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Research: Care Delivery

Improving quality of care in people with Type 2 diabetes through the Associazione Medici Diabetologi-annals initiative: a long-term cost-effectiveness analysis

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Abstract

Aims The Associazione Medici Diabetologi-annals initiative is a physician-led quality-of-care improvement scheme that has been shown to improve HbA_{1c} concentration, blood pressure, lipid profiles and BMI in enrolled people with Type 2 diabetes. The present analysis investigated the long-term cost-effectiveness of enrolling people with Type 2 diabetes in the Associazione Medici Diabetologi-annals initiative compared with conventional management.

Methods Long-term projections of clinical outcomes and direct costs (in 2010 Euros) were made using a published and validated model of Type 2 diabetes in people with Type 2 diabetes who were either enrolled in the Associazione Medici Diabetologi-annals initiative or who were receiving conventional management. Treatment effects were based on mean changes from baseline seen at 5 years after enrolment in the scheme. Costs and clinical outcomes were discounted at 3% per annum.

Results The Associazione Medici Diabetologi-annals initiative was associated with improvements in mean discounted life expectancy and quality-adjusted life expectancy of 0.55 years (95% CI 0.54–0.57) years and 0.48 quality-adjusted life years (95% CI 0.46–0.49), respectively, compared with conventional management. Whilst treatment costs were higher in the Associazione Medici Diabetologi-annals arm, this was offset by savings as a result of the reduced incidence and treatment of diabetes-related complications. The Associazione Medici Diabetologi-annals initiative was found to be cost-saving over patient lifetimes compared with conventional management [€ 37,289 (95% CI 37,205–37,372) vs € 41,075 (95% CI 40,956–41,155)].

Conclusions Long-term projections indicate that the physician-led Associazione Medici Diabetologi-annals initiative represents a cost-saving method of improving long-term clinical outcomes compared with conventional management of people with Type 2 diabetes in Italy.

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Introduction

The prevalence of diabetes in Italy is approaching 8% (including diagnosed and undiagnosed cases), and the disease was responsible for > 26,000 deaths in 2011 [1]. In 2010, diabetes-related healthcare expenditure was > $20 bn and is expected to increase to ~ $23 bn by 2030 [2]. The principle driver of this expenditure is diabetes-related complications as a result of patients not receiving optimized treatment.

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The key challenges in the successful treatment of Type 2 diabetes include maintaining tight glycaemic control, controlling cardiovascular risk factors and reducing hypoglycaemia risk, but the existing treatment strategies do not all represent a true multifaceted solution that meets each of the clinical needs of a patient with diabetes [3]. To address the multifactorial needs of the modern patient with Type 2 diabetes, a number of organizations worldwide have started continuous monitoring programmes to evaluate and optimize the treatment that patients receive [4,5]. The Associazione Medici Diabetologi (AMD) has introduced the AMD-annals initiative in Italy, a physician-led qual-

What's new?

- The Associazione Medici Diabetologi-annals initiative has described improvements in physiological measurements, but this has involved increased short-term costs.
- This analysis is the first to evaluate the long-term clinical and cost outcomes of enrolling people with Type 2 diabetes in this initiative.
- Over patient lifetimes, enrolment in the initiative is associated with a lower incidence of diabetes-related complications, longer life expectancy, longer quality-adjusted life expectancy, and lower direct medical costs.
- Improving diabetes care in Italy through this initiative results in significant clinical benefits and cost-savings over the long term.

ity-of-care improvement scheme based on the systematic evaluation of routine data. Work to introduce the AMD-annals initiative began in 2000 with the first report issued in 2006. Initially, data were collected from 100 of the 680 diabetes treatment centres in Italy, but since the inception of the scheme the number of participating centres has increased and now includes one third of all centres and one sixth of all people with diabetes across Italy. Data are collected on 46 quality indicators, including process measures that evaluate the diagnostic, preventative and therapeutic procedures performed, and outcome indicators such as HbA_{1c} concentration, blood pressure and lipid profiles [6]. Results are published annually and are freely available from the AMD website [7]. Diabetologists have access to the results of the initiative, and the quality-of-care profiles, and the experiences of the best-performing centres can be used to guide future changes in care. Quality-of-care improvement initiatives can be successful if they are perceived as a natural component of clinical practice, and not as an external intervention to control clinical performance; thus, a voluntary initiative, promoted within the national healthcare system by diabetes specialists, can produce tangible improvements in quality of care. The aim of the AMD-annals initiative is that, through sharing of data, steps can be taken to improve diabetes care for all patients in all centres.

