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RESEARCH ARTICLE



A center-based, ambulatory care concept for hidradenitis suppurativa improves patient outcomes and is also cost-effective

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ABSTRACT

Background: Hidradenitis suppurativa (HS) is a chronic inflammatory skin disease affecting approximately 1% of the population. The patient journey through the German health care system leads to high disease burden and substantial treatment costs. The EsmAiL study showed that an innovative, interprofessional, multimodal care-concept reduces disease activity and burden of HS compared to standard care. This paper examines the costs of treating HS in Germany and compares them with those of the innovative care concept implemented in EsmAiL.

Methods: EsmAiL was a two-arm, multicenter, prospective randomized controlled trial including 553 adults with HS. The study was registered in the German Clinical Trials Registry (DRKS00022135). The control group (CG) remained in standard care, whereas the intervention group (IG) was referred to specialized so-called 'acne-inversa-centres (AiZ)' where patients were treated with a structured, interdisciplinary approach. The present paper analyses the treatment costs for a subpopulation based on health insurance cost data from the two largest German health insurers. Quality-Adjusted Life Years (QALY) was assessed based on Dermatology Life Quality Index (DLQI).

Results: Total annual treatment costs per patient were €3,966.07 in standard care ($n=89$) and €3,974.37 in the innovative care ($n=93$). The costs per additional QALY amounted to €12,698.72 in the IG. Given the conventional and established threshold of €22,600 to €33,900 per QALY, the innovative treatment in AiZ proved to be cost-effective.

Conclusion: Treatment costs of HS are substantial and increase with disease severity. The new form of care is cost-effective and is expected to decrease costs in the long run.

KEY MESSAGE

A structured, multimodal form of care reduces costs in the treatment of Hidradenitis suppurativa compared to standard care.

ARTICLE HISTORY

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1. Introduction

Hidradenitis suppurativa (HS) – also known as acne inversa (Ai) – is a chronic inflammatory skin condition with multiple associated comorbidities (1, 2). This leads to an increased risk of early cardiovascular morbidity and mortality. Around 1% of the population suffers from HS (3–5). On average it takes 7 years to get the proper diagnosis (6).

In addition to the limitations in personal life, the impact on work ability and on the use of the health care system is also substantial and consequently leads to high socioeconomic costs (7–9).

Due to an insufficient ambulatory care network, early stages of the disease are frequently not treated effectively to halt its progression, and patients often receive adequate care only when the disease has advanced (10).

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The medical first-line treatments, according to the European guidelines, includes topical and oral antibiotics (11, 12). For moderate to severe disease, continuous treatment with adalimumab or secukinumab as biologic therapy is applicable after failed systemic antibiotic treatment (12). Even in the early stages of the disease, surgical interventions can be necessary. Both biologics and extensive surgeries impose substantial costs; thus expenditures rise with progression of the disease (13).

The difficulties of HS patient care with the resulting burdens on those affected as well as the considerable costs for the health care system associated with the treatment of advanced disease stages are clearly addressed globally (14). However, there is only limited literature on the specific magnitude of treatment costs of HS, separated by cost source.

EsmAiL was a two-arm, multicenter, prospective randomized controlled trial involving 553 adults with HS (15, 16). The control group (CG) received standard care while the intervention group (IG) was treated according to a structured, interdisciplinary treatment plan based on current guidelines and innovative scientific evidence. Within this new form of care implemented in EsmAiL, outpatient offices, clinics and wound care centers of various specialties throughout Germany have been qualified as so-called 'acne inversa centres (AiZ)'. In each AiZ, the intervention was provided by at least one trained physician (e.g., general practitioner, dermatologist or surgeon) and by at least two trained health care professionals (e.g., registered nurse, wound manager). The new form of care in AiZ placed a strong focus on patient education, improved pain management and lesion care. In addition, care in AiZ used a combination therapy of intense pulsed light and radiofrequency (LAight®-therapy, LENICURA, Germany) as a non-invasive, physical first-line treatment in addition to the recommendations of in the current guidelines. A preceding paper on EsmAiL has shown that the new care concept significantly outperforms standard care in reducing disease activity and burden (16). This paper compares the health care costs of AiZ treatment with those of standard care.

2. Materials and methods

2.1. Trial design

EsmAiL was designed as a multicenter, randomized controlled trial (RCT) with blinded assessment. The CG remained in standard care while the intervention group IG was referred to care in AiZ. A detailed description of the intervention and the baseline characteristics of the included patients are given elsewhere (15, 16). The study was approved by the ethics committees of all participating states and registered in the German Clinical Trials Registry (DRKS00022135).

Patients were eligible for study participation if they were diagnosed with HS of all Hurley stages, were of legal age and had the mental ability to understand the patient information, follow the study procedure and signed the written informed consent. Participation was voluntary and could be withdrawn at any time. Moreover, they must have had at least 3 inflammatory lesions at the time of inclusion and the disease had to have at least a moderate impact on quality of life as measured by the Dermatologic Quality of Life Index (DLQI, (17)). Thus, the DLQI needed to be above 5. The two largest German health insurances participated in the project and contributed billing data of treatment costs of the intervention year. For this purpose, an additional patient consent was signed at inclusion into the trial, to allow evaluation of the

cost data. No changes to endpoints or methods of data collection were made during the trial.

