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Drug treatment of type 2 diabetes: Its cost is significantly associated with HbA1c levels

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Abstract

Aims: To examine the relationship between costs of hyperglycaemia drug treatment and glycemic control amongst people with type 2 diabetes (T2D).

Methods: This observational study utilised data from the QUALIDIAB database on 3,452 T2D patients seen in Diabetes Centers in Argentina. Patients were classified according to their HbA1c value into two groups: on target (OT; HbA1c ≤ 7%), and not on target (NOT; HbA1c > 7%); within each category we considered clinical and metabolic indicators, as well as type of hyperglycaemia treatment. Monthly expenditure on drugs was estimated by micro-costing. Multivariable regression analysis was used to evaluate the association between cost of hyperglycaemia treatment and HbA1c values.

Results: In total, 48.9% of the participants have HbA1c OT values. Overall monthly per capita costs of this treatment increased significantly (134%) in the NOT group. Multivariable regression analysis showed that expenditure for hyperglycaemia drugs treatment was significant associated with glycemic control (OR: 0.705), diabetes duration (OR: 1.017), systolic blood pressure (OR: 1.006) and treatment of T2D (OR: 2.622).

Conclusions: HbA1c NOT significantly increases drugs monthly cost of hyperglycaemia treatment in people with T2D in a country with an emerging market economy.

1 | INTRODUCTION

Type 2 diabetes (T2D) is a serious public health problem worldwide due to its progressively rising prevalence associated to the frequent development of chronic complications, which increase treatment costs and impose a heavy burden for the patient and society.[1-5]

Although available evidence support the concept that appropriate control of blood glucose and associated cardiovascular risk factors (CVRF) can reduce diabetes complications, attainment of such control is rarely observed in real world clinical practice.[6-9] In fact, care received by people with diabetes is frequently far from optimal.[10-13]

On line with this situation, data in the literature dealing with decreasing cost of T2D mainly focus on the long-term complications of the disease that negatively impact on life quality and economical costs. However, it is likely that drug therapy for diabetes could also significantly affect the use of costly resources.[14] In this regard, some evidence suggests that better glycaemic control of people with T2D may be associated with lower yearly health care resource use and costs.[15-21] Supporting the concept, Shetty and colleagues analysing data from a cohort of patients with diabetes in a managed care setting found that patients with HbA1c level ≤ 7% have a substantial yearly cost savings of 32% compared to those with HbA1c levels > 7%.[17] Likewise, Oglesby and colleagues reported that diabetes-related costs were 16% and 20% lower for patients with HbA1c levels of 7% or less compared with those with values between 7%-9% and > 9%, respectively.[18] In particular, they found that prescription drug costs were significantly lower for people with HbA1c < 7%

than in the other two groups.[18] Similarly, other authors recently reported a strong association between poor glycaemic control in T2D and healthcare resource use and costs.[19-22] Altogether these results demonstrate that poor glycaemic control not only results in increased future costs of the disease but also in the yearly treatment costs. Such evidences would be important everywhere but particularly in countries with an emerging market economy where most of the time health ministries are short of health economic resources and ask for immediate rather than long term effects to take decisions on appropriate treatment costs. Unfortunately, there is scarce evidence of such relationship between cost of drug treatment and glycaemic control from countries with an emerging market economy.

On account of such situation the aim of this study was to examine the relationship between monthly cost of drug treatment of hyperglycaemia and glycaemic control amongst patients with T2D. Mainly, this study sought to test the hypothesis that poorer glycaemic control (HbA1c > 7%) is associated with higher monthly drug treatment costs in patients with T2D in countries with an emerging market economy.

What's known

- Some evidence suggests that better glycemic control of people with T2D may be associated with lower yearly health care resource use and costs in developed countries.
- Unfortunately, there is scarce evidence of such relationship between cost of drug treatment and glycemic control from countries with an emerging market economy.

What's new

- We reported for the first time in a country with an emerging market economy, the association between cost of drug treatment of hyperglycaemia and glycemic control amongst patients with T2D.
- Attaining HbA1c levels recommended by international guidelines can significantly decrease monthly/annual per capita expenditure of the drugs treatment.

2 | RESEARCH DESIGN AND METHODS

2.1 | Study population and sampling

This observational study utilised data from the QUALIDIAB database, which includes patients attended at public and privateDiabetes Service Centers in Argentina. QUALIDIAB is a program that records clinical, metabolic and therapeutic indicators of the quality of care provided to people with diabetes in Latin America as well as on micro and macrovascular complications, the rate of use of diagnostic and therapeutic elements and annual patient hospitalisation.[13,23] The development of the QUALIDIAB net was promoted by the Declaration of the Americas (DOTA) and based on the benefits of a common data registry in Latin American countries to enable comparison of data to correct mistakes and strengthen successful strategies. All this information is reported directly by physicians during personal interviews; thereafter, data are loaded and stored in anonymous format for subsequent analysis.