A number of previously published articles have detailed the effectiveness of the AMD-annals initiative, describing improvements in physiological measurements [8–10]. However, optimizing patient care often involves a greater number of physician visits and increased prescription costs, as well as the costs of maintaining and analysing the database. The aim of the present study was to examine the long-term cost-effectiveness of improving quality of care through the AMD-annals initiative, in comparison with the continued conventional management of people with Type 2 diabetes mellitus in Italy.

Methods

Model description

The analysis was performed using the CORE Diabetes Model, the architecture, assumptions, features and capabilities of which have been previously published [11]. The model is a validated, non-product-specific diabetes policy analysis tool and is based on a series of interdependent sub-models that simulate the complications of diabetes. Monte Carlo simulation using tracker variables overcomes the memory-less properties of the standard Markov model, and allows interconnectivity and interaction between individual complication sub-models. Long-term outcomes projected by the model have been validated against real-life data in 2004 and more recently in 2012 [12,13]. Model outputs are mean life expectancy (measured in years), quality-adjusted life expectancy (measured in quality-adjusted life years), direct costs (measured in 2010 Euros [€]), diabetes-related complication rates (described in terms of cumulative incidence), and mean time to onset of diabetes-related complications (measured in years).

Simulation cohort and treatment effects

The simulated cohort (Table 1) was based on the baseline physiological measurements of people with Type 2 diabetes enrolling in the AMD-annals initiative and supplemented with prevalence-of-complication data from the Renal Insufficiency and Cardiovascular Events (RIACE) study [14, 15]. The analysis considered a closed cohort of people with Type 2 diabetes enrolled in the AMD-annals initiative for a minimum of 5 consecutive years. This criterion was chosen to identify data on the effects of taking part in the AMD-annals initiative. The programme is long-term with a focus on follow-up/continuous monitoring; patients staying for a short time would probably not have been exposed to multiple assessments. A total of 195,851 people with Type 2 diabetes met the inclusion criteria. Treatment effects (Table 2) were applied in the 1st and 3rd years of the simulation in the AMD-annals arm, based on the mean changes from baseline seen over the equivalent period in patients meeting the inclusion criteria. In the conventional treatment arm (control group), all variables were assumed to remain at baseline values, thereby reflecting the management received before entering the AMD-annals initiative. Hypoglycaemia rates were assumed to be equivalent in the two arms of the study. After the application of treatment effects, HbA_{1c} concentration was assumed to remain constant in the active arm, based on the lack of increase seen over 5 years in the patients in the AMD-annals arm and to capture the legacy effect (where improved HbA_{1c} concentration has clinical benefits after the difference has been abolished), but to be consistent with the HbA_{1c} gradual increase described in

Table 1 Baseline cohort characteristics

Characteristic	Value
Demographics and risk factors	
Mean (SD) baseline age, years	63.7 (10.1)
Mean (SD) duration of diabetes, years	10.0 (8.6)
Males,%	53.9
Mean HbA_{1c}, mmol/mol	62
Mean (SD) HbA_{1c}, %	7.8 (1.6)
Mean (SD) systolic blood pressure, mmHg	142.4 (19.5)
Mean (SD) total cholesterol, mmol/L	5.3 (1.1)
Mean (SD) HDL cholesterol, mmol/L	1.3 (0.3)
Mean (SD) LDL cholesterol, mmol/L	3.2 (0.9)
Mean (SD) triglycerides, mmol/L	1.8 (1.6)
Mean (SD) BMI, kg/m^2	29.5 (5.0)
Smokers, %	24.9
Cigarettes per day	5
Alcohol consumption, fluid ounces/week	5.64
Ethnic group,%	
White	98.5
Black	0.5
Asian/Pacific Islander (West Asian patients)	0.5
Hispanic (Central and South American patients)	0.5
Baseline cardiovascular disease complications,%	
History of myocardial infarction	10.9
History of angina	15.0
History of peripheral vascular disease	2.8
History of stroke	3.2
History of heart failure	10.0
History of atrial fibrillation	2.0
Baseline renal complications,%	
History of microalbuminuria	26.6
History of gross proteinuria	4.7
History of end-stage renal disease	0.2
Baseline retinopathy complications,%	
History of background diabetic retinopathy	12.5
History of proliferative diabetic retinopathy	9.7
Baseline ocular complications,%	
History of macular oedema	2.0
History of cataract	7.3
History of severe vision loss	0.0
Baseline neuropathy, ulcer and amputation,%	
History of neuropathy	8.8
History of ulcer	3.3
History of amputation	1.0