This paper analyses a subsample of $n=182$ patients for whom treatment costs were available from data of the two largest German health insurances.

2.2. Methods and data

The analysis was carried out in the intention-to-treat (ITT) population and covered the 12 months after a patient's individual inclusion into the trial. Patient characteristics of the subgroup were compared with the total sample using χ^2 -test and t-test, respectively. The statistical evaluation was carried out by the Martin Luther University Halle-Wittenberg, Germany as an independent institution.

The analysis used the following data:

- The validated International Hidradenitis Suppurativa Severity Score System – IHS4 (18) and Hurley Stage were assessed by blinded, trained physicians ('screeners') at baseline and after 12 months. The IHS4 was used for the stratified analysis of treatment costs and therapy allocation. These data were collected as part of the EsmAiL trial and were therefore available for the health-economic evaluation.
- DLQI was assessed as patient reported outcome at baseline and after 12 months.
- All treatment costs for standard care of HS were derived from patient data from the two largest health insurance companies in Germany. These treatment costs for standard care were calculated as the sum of the following components: Outpatient care, inpatient care and medication prescriptions.
- Costs of inpatient and outpatient care were selected according to a list of ICD-10-codes that accounted for the primary code L73.2 as well as typical misdiagnoses (Supplement 1). LOCF imputation was applied to the outpatient care category to cover the entire study period, as these costs were only available until the end of December 2021 at the time of data extraction.
- For medication prescriptions a list of ATC-codes (Anatomical Therapeutic Chemical Classification System) was defined including the suggestions of the guidelines as well as other relevant medications (e.g., topical antibiotics, systemic antibiotics, biologics and analgesics, Supplement 2). The source was again the patient data from the health insurance companies. To represent costs of medication, the average of the analyzed and the preceding quarter was calculated. The reason for this was that that costs of medications were presented in billing date once they were prescribed. However, medication use often extends into the next quarter, especially in HS, where treatment cycles often last up to 10–12 weeks and longer, or are continuous treatment (e.g., with biologics).
- The costs for the new care concept were calculated according to the real utilization in the project. This data was extracted from the treatment file recorded for each individual patient during the EsmAiL trial. The new care concept for the IG included the following components (see Supplement 3): Initial assessment, patient education, follow-up assessment, final assessment, wound and lesion care and LAight therapy. For the CG, we recorded the

number of LAight therapies that patients accessed independently and outside the study intervention (self-paid). Number of LAight therapies for CG was based on self-reported data from the patient questionnaire and the final study assessment.

All costs were presented as averages for both standard care and AiZ treatment (new form of care), stratified by quarter and also summed over the whole study year. Moreover, the proportion of patients receiving a certain medical cost category (inpatient care, outpatient care, medication, new care concept, no care) in each group was reported. Differences in relative frequencies were tested for statistical significance using the χ^2 test. Analyses were stratified according to the three IHS4 severity categories (IHS4-score: mild ≤ 3 , moderate 4 to 10 and severe >10 ; (18)).

To compare the cost-effectiveness of AiZ-care to that of standard care, we applied two analyses:

1. Isolated cost-utility evaluation of project year:

As a conservative case, the delta in direct costs between IG and CG of the intervention year was compared to the difference in QALY. The result was then assessed with respect to the standard values proposed by the National Institute for Health and Care Excellence (19) to evaluate cost-effectiveness. The cost-utility analysis was based on the changes in DLQI from baseline to the final screener assessment. Based on the mapping procedure described by Ali et al. the changes in DLQI were transformed into corresponding EuroQoL Five-Dimension Three-Level questionnaire (EQ-5D-3L) values (20). Making use of the preference weights determined by Greiner et al. for Central Europe, these estimated EQ-5D-3L utility values were converted into the VAS-based weighted health status index from which Quality-Adjusted Life Years (QALY) gains could be derived (21).

2. Scenario analysis considering consecutive years, changes in severity and treated patients only:

Projected costs for a subsequent year were calculated for both study groups. These projected costs were derived from the costs of the regular care components by IHS4 disease severity, weighted by the severity distribution in the IG and CG at the end of the 12-month intervention. Only enrolled patients who received at least one treatment for HS during the study period were included in the analysis to account for the higher proportion of untreated patients within standard care.

To compare the allocation of therapies between IG and CG, we plotted the percentages of patients receiving topical antibiotics, systemic antibiotics, biologics, outpatient care, and inpatient care during the intervention period. We also investigated the proportions of patients receiving none of these therapies during the intervention year ('without care'). Differences in relative frequencies were tested for statistical significance using the χ^2 test.

3. Results

3.1. Patient characteristics

Patients were recruited throughout Germany from September 9th, 2020, until July 31st, 2021, by 15 trained, blinded screeners and allocated to either the CG ($n=279$) or IG ($n=274$). Billing data on

HS-associated costs were available for 182 patients. Of those 89 patients belonged to the CG and 93 to the IG. Both groups were comparable on baseline characteristics (Supplement 4). The characteristics of the sub-group (Table 1) mimicked the whole sample of the 553 patients participating in the EsmAiL study, except for the Hurley stage distribution ($p=0.013$), a lower IHS4 ($p=0.007$) and a lower DLQI ($p=0.011$).