We included all adult patients with diagnosis of T2D (3452), that have filled out a QUALIDIAB form between January 2015 and December 2016. From that number, we excluded 1842 records due to the missing data on glycated haemoglobin (HbA1c); consequently, the final number of people used for the statistical analysis was 1,610.

2.2 | Data analysis

HbA1c data were classified and divided according to the ADA criteria into two groups: on target (OT; HbA1c ≤ 7%) and not on target (NOT; HbA1c > 7%).[24] Within each category, we utilised clinical and metabolic indicators, as well as type of hyperglycaemia treatment (drug and daily dose prescribed).

2.3 | Cost of drug treatment calculation

Monthly expenditure on drugs was estimated by micro-costing.[25] For that purpose, we calculated a mean unit retail price per milligram of each drug or per insulin units in Argentina. Drug costs were obtained from representative databases (Alfabeta.net); with these data, we estimated an average price for each drug. Monthly drug treatment expenditures was calculated individually for each patient according to resource utilisation, as follows: the daily dose was multiplied by 30 (a month), then multiplied by the average price, resulting in monthly expenditures.

2.4 | Statistical analysis

Statistical analyses utilised the Statistical Package for Social Sciences version 15 (SPSS Inc, Chicago, IL, US). Descriptive statistics are presented as percentages and mean ± standard deviation (SD). Group comparisons for continuous variables utilised parametric or non-parametric tests according to the data distribution profile. The Chi-square test was used to estimate differences between proportions. Multivariable regression analysis was used to evaluate the association between cost of hyperglycaemia treatment and HbA1c targets. For regression analysis, to account for the skewed distribution of cost of drug treatment we developed a generalised linear model (GLM) with Gamma distribution and log-link function to estimate the association between hyperglycaemia treatment cost and HbA1c targets, patient demographic characteristics, diabetes treatments, complications and comorbidities. For our analyses the level of significance was established as $P \leq 0.05$.

2.5 | Ethical statement

The study protocol was analysed and approved by the Bioethical Committee of the National University of La Plata and developed according to Good Practice Recommendations (International Harmonisation Conference) and the ethical guidelines of the Helsinki Declaration. Informed consent was waived because this retrospective study involves secondary analysis of existing database, which was de-identified and anonymously stored to protect private information. Therefore, this procedure ensured compliance with the National Law 25.326 of Personal Data Protection.

3 | RESULTS

Clinical and metabolic characteristics of the study population classified according to its HbA1c values showed that 48.9% of the participants were on target (HbA1c ≤ 7%) and the remaining 51.1% were not (Table 1). The percentages of female and mean age were significantly greater in the OT than in the NOT group. Diabetes duration was lower in OT than NOT group (6.8 ± 7 vs 9.8 ± 7.7 years). Body mass index, systolic and diastolic blood pressure, total serum cholesterol, HDL-c and LDL-c values were comparable in both groups. Conversely, triglyceride levels were higher in NOT than in OT group ($P \leq 0.05$).

The percentages of complications were significantly lower in the OT than in the NOT group (31% vs 45%), while similar percentages of hypertension, dyslipidemia, overweight and obesity were recorded in both groups (Table 1).

Significant differences between groups were found in hyperglycaemia treatment (Table 2). The proportion of patients treated with only diet and physical activity as well as those on oral monotherapy was significantly higher in OT group, whereas administration of oral glucose lowering drugs (OGLD) associated with insulin or insulin alone were significantly higher in the NOT group. No significant differences amongst groups were recorded in people treated with combination of OGLD.