Table 2 Treatment effects applied in the AMD-annals arm of the analysis

Physiological variable	Mean (SD) change applied in year 1	Mean (SD) change applied in year 3
HbA_{1c},%	–0.2 (2.1)	0.01 (1.9)
Systolic blood pressure, mmHg	–0.9 (27.3)	–1.8 (26.7)
Total cholesterol, mmol/L	–0.4 (1.5)	–0.3 (1.4)
LDL, mmol/L	–0.3 (1.3)	–0.2 (1.2)
HDL, mmol/L	0.0 (0.5)	–0.04 (0.5)
Triglycerides, mmol/L	–0.2 (1.9)	–0.1 (1.5)
BMI, kg/m^2	0.02 (7.0)	–0.07 (7.1)

the United Kingdom Prospective Diabetes Study (UKPDS) in the conventional management arm. All other variables, in both arms, followed the progression algorithms of the CORE Diabetes Model, which are based on the UKPDS and the Framingham Heart Study, reducing the differences between treatment arms over time.

Costs and utilities

Direct costs (in 2010 Euros) included pharmacy costs, the costs of diabetes-related complications and patient management costs, and were accounted from the perspective of a third party healthcare payer in Italy. Costs of diabetes-related complications (Table 3) were collected through

Table 3 Diabetes-related complication costs

Complication	Cost, EUR	Reference
Cardiovascular and cerebrovascular complication costs		
Myocardial infarction (year of event)	16,032	20
Myocardial infarction (years 2+)	2,784	20 and 21
Angina (year of event)	16,032	20
Angina (years 2+)	2,784	20 and 21
Congestive heart failure (year of event)	1,768	22
Congestive heart failure (years 2+)	1,768	22
Stroke (year of event)	19,415	23
Stroke (years 2+)	1,382	23
Stroke (death within 30 days)	3,473	24
Peripheral vascular disease (year of event)	14,672	25
Peripheral vascular disease (years 2+)	2,040	26
Renal complication costs		
Haemodialysis cost (year of event)	46,492	27
Annual cost of haemodialysis (years 2+)	44,905	27
Peritoneal dialysis cost (year of event)	32,694	27
Annual cost of peritoneal dialysis (years 2+)	31,107	27
Renal transplant cost (year of event)	41,354	27
Annual cost of renal transplant (years 2+)	11,351	27
Acute events		
Major hypoglycaemic event	2,055	24
Minor hypoglycaemic event	0	24
Ocular complication costs		
Laser treatment	132	24
Cataract operation	952	24
Blindness (year of onset)	5,849	24
Blindness (subsequent years)	5,849	24
Neuropathy, foot ulcer and amputation costs		
Neuropathy (year of event)	1,374	24
Neuropathy (years 2+)	604	28
Amputation (event-based)	8,957	24
Prosthesis (event-based)	507	24
Gangrene treatment	18,054	25
Infected ulcer	13,222	25
Standard uninfected ulcer	4,148	25

EUR = 2010 Euros.

systematic literature review, with inflation to 2010 values using the Italian consumer prices index where necessary [16]. The increased costs associated with the administration of the AMD-annals initiative were based on the annual budget for the project and captured the administrative and analytical burden, as well as the start-up cost of enrolling new centres. Resource use associated with diabetes medications was taken from the AMD-annals data and it was assumed that patients in the conventional management arm continued their baseline medication use for the duration of the analysis. Costs of diabetes medications were taken from a 2006 study investigating the annual *per capita* cost of diabetes prescriptions in Italy [17]. This was considered the best method of estimating treatment costs because, in the AMD-annals initiative, data were collected on the type of diabetes medication received but not the formulation or dosing, making a micro-costing approach impossible. Based on the published data, enrolling in the AMD-annals initiative was associated with increased prescription costs of € 77 per patient per year compared with conventional management. The CORE Diabetes Model default health-related quality-of-life utility values were used.