3.2. Therapy allocation

In line with the suggestions of the guidelines, antibiotics were the most utilized treatment modality in standard care (Table 2 and Figure 1). Comparing this distribution with the self-reported data from the patient questionnaires of the EsmAiL total sample (Figure 2) the results show a high accordance in tendencies. Both distributions coincide in the finding that about one fourth of the CG did not receive any treatment. The EsmAiL project only enrolled patients with a certain disease activity and burden, indicating that treatment was necessary for the CG but not provided.

As compared to the CG, a lower proportion of patients in the IG received systemic antibiotics, biologics, analgesics, and inpatient hospital services. These differences were not statistically significant. A higher proportion of patients in the IG received topical antibiotics. Also, only 1.1% of the IG did not receive any treatment with respect to HS during the intervention period. To better understand the allocation of treatment modalities in the new care concept vs. standard care, Figure 3 shows the corresponding proportions only for those patients who received at least one medical intervention during the 12-month study. This analysis shows a significantly higher proportion of prescribed systemic antibiotics and biologics within the CG compared to the IG (51.5% vs. 26.1% and 21.2% vs. 9.8%, Figure 3), as well as a tendency toward more inpatient hospital services and prescriptions of analgesics (9.8% vs. 16.7% and 10.9% vs. 19.7%, Figure 3). As expected, a higher proportion of the IG received outpatient care services (89.1% vs. 71.2%) while topical antibiotics were used in an almost identical proportion of patients in both the IG and CG (25.0% vs. 24.2%). Table 2 stratifies this subgroup analysis with respect to the IHS4 severity stages at baseline. Particularly in the mild and moderate severity stages, the patients of the IG show a significantly lower rate of prescribed biologics and systemic antibiotics.

3.3. Direct costs

The average yearly total costs per patient for standard care components (computed as the sum of outpatient care, inpatient care, medication prescriptions) amounted to €2,281.81 for the IG and to €2,679.71 for the CG (Table 3). Of note is the lower cost for medication prescriptions in the IG compared to the CG (€1,447.38 vs €1,837.92), even though 25.8% of patients in the CG did not receive any care during the intervention period. This difference is mainly due to the comparatively less frequent prescriptions of biologics in the IG (the respective costs per medication category are shown in Supplement 5). When stratifying with respect to IHS4 severity categories (Table 3), the average total annual costs of standard care components per patient range from €174.43 (mild HS) to €2,760.06 (severe HS) in the IG and from €626.15 (mild HS) to €2,358.46 (severe HS) in the CG. Once limiting the analysis to patients, who received treatment (Table 3, lower three rows), mild and moderate cases in the IG resulted in considerably lower costs while for severe cases the costs were comparable for both groups.

Table 1. Comparison of baseline characteristics between patients with and without available billing data for the economic evaluation.

