	Included general practitioner, rheumatologist, and—as applicable—other specialist fees for consulting (history taking, body examination, documentation, and communication fees)	KVN
1.1.2. Outpatient surgery	Outpatient surgical services performed in hospital and non-hospital settings are differently accounted for; costs for both, the procedures, and the anaesthetic support were included	AOKN and KVN
1.1.3. Emergency room visits	Not separately accounted for in Germany; costs are included in the inpatient cost domains	AOKN
1.1.4. Non-physician service use	Included physical medicine as well as psychological interventions	KVN
1.1.5. Drugs	Costs for RA relevant subgroups were identified: DMARDs, steroids, NSAIDs, and osteoporosis drugs	AOKN Disaggregation based on PZN code ("Pharma-zentralnummern")
1.1.6. Diagnostic/therapeutic procedures and test	Disaggregation was performed to identify relevant procedures for RA and treatment surveillance: imaging of bone and chest (x rays, MRI, CT, or nuclear bone scan, ultrasound of joints and abdomen, osteodensitometry); laboratory tests (tests for inflammatory activity, other immunological tests, antibody screening, blood count, liver enzymes, kidney, and urine tests), and other procedures (joint biopsy, radioactive synovectomy)	KVN Disaggregation based on EBM code ("Einheitlicher Bewertungsmaßstab")
1.1.7. Devices and aids	Total costs for devices and aids included. However, data may be of limited validity owing to complicated flow of information: prescriptions are initiated by the doctor, transferred by patients to an aids and devices magazine, and from there directly to the insurance scheme. According to the AOKN data management personnel delays and various other irregularities are very common	AOKN
<i>1.2. Inpatient costs</i>		
1.2.1. Acute hospital facilities (without surgery)	RA related hospital admissions were identified and calculated. Owing to the accounting procedures between hospitals and health insurance schemes only summary costs per patient per stay are available; further disaggregation into costs for accommodation, diagnostics, etc, is not possible	AOKN Identification of RA related admissions based on ICD-10 (International Classification of Diseases) admission codes
1.2.2. Acute hospital facilities (surgery)	RA related surgical procedures were identified and calculated separately	AOKN Identification of RA related procedures based on surgery code (OPS 301)
1.2.3. Non-acute hospital facilities	Rehabilitation and nursing home expenses covered by the statutory sickness fund were included. No data were available from the retirement funds, which account for the majority of rehabilitation expenditure. Owing to the accounting procedures between hospitals and health insurance schemes only summary costs per patient per stay are available; further disaggregation is not possible	AOKN Identification of RA related admissions based on ICD-10
2. Other disease related costs (direct)		
2.1. Transportation	Total transportation costs were covered, including patient's co-payment	AOKN
2.2. Home healthcare services	Home healthcare services are covered in Germany by a special nursing insurance scheme. We did not have access to these data. However, we examined the nursing codes of the statutory health insurance (AOKN) and did not find any expenditure for this cost domain	Nursing codes of AOKN
3. Productivity costs		
3.1. Loss of productivity	Included (a) sick leave payments and (b) RA related retirement payments for patients. Yearly employee income was received by sickness fund (data are always up to date because insurance rates are determined as a percentage of yearly income). Sick leave payments were calculated as daily employee income (yearly income/250 working days) times days of sick leave. A separate code covered sick leave payments from the AOKN, which allowed us to discriminate between AOKN and employer payments for sick leave. Retirement payments equalled yearly income of retired patients	AOKN

*AOKN, Health Insurance Scheme ("Allgemeine Ortskrankenkasse Niedersachsen"); KVN, Physicians Association: ("Kassenärztliche Vereinigung Niedersachsen").

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