Statistical approach and other model settings

A simulated cohort of 1,000 patients was run through the model 1,000 times for each simulation (base case and sensitivity analysis). Mean values and standard deviations were generated for long-term outcomes. The time horizon was set to 50 years in the base case to capture all relevant long-term complications, and associated costs, to assess their impact on life expectancy and quality-adjusted life expectancy. Future costs and clinical benefits were discounted symmetrically by 3% *per annum* in line with health economic guidance for Italy [18].

Sensitivity analyses

A series of one-way sensitivity analyses were conducted to identify the key drivers of outcomes and to assess the robustness of the results of the base case analysis. This included variation of the time horizon of the analysis, discount rates, cost of diabetes complications and clinical effects applied in the AMD-annals arm. In addition, a sensitivity analysis using the UKPDS Tobit regression method to calculate quality-adjusted life expectancy, as opposed to the CORE Diabetes Model default in the base case, was conducted. In the base case analysis, increased costs of prescriptions were estimated using cost data collected in the general diabetes population, rather than the AMD-annals population. To investigate the impact of the increased cost of enrolling in the AMD-annals initiative, analyses were conducted where the annual cost per patient taking part in the scheme was € 200, € 400, € 600 and € 800 higher than in the conventional management arm.

Results

Base case analysis

In the base case analysis, participation in the AMD-annals initiative was associated with improved mean [SD] life expectancy (9.92 [0.18] years vs 9.37 [0.18] years) and quality-adjusted life expectancy (6.84 [0.13] quality-adjusted life years vs 6.36 [0.12] quality-adjusted life years) compared with the conventional management arm (Table 4). The increase in life expectancy projected for the AMD-annals arm (Fig. 1) was attributable to a lower incidence of most diabetes-related complications, including ophthalmic complications, renal complications, ulcers and cardiovascular disease (Fig. 2). The separation in the survival curve was greatest at 19 years, reflecting the long-term benefit of improved treatment. As the analysis progressed beyond this, the difference between the curves was reduced as the influence of background mortality became increasingly important. The only complication with increased incidence

Table 4 Summary of results from the base case analysis

	AMD-annals initiative Mean (SD)	Conventional management Mean (SD)	Difference
Life expectancy, years	9.92 (0.18)	9.37 (0.18)	0.55
Quality-adjusted life expectancy, QALYs	6.84 (0.13)	6.36 (0.12)	0.48
Direct costs, EUR	37,289 (1,348)	41,075 (1,597)	–3,784
ICER, EUR per QALY gained	AMD-annals dominates		

EUR = 2010 Euros; ICER, incremental cost-effectiveness ratio; QALYs, quality-adjusted life years.

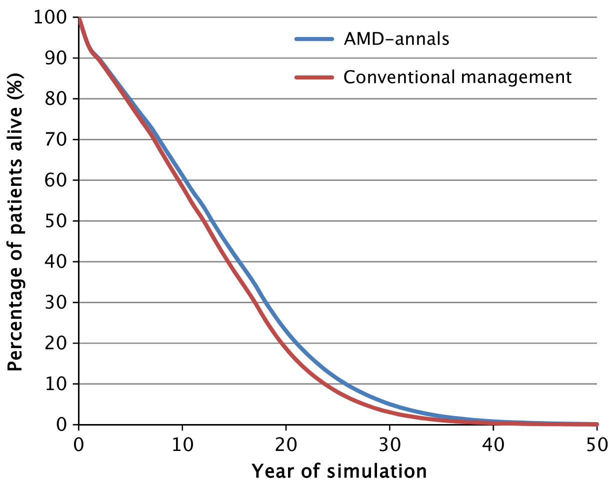

FIGURE 1 Survival rates in the AMD-annals and conventional management arms of the analysis.