	Without cost data (n = 371)	Economic analysis (n = 182)	Group difference
	mean ± SD n/n _{valid} (%)	mean ± SD n/n _{valid} (%)	
Study group			
IG	181/371 (48.8 %)	93/182 (51.1 %)	$\chi^2_{(df=2)} = 0.261$
CG	190/371 (51.2 %)	89/182 (48.9 %)	$p = 0.609$
Age [in years]	38.8 ± 10.0	39.6 ± 11.5	$t_{(df=551)} = 0.845$
Gender			
Male	81/371 (21.8 %)	39/182 (21.4 %)	$\chi^2_{(df=1)} = 0.012$
Female	290/371 (78.2 %)	143/182 (78.6 %)	$p = 0.914$
Smoking status			
Smoker (incl.: E-cigarette)	244/371 (65.8 %)	109/182 (59.9 %)	$\chi^2_{(df=2)} = 2.006$
Non-smoker	64/371 (17.3 %)	39/182 (21.4 %)	$p = 0.367$
Former smoker	63/371 (17.0 %)	34/182 (18.7 %)	
Cigarettes/day (n = 333, Excl. E-cigarette)	14.1 ± 7.2 (n = 229)	14.8 ± 8.3 (n = 104)	$t_{(df=331)} = 0.764$ $p = 0.445$
Body Mass Index	32.5 ± 7.3	31.6 ± 7.3	$t_{(df=551)} = 1.247$ $p = 0.213$
Comorbidities (sum)	1.6 ± 1.0	1.5 ± 0.9	$p = 0.493$
Acne conglobata	14/371 (3.8 %)	6/182 (3.3 %)	$p = 0.778$
High blood pressure	75/371 (20.2 %)	33/182 (18.1 %)	$p = 0.561$
Inflammatory bowel disease	28/371 (7.6 %)	7/182 (3.9 %)	$p = 0.093$
Depression	104/371 (28.0 %)	48/182 (26.4 %)	$p = 0.681$
Diabetes mellitus type II	97/371 (26.2 %)	36/182 (19.8 %)	$p = 0.100$
Inflammatory joint disease	46/371 (12.4 %)	21/182 (11.5 %)	$p = 0.771$
Lipometabolic disorder	22/371 (5.9 %)	7/182 (3.9 %)	$p = 0.302$
Cardiovascular disease	12/371 (3.2 %)	6/182 (3.3 %)	$p = 0.969$
Polycystic ovarian syndrome	16/371 (4.3 %)	10/182 (5.5 %)	$p = 0.537$
Thyroid dysfunction	63/371 (17.0 %)	42/182 (23.1 %)	$p = 0.086$
Other	120/371 (32.4 %)	66/182 (36.3 %)	$p = 0.840$
Marital status (n=508)			
Single	126/339 (37.2 %)	53/169 (31.4 %)	$\chi^2_{(df=2)} = 1.667$
Married	131/339 (38.6 %)	72/169 (42.6 %)	$p = 0.432$
Divorced/widowed	82/339 (24.2 %)	44/169 (26.0 %)	
Educational level (n=508)			
School education	160/339 (47.2 %)	87/169 (51.5 %)	$\chi^2_{(df=2)} = 1.061$
Apprenticeship	137/339 (40.4 %)	65/169 (38.5 %)	$p = 0.588$
Higher educationa	42/339 (12.4 %)	17/169 (10.1 %)	
Work status			
Employed	257/371 (69.3 %)	123/182 (67.6 %)	$\chi^2_{(df=1)} = 0.162$
Not-employed ^b	114/371 (30.7 %)	59/182 (32.4 %)	$p = 0.687$
IHS4	19.7 ± 20.4	15.2 ± 13.5	$t_{(df=551)} = 2.726$ $p = 0.007$
Hurley stage			
Hurley I	41/371 (11.1 %)	31/182 (17.0 %)	$\chi^2_{(df=2)} = 8.762$
Hurley II	225/371 (60.7 %)	118/182 (64.8 %)	$p = 0.013$
Hurley III	105/371 (28.3 %)	33/182 (18.1 %)	
Pain NRS	6.9 ± 2.2	6.7 ± 2.1	$t_{(df=551)} = 1.040$ $p = 0.299$
DLQI	18.3 ± 6.5	16.8 ± 6.5	$t_{(df=551)} = 2.542$ $p = 0.011$
HADS (total)	17.6 ± 7.8	16.6 ± 7.9	$p = 0.172$
HADS anxiety	9.5 ± 4.1	9.1 ± 4.1	$p = 0.281$
HADS depression	8.1 ± 4.4	7.5 ± 4.5	$p = 0.159$
Days of work inability ^c (n=380)	16.3 ± 36.2 (n = 257)	16.6 ± 32.6 (n = 123)	$t_{(df=378)} = 0.069$ $p = 0.945$

^aUniversity of applied sciences degree, university degree, doctorate.

^bStudent, unemployed, disabled, pensioner or others.

^cDuring 12 months before inclusion in trial.

Bold values represent $p < 0.05$.

The average total costs per patient over 12 months in an AiZ amounted to €1,649.83 (Supplement 3). 95.7% of the patients in the IG used at least one of the innovative components (4.3% of IG patients did not enter AiZ-care but were kept in the analysis due to the ITT procedure). The LAight treatment accounted for the majority of costs, averaging to €1,354.20 per IG patient. Based on self-reporting, 26.4% of patients in the CG received at least one LAight treatment during the 12 months of EsmAiL outside the

intervention as self-payer, which resulted in estimated average costs per patient of €261.42 (Supplement 3).

The total costs per patient amounted to €3,931.63 in the IG and to €2,941.13 in the CG (Table 3). When considering the high proportion of patients in the CG who did not receive any treatment the differences in the average total of annual costs between IG and CG leveled out to a difference of €8.30 (€3,974.37 to €3,966.07).

Table 2. Allocation of therapies during the intervention period for treated patients in the economic analysis based on health insurance data, broken down by IHS4 severity category.

	IHS4 mild (1–3 points)			IHS4 moderate (4–10 points)			IHS4 severe (≥ 11 points)		
	IG (n=8)	CG (n=6)	p	IG (n=36)	CG (n=26)	p	IG (n=48)	CG (n=34)	p
Topical antibiotics	37.5 %	16.7 %	0.393	25.0%	26.9%	0.864	22.9%	23.5%	0.948
Systemic antibiotics	0.0 %	50.0 %	0.024	19.4%	38.5%	0.098	35.4%	61.8%	0.018
Biologics	0.0 %	0.0 %	–	5.6%	26.9%	0.018	14.6%	20.6%	0.476
Outpatient care	87.5 %	66.7 %	0.347	80.6%	76.9%	0.729	95.8%	67.7%	0.001
Inpatient care	0.0 %	16.7 %	0.231	5.6%	11.5%	0.393	14.6%	20.6%	0.476
Analgesics	12.5 %	16.7 %	0.825	8.3%	11.5%	0.674	12.5%	26.5%	0.107

Bold values represent p < 0.05.