TABLE 1 Characteristics of the study population

	Overall		Patients on target (HbA1c ≤ 7%)		Patients not on target (HbA1c > 7%)	
Parameters	**Value**	**n**	**Value**	**n**	**Value**	**n**
Females (%)	50.5	813	53.6[a]	422	47.6[a]	391
Age (y)	54.1 ± 10.8	1604	54.7 ± 10.0[a]	784	53.5 ± 11.5[a]	820
Diabetes duration (y)	8.7 ± 7.6	1038	6.8 ± 7.0[a]	407	9.8 ± 7.7[a]	631
BMI (kg/m^2)	32.6 ± 7.15	1496	33.2 ± 13.3	740	32.9 ± 10.7	756
FBG (mg/dL)	153.5 ± 70.7	1586	115.4 ± 31.2[a]	722	189.6 ± 78.3[a]	814
SBP (mm Hg)	128.6 ± 17.2	1564	127.8 ± 16.1	764	129.3 ± 18.2	800
DBP (mm Hg)	78.6 ± 11.6	1560	78.6 ± 11.8	762	78.6 ± 11.5	798
HbA1c (%)	7.8 ± 2.2	1610	6.1 ± 0.5[a]	788	9.4 ± 1.9[a]	822
HbA1c [mmol/mol]	*[62 ± 24]*		*[43 ± 5.5]*[a]		*[79 ± 20.8]*[a]	
Total Cholesterol (mg/dL)	164.9 ± 25.6	875	164.9 ± 25.8	428	164.9 ± 25.4	447
HDL-c (mg/dL)	48.4 ± 18.1	1375	49.3 ± 14.4	678	47.4 ± 21.1	697
LDL-c (mg/dL)	113.8 ± 38.8	1147	113.5 ± 38.4	549	114.1 ± 39.1	598
Triglycerides (mg/dL)	177 ± 135.4	1452	160.2 ± 105.6[a]	711	193 ± 157.1[a]	741
Complications (%)	37.99	511	30.99[a]	212	45.23[a]	299
Hypertension (%)	64.78	1043	65.99	520	63.63	523
Dyslipidemia (%)	60.62	976	59.90	472	61.31	504
Overweight (%)	28.63	426	29.21	215	28.06	211
Obesity (%)	61.96	922	63.45	467	60.51	455
TG < 150 mg/dL (%)	54.34	789	59.35[a]	422	49.53[a]	367
LDL-c < 100 mg/dL (%)	27.20	438	26.02	205	28.35	233

Each value represents mean ± SD (standard deviation).
BMI, body mass index; FBG, fasting blood glucose; DBP, diastolic blood pressure; SBP, systolic blood pressure.
[a]Significant compared with patients on target ($P < 0.05$).

Overall monthly per capita costs of drug treatment of hyperglycaemia increased significantly (134%) in the NOT group (Figure 1). While cost of monotherapy treatment and OGLD plus insulin treatment were greater in NOT than in OT group, no significant differences were observed in the cost of combined OGLD or insulin alone treatment. NOT people increased their monthly per capita cost of monotherapy and OGLD plus insulin medications by 8% and 21%, respectively (Figure 1). Each month, NOT people spent AR$19.1 and AR$336.9 more than OT patients, respectively.

Multivariable regression analysis showed that expenditure for hyperglycaemia drugs treatment was significant and independently associated with diabetes duration, LDL-c, systolic blood pressure (SBP), glycemic control and treatment of T2D (Table 3). Expenditure on drugs was 29.5% lower in persons with T2D OT than in NOT, and expenditure was higher in patients treated with insulin (OR: 2.622). Furthermore, each year of change in diabetes duration was associated with a 1.7% increase in the drugs expenditure.

TABLE 2 Type of hyperglycaemia treatment according to HbA1c values

	Patients on target (HbA1c ≤ 7%)		Patients not on target (HbA1c > 7%)	
Treatment	**%**	**n**	**%**	**N**
Diet and physical activity	8.06[a]	46	1.13[a]	8
Monotherapy	65.5[a]	374	36.01[a]	256
Combined OGLD	16.99	97	24.05	171
OGLD + Insulin	7.53[a]	43	30.80[a]	219
Insulin alone	1.93[a]	11	8.02[a]	57

[a]Significant compared with patients on target ($P < 0.05$).

4 | DISCUSSION

Analysis of our QUALIDIAB net database corresponding to the 2015-2016 time-period showed that the monthly per capita drugs treatment cost of hyperglycaemia in people with T2D was significantly higher when their HbA1c levels were > 7.0% than with values < 7.0%. Results from the multivariable regression analysis also showed that in these population, expenditure for hyperglycaemia drugs treatment was significant and independently associated with diabetes duration, LDL-c, systolic blood pressure (SBP) and glycaemic values.