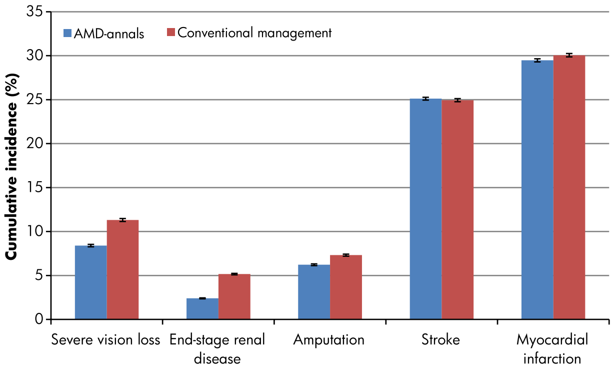

FIGURE 2 Incidence of selected end-stage diabetes-related complications. Error bars show 95% CIs.

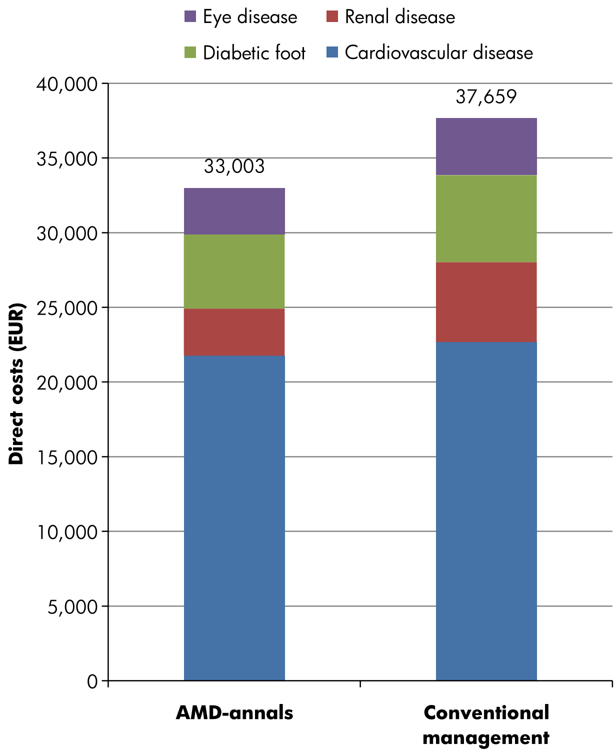

FIGURE 3 Direct medical costs of diabetes-related complications in patients enrolling in the AMD-annals initiative compared with conventional management. EUR = 2010 Euros.

in the AMD-annals arm was stroke. This was attributable to the survival paradox, where more events occur because of the increase in life expectancy. In addition to a lower cumulative incidence of complications, the mean time to onset of most complications was prolonged in the AMD-annals arm compared with the conventional management arm. Patients in the AMD-annals arm remained complication-free for a mean of 1.6 years in comparison with 1.2 years in the conventional management arm.

Over the 50-year time horizon of the analysis, enrolling people with Type 2 diabetes into the AMD-annals initiative was found to be cost-saving compared with conventional management (€ 37, 289 vs € 41,075). This was driven by the avoidance of costs associated with diabetes-related complications (Fig. 3). Most notable was the € 2,189 cost-saving as a result of avoided renal complications (€ 3,153 vs € 5,342). The increased administrative and pharmacy costs in the AMD-annals arm (€ 4,287 vs € 3,416) were more than offset by other cost savings.

A cost-effectiveness plane presenting the incremental costs vs the incremental effectiveness for AMD-annals compared with conventional management shows 1,000 mean values, each representing a cohort of 1,000 patients run through the model, is shown in Fig. 4. This found that the probability that enrolling people with Type 2 diabetes in the AMD-annals initiatives would improve clinical outcomes, in terms of quality-adjusted life expectancy, was 99%. Furthermore, the probability that the initiative would be cost-saving was 96%. Based on these data, enrolment in the AMD-annals initiative is highly likely to improve clinical outcomes for people with Type 2 diabetes, and to do so at a cost saving to healthcare payers.

Sensitivity analyses

Sensitivity analyses (Table 5) showed that shortening the time horizon had the most notable impact on the cost-effectiveness profile of enrolling people with Type 2 diabetes in the AMD-annals initiative. When a time horizon of 5 years was considered, enrolment in the AMD-annals initiative improved clinical outcomes, but the incremental benefit was reduced to 0.003 quality-adjusted life years compared with 0.48 quality-adjusted life years over a 50-year time horizon. The initiative also remained cost-saving compared with current care, but the cost savings were reduced to € 469, compared with savings of € 3,786 in the base case scenario. Improvements in clinical and cost outcomes were smaller primarily because improvements in physiological measurements associated with enrolling in the initiative reduce the risk of long-term complications, and the benefits of this are not fully realised over shorter time horizons.