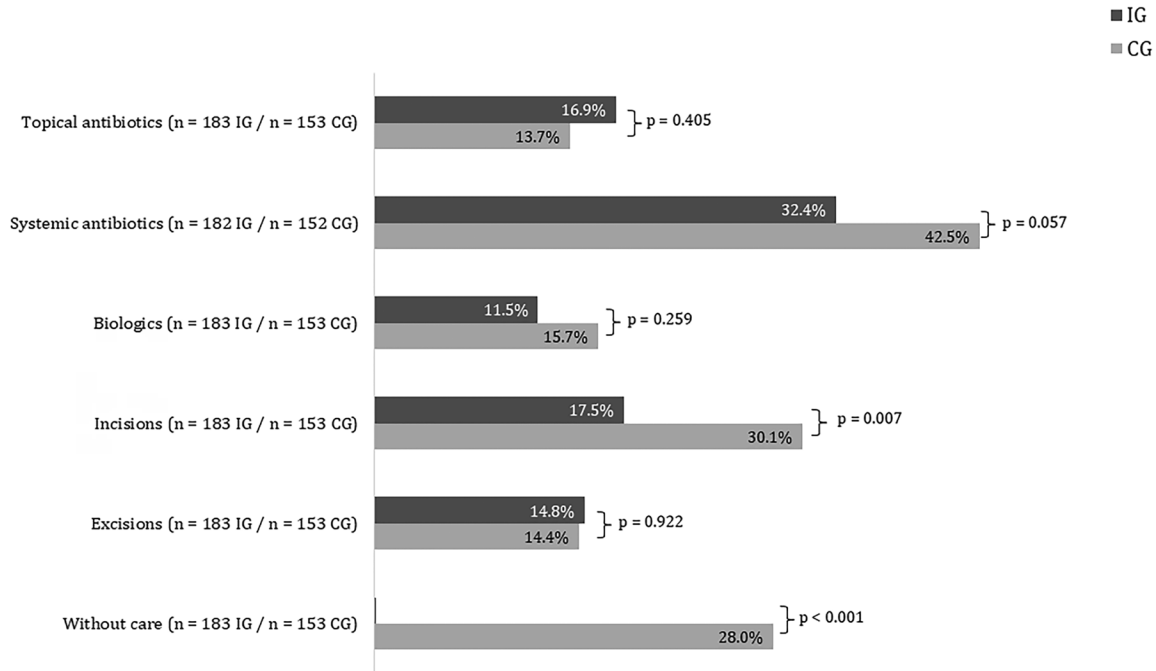


Figure 1. Allocated therapies during the intervention period for the patients in the economic analysis based on the health insurance data.

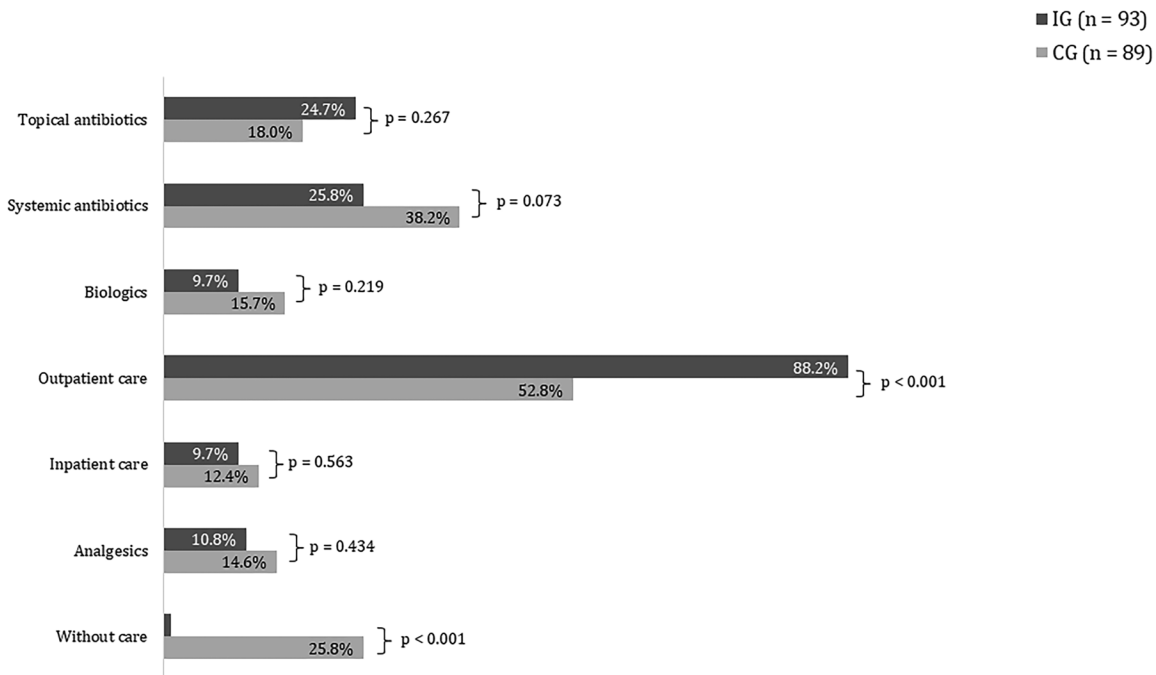


Figure 2. Comparison of medical distribution with the self-reported data from the patient questionnaires of the EsmAiL total sample (note the categories ‘incision’ and ‘excision’ in Figure 1 cannot be clearly assigned to the outpatient and inpatient care services from Figures 2 and 3).

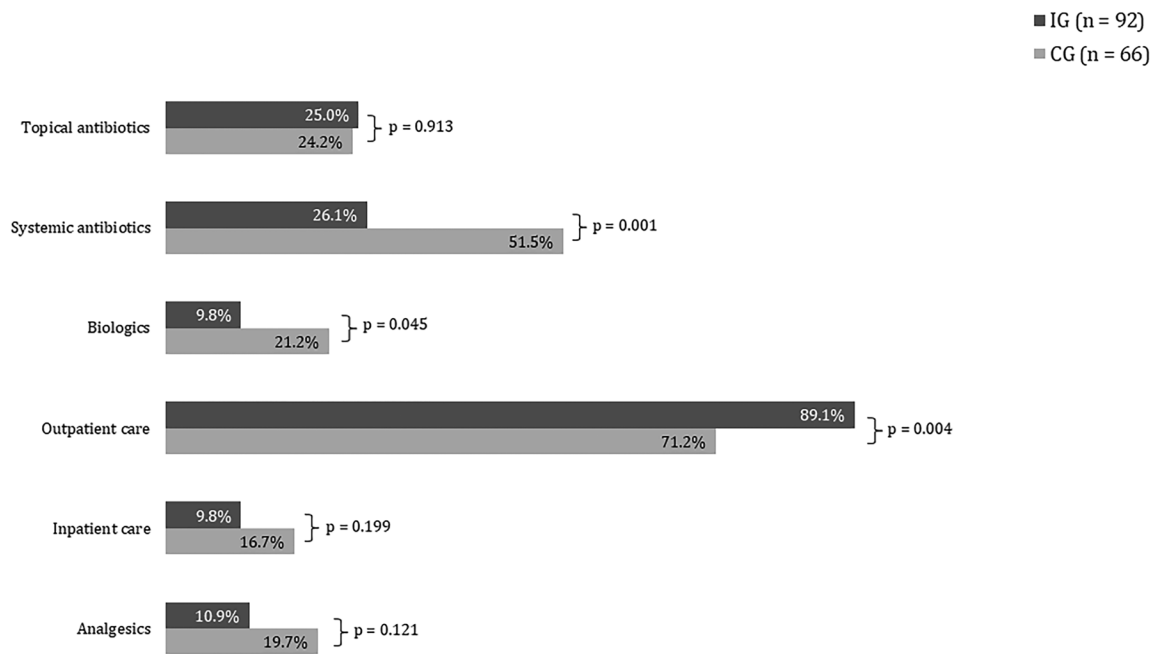


Figure 3. Proportions for patients who received at least one medical intervention during the 12-month-period based on the health insurance data.

Table 3. Average total annual cost of standard care components and new care concept per total patient and treated patients after baseline and broken down by IHS4 severity category.

	All patients of economic analysis		IHS4 mild (1–3 points)		IHS4 moderate (4–10 points)		IHS4 severe (≥ 11 points)	
	IG (n=93)	CG (n=89)	IG (n=8)	CG (n=8)	IG (n=36)	CG (n=38)	IG (n=49)	CG (n=43)
All costs in EUR								
Without care ^a	1.08%	25.84%	0%	25.00%	0%	31.58%	2.04%	20.93%
Medication prescriptions	1,447.38	1,837.92	24.13	205.19	1,406.01	2,909.83	1,710.15	1,194.40
Outpatient care ^b	438.81	302.60	150.30	152.38	391.32	400.52	520.81	244.02
Inpatient care	395.61	539.19	0.00	268.58	301.82	165.20	529.10	920.04
Standard care components (sum of medication, outpatient and inpatient care)	2,281.80	2,679.71	174.43	626.15	2,099.15	3,475.55	2,760.06	2,358.46
New care components	1,649.83	261.42	1,236.37	250.19	1,770.84	320.88	1,628.44	210.96
Standard care components + new care concept (sum)	3,931.63	2,941.13	1,410.80	876.34	3,869.99	3,796.43	4,388.50	2,569.42
Standard care components per treated patient ^c (sum)	2,306.60	3,613.55	174.43	834.87	2,099.15	5,079.65	2,817.56	2,982.76
New care components per treated patient ^c	1,667.76	352.52	1,236.37	333.59	1,770.84	468.98	1,662.37	266.80
Standard care components + new care components per treated patient ^c (sum)	3,974.37	3,966.07	1,410.80	1,168.45	3,869.99	5,548.63	4,479.93	3,249.56

^aThe proportions of patients without care during the intervention period also consider the care provided in the context of the new care concept in an AiZ (IG only) and the costs of LAight therapies used outside the study intervention (CG only).

^bImputed costs based on LOCF after December 2021.

^cn=92 for IG and n=66 for CG.

3.4. Cost-utility-analysis

Isolated cost-utility evaluation of project year:

Total annual treatment costs (including both standard care and new care components) per included patient were €2,941.13 in CG and €3,931.63 in IG (Table 3). For the IG, the 12-month-treatment in an AiZ resulted in a decrease in DLQI of 6.9 ± 6.22 points and an estimated gain of 0.145 QALYs while the CG achieved a decrease in DLQI of 3.7 ± 6.41 points and an estimated gain of 0.067 QALYs (Supplement 6).