Altering the discount rate also reflected the long-term benefits associated with taking part in the AMD-annals initiative; clinical improvements and cost savings both increased when a discount rate of 0% was used. Increasing the cost of complications increased the cost savings in the AMD-annals arm to € 4,251 per patient, whilst reducing the cost of complications had the opposite effect, reducing the cost savings to € 3,320 per patient. When the significance of clinical drivers was investigated, it was found that abolishing the HbA_{1c} benefit in the AMD-annals arm had the largest effect on clinical and cost outcomes (quality-adjusted life expectancy benefit reduced to 0.37 quality-adjusted life years, whilst cost savings fell to € 2,826). Using an alternative method to calculate quality-adjusted life expectancy resulted in changes in absolute values in the two arms, but

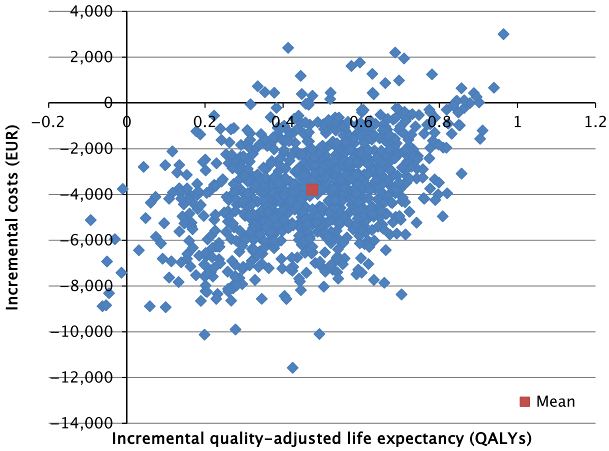

FIGURE 4 Cost-effectiveness plane of the base case analysis. EUR = 2010 Euros. QALYs, quality-adjusted life years.

the incremental benefit associated with enrolling patients in the AMD-annals initiative changed only slightly.

Enrolling people with Type 2 diabetes in the AMD-annals initiative was found to be cost-saving over patient lifetimes when the annual cost increase of taking part, compared with conventional treatment, was < € 434 per patient (Fig. 5). At the highest cost increase evaluated, enrolment in the AMD-annals initiative was found to increase direct medical costs by € 3,888 per patient over patient lifetimes, and was associated with an incremental cost-effectiveness ratio of € 8,192 per quality-adjusted life year gained. This is below the commonly quoted willingness-to-pay threshold of € 30,000 per quality-adjusted life year gained.

Discussion

Previous publications of the results of the AMD-annals initiative have shown that enrolling people with Type 2 diabetes in the scheme is associated with important improvements in physiological risk factors for diabetes-related complications in the short term [6,8]. Applying the data collected from Italian clinical practice to this long-term modelling analysis has shown that these improvements in surrogate outcomes are likely to lead to improvements in life expectancy, quality-adjusted life expectancy and reduced incidence of micro- and macrovascular diabetes-related complications. Moreover, these improvements in clinical outcomes are achieved at a cost saving to healthcare payers. Notably, the AMD-annals initiative was associated with cost savings over time horizons as short as 5 years, meaning that investment in the AMD-annals initiative (including increased treatment costs and costs of running the programme) can be recouped quickly. The scheme remained cost-saving when