Focusing on the single intervention year, care in an AiZ resulted in additional total costs of €990.50 compared to standard care and

differed from standard care by a gain of 0.078 additional QALYs. This results in costs of €12,698.72 per gained QALY. The National Institute for Health and Care Excellence (NICE) currently estimates a threshold of €22,600 to €33,900 (£20,000 to £30,000, €1.13 per £) per QALY in the implementation of new therapies (19). As shown in the corresponding cost-effectiveness plane (Figure 4), the new care concept is cost-effective compared to standard care in the context of this threshold for the single intervention year.

Scenario analysis considering consecutive years, changes in severity and treated patients only:

When only considering treated patients, the cost difference between IG and CG during the first year of intervention decreases

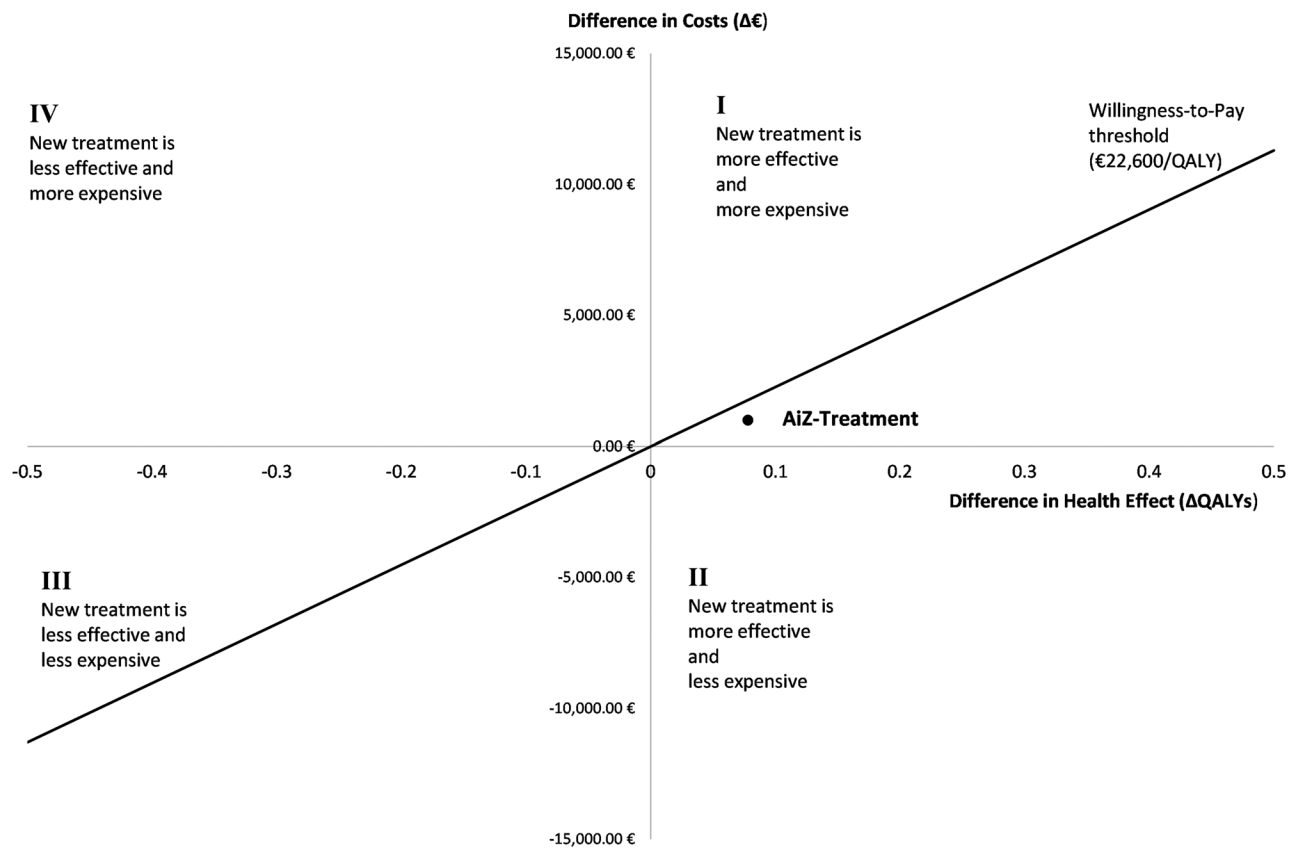


Figure 4. Cost-effectiveness plane for AiZ-treatment in comparison to standard care.

to €8.31 per patient (Table 3, lower rows). Under the assumption of the shifted disease IHS4 severity distributions, the continuation of the new care concept leads to cost savings of €889.33 for projected subsequent years (Supplement 7).

4. Discussion

Up to date, there is only limited literature that addresses treatment costs of HS even though those are estimated to be substantial. However, studies imply that higher health care costs do not necessarily correlate with better treatment outcomes (22,23). There is consensus that inpatient care and biologic therapy are the prominent cost drivers (9,22,24). Medical costs have been shown to be up to 2.4 times higher in more severe HS cases (25) which is also confirmed by the analysis at hand (Table 3). The recent approval of additional monoclonal antibodies for the treatment of HS such as secukinumab (26) and the expected approval of bimekizumab (27) are likely to reinforce this trend (10).