Table 5 Summary of results from sensitivity analyses

Analysis	Quality-adjusted life expectancy, QALYs: AMD-annals	Conventional management	Difference	Direct costs, EUR: AMD-annals	Conventional management	Difference	ICER, EUR per QALY gained
Base case	6.84	6.36	0.48	37,289	41,075	–3,786	AMD dominates
One-way sensitivity analyses							
20-year time horizon	6.46	6.10	0.36	31,881	35,985	–4,104	AMD dominates
10-year time horizon	4.77	4.64	0.13	18,952	20,833	–1,881	AMD dominates
5-year time horizon	2.89	2.85	0.03	9,701	10,170	–469	AMD dominates
0% discount rate	8.91	8.13	0.78	54,285	59,143	–4,858	AMD dominates
8% discount rate	4.81	4.57	0.24	22,866	25,258	–2,392	AMD dominates
Alternative method for calculating quality-adjusted life expectancy	7.84	7.34	0.50	37,289	41,075	–3,786	AMD dominates
Costs of complications +10%	6.84	6.36	0.48	40,587	44,838	–4,251	AMD dominates
Costs of complications –10%	6.84	6.36	0.48	33,991	37,311	–3,320	AMD dominates
No HbA_{1c} difference	6.73	6.36	0.37	38,248	41,075	–2,826	AMD dominates
No systolic blood pressure difference	6.80	6.36	0.44	37,783	41,075	–3,291	AMD dominates
No cholesterol and triglyceride differences	6.74	6.36	0.38	37,551	41,075	–3,524	AMD dominates
No BMI difference	6.84	6.36	0.48	37,328	41,075	–3,747	AMD dominates

EUR = 2010 Euros; ICER, incremental cost-effectiveness ratio; QALYs, quality-adjusted life years.

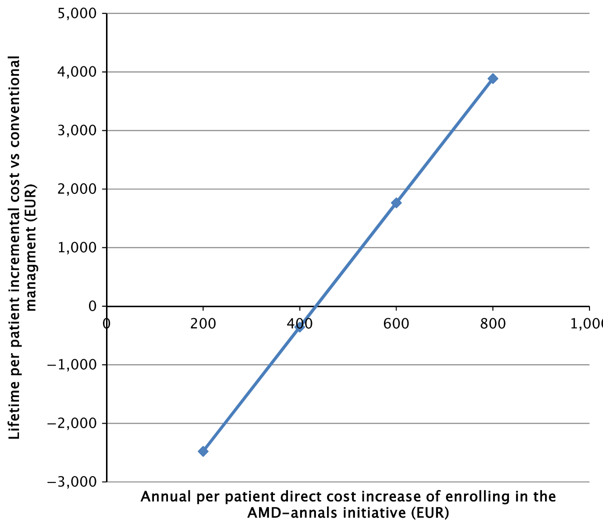

FIGURE 5 Effect of increasing the cost of enrolling in the AMD-annals initiative on lifetime direct medical costs. EUR = 2010 Euros.

the annual per patient cost was as much as € 434 greater than with conventional management, showing the robustness of the conclusion that the AMD-annals initiative is likely to be cost saving over patient lifetimes. Whilst the improved glycaemic control associated with taking part in the AMD-annals initiative is a key driver of improved outcomes, it is important to recognize that it is not the only driver. The AMD-annals initiative assesses best practice through the measurement of 46 quality indicators, thereby promoting a multifaceted approach to care, as recommended in recent treatment guidelines, and this approach leads to long-term cost savings and improvements in clinical outcomes [3].

The number of centres participating in the AMD-annals initiative has grown steadily since the inception of the scheme and now one third of all diabetes treatment centres are taking part. This has resulted in an ever increasing pool of data to be analysed annually, but has also offered improved care to more and more people with Type 2 diabetes, with around one sixth of all people with Type 2 diabetes in Italy taking part in 2012. Increasing the number of centres participating in the AMD-annals initiative, and therefore the number of people with Type 2 diabetes enrolled, must be a key objective for the future, with the aim of standardizing and optimizing diabetes therapy across Italy.

A limitation of the present analysis is the reliance on short-term clinical data in making long-term predictions of outcomes over time horizons of up to 50 years. However, this is a limitation inherent to most cost-effectiveness modelling studies, and despite this, such studies represent one of the best available options for making estimates of long-term clinical and economic outcomes in the absence of long-term clinical data. The present study aims to minimize this limitation, through the use of a recently validated model to conduct the analysis, and basing changes in physiological variables on data that accurately reflect clinical practice in Italy.

There are, however, limitations associated with the use of AMD-annals data. The present analysis uses data from participants that were enrolled in the initiative for 5 consecutive years, as this was considered appropriate to identify changes associated with a long-term continuous monitoring programme. However, participants who did not meet this inclusion criterion may have shown less improvement than participants remaining in the scheme for longer. Furthermore, centres participating in the scheme may differ systematically from centres not currently participating, and therefore the improvement in patient physiological variables may not be generalizable to centres joining the initiative in the future. In addition, the AMD-annals initiative relies on the physicians of the participating centres, since no financial or other incentive is offered for participation. The applicability of these results to other diabetes centres not yet participating in the AMD-annals initiative depends on the clinicians of these centres showing the same willingness to share data and alter clinical practice to optimize therapy as those who are currently participating.

The selection of the control group may represent a further limitation, as improvements seen upon enrolling in the AMD-annals initiative were compared with conventional management through variables remaining at baseline values. Members of the control group were, therefore, those who were engaged with treatment, as evidenced by their participation in the AMD-annals initiative for at least 5 consecutive years. Whilst the results of the analysis suggest that the programme is advantageous in this set of people with Type 2 diabetes, the application to people with Type 2 diabetes not enrolled in the AMD-annals initiative is more complex. It may be the case that people with Type 2 diabetes who are less engaged in their treatment will not show the same level of improvement on registering with the scheme. However, it may also be the case that people with Type 2 diabetes not captured in the present analysis experience worse glycaemic control at baseline than included people with Type 2 diabetes. Therefore, they have more to gain as a result of even small improvements in glycaemic control and other risk factors for diabetes-related complications. The implications of increasing the number of participants in the AMD-annals initiative, to include people with Type 2 diabetes who are currently poorly controlled or not engaged in their diabetes care, is worth further investigation.

An additional limitation regarding the control group is the assumption that physiological risk factors remain at baseline values. An implication of this assumption is that new interventions, and their potential clinical benefits, which have become available in the 5 years over which participants were followed are not included in this arm of the analysis. Over the 5 years of data collection, a number of new diabetes therapies have become available in Italy, including long-acting insulins, glucagon-like peptide 1 receptor agonists and dipeptidyl peptidase-4 inhibitors. It may be the case that conventional management has improved from the baseline measure used in the present analysis, and perhaps clinical estimates are pessimistic. However, it seems unlikely that clinical outcomes would improve from baseline as part of standard care, as shown by non-interventional studies such as The Health Improvement Network in the UK [19]. This is balanced, however, by the fact that the costs of the newer and more expensive interventions are not included is this arm, so overall cost-effectiveness conclusions are unlikely to be changed. Linked to this is the use of UKPDS and Framingham data to determine variable progression. These sources of evidence are of high methodological quality and are widely used within health economic modelling studies of diabetes, but there is concern that, because of the age of the data, they do not reflect changes in physiological measurements over time in the modern patient with Type 2 diabetes. The present study has attempted to mitigate this issue by using a recently validated health economic model [13].

A final limitation pertains to the accounting of the costs of diabetes medications, in both the conventional management arm and the AMD-annals arm. In the conventional arm it was assumed that diabetes-medication use remained unchanged from baseline. This is conservative, as it is likely that treatment would be intensified, through dose increases or the addition of further therapies, leading to higher costs. Cost increases associated with enrolment in the AMD-annals initiative were based on a previous analysis of prescription data in the general Type 2 diabetes population. A micro-costing approach was not possible as data on formulations and dosing were not available from the AMD-annals initiative. Whilst the estimation used represented the best possible method to account for the increased cost of medications on enrolling people with Type 2 diabetes in the AMD-annals initiative, it is a potential source of error in the modelling analysis. Nevertheless, extensive sensitivity analyses found that the conclusion of cost savings over patient lifetimes is unlikely to change, unless annual per patient costs are > € 434 higher than in conventional care.

The present analysis has shown that the AMD-annals initiative is likely to lead to improvements in life expectancy, quality-adjusted life expectancy and reduced direct medical costs. Increasing the number of centres and people with Type 2 diabetes participating in the scheme represents a highly effective method of improving diabetes care and reducing diabetes-related healthcare expenditure in Italy in the future.

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Competing interests

C.K.K. is an employee of Novo Nordisk. B.H. and W.J.V. are employees of Ossian Health Economics and Communications. Ossian received a fee from Novo Nordisk to support medical writing activities for the present analysis. C.B.G., A.N., F.P. and G.V. have no competing interests to declare.

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