In the analyzed sample, 25.4% of patients in the CG did not receive any therapy at all in standard care (Table 3). Due to the diagnostic gap (28) and currently often dysfunctional patient journeys through ambulatory care in Germany many patients get access to specialists only after they have experienced a more severe manifestation of their disease, which makes measures such as surgery or treatment with biologics necessary interventions that significantly increase costs (29). These may be prevented by early adequate care hindering progression.

A preceding publication of the EsmAiL project has shown that the establishment of specialized AiZs in ambulatory care

outperforms standard care in decreasing the severity and burden of HS and significantly increases patient satisfaction (16). The present analysis is the first of its kind to estimate the costs of treating HS in standard care in Germany and shows that these costs can be reduced by structured, multimodal care. The present analyses did not aim to evaluate the cost-effectiveness of individual components of the new care model. Instead, the aim of the present analyses was to compare the cost of the new care approach – including the interactions between all its individual components with the cost of standard care. In contrast to the CG, 99% of the included IG patients were treated with respect to their HS. Given the progressive disease course of HS, this is an important finding. Our results reveal that especially in the mild and moderate IHS4 severity categories patients in the IG needed less biologics, systemic antibiotics, and inpatient care. These findings suggest that the treatment algorithm within the new care concept was able to achieve remission in early steps of the algorithm, preventing the allocation of burdensome and costly medication therapies and surgery. However, the present analysis implies that – even though prescribed more often – the treatment with antibiotics imposes lower costs in the CG than in the IG (Table S1a). Yet, it should be emphasized that the guidelines suggest long-term antibiotic therapy of up to 16 weeks (12). Short-term treatment cycles are certainly cheaper but are not recommended. Thus, the presented cost analysis also implies that CG patients may not have been treated according to current HS therapy recommendations.

The new form of care proved to be cost-effective and is even expected to decrease cost of care in the long run (Supplement 7): Within the conservative model based on the solitary intervention

year, the additional total annual cost of the IG of €990.50 per patient are justified by the additional gain of 0.078 QALYs over the CG. Considering that missing treatment will not lead to any improvement and could result in higher costs when untreated patients seek medical care in the future, the scenario analysis based on a projected subsequent year shows that the additional costs of the first year of the new care concept decrease to a marginal €8.31, while for the projected subsequent years cost savings per patient amount to €889.33 (Supplement 7).

Our study has limitations. We acknowledge that the economic evaluation could not be applied to all patients in the EsmAiL cohort. The studied subgroup appears to be somewhat less affected considering disease activity than the total EsmAiL-cohort (Table 1). This may underestimate the costs of care presented. However, since the analysis distinguishes between IHS4 severity categories, the present results can be directly transferred to the general EsmAiL-cohort. Another limitation of our study is that we did not obtain generic quality of life questionnaire data, such as the EQ-5D-3L, during the trial. Instead, we transformed the DLQI to EQ-5D-3L values post-trial, which may introduce biases in the assessment of health-related quality of life.

It should be noted that medication costs have been identified with respect to a list of typical HS-relevant substances. However, the German system does not allow for a direct association of medication prescriptions with diagnoses. Thus, a certain bias can be arising from the fact that medication might have been prescribed for other reasons. However, those effects are assumed to be mitigated due to the randomization of the study population.

It is described that even up to 50% of patients diagnosed with HS do not receive any treatment (30). So, the proportion of 25.2% of patients not treated in standard care is rather low. This might be because patients of the CG were usually contacted by the study team if they missed a timely completion of the questionnaires; it thus appears likely that the additional attention motivated CG patients to also seek care for their disease.

In the context of our study, it is worth noting that health economic evaluations have also been conducted for other inflammatory skin diseases, such as psoriasis or atopic dermatitis (31, 32). Their findings suggest that, similar to ours in HS, the increased use of biologic treatments has had a significant impact on the economic burden of treatment. The introduction of biologics in psoriasis and atopic dermatitis has led to a notable increase in direct costs, reflecting a trend that is expected to be fostered for the treatment of HS. Our analysis implies that structured care concepts can have a substantial impact on treatment costs in various dermatoses, not only HS.

In summary, the analysis shows that cost for the care of HS are substantial and increase with disease severity with inpatient surgical care and biologic therapy as main cost drivers. Antibiotics are still the most frequently prescribed intervention. The new form of care has a positive impact on the course of the disease, is cost-effective and is expected to decrease direct cost of care in the long run. It is known that HS is also associated with high secondary costs, such as comorbidities and impairment of work ability (13,33). It is hardly possible to measure the indirect costs of the HS. However, it can be assumed that the indirect costs of disease will also decrease as a result of the increased ability to work due to the new form of care.

Due to the specifics of the German health care system, in which the costs for biologics and other components of standard care are reimbursed directly by the health insurance funds, and the LAight therapy is available nationwide, results are not fully transferable to other countries with different health care systems.

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