Ourresults are supported by data from other authors.[14-22] Heald et al, using available data from a large number of general practitioners (GP) in England, looked at how medication prescription and other factors influence outcomes in their T2D population.[22] They show there is significant variation in general practitioners' prescribing of agents to treat T2D with consequences in the quality of glycaemic

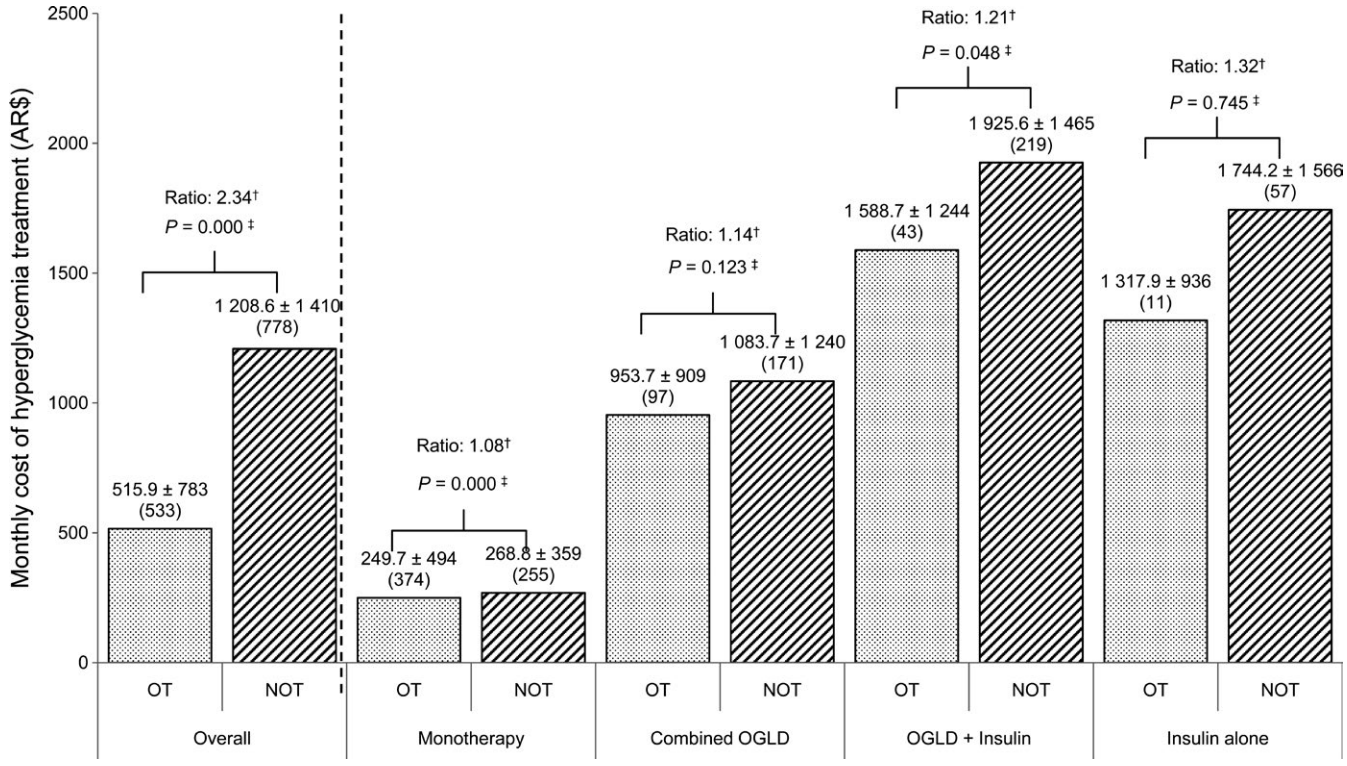

FIGURE 1 Monthly per capita cost of hyperglycaemia treatment according to HbA1c values. Costs of treatment are expressed in Argentinean Pesos (AR$). Value represents, mean ± standard deviation (SD). OT: patients on target (HbA1c ≤ 7%); NOT: patients not on target (HbA1c > 7%). †Ratio based on patients on target (HbA1c < 7.0%). ‡*P* value between groups (Mann-Whitney *U* test)

TABLE 3 Multivariate analysis

Factor	Odds ratio	IC 95%		p-value
		Lower	Upper	
Age (y)	1.005	0.992	1.018	0.403
Gender				
Female	1.00	—	—	
Male	1.081	0.877	1.331	0.462
Diabetes duration (y)	1.017	1.000	1.034	0.044
LDL-cholesterol (mg/dL)	0.995	0.992	0.997	0.001
Triglycerides (mg/dL)	0.999	0.999	1.000	0.704
Systolic blood pressure (mmHg)	1.006	1.000	1.012	0.048
Body mass Index (kg/m^2)	1.006	0.987	1.026	0.515
Glycaemic control				
HbA1c > 7%	1.00	—	—	
HbA1c ≤ 7%	0.705	0.572	0.869	0.001
Treatment of T2D				
Non-insulin antidiabetic agents	1.00	—	—	
Insulin[a]	2.622	2.065	3.329	0.000
T2D complications				
No	1.00	—	—	
Micro or Macrovascular	1.152	0.913	1.453	0.232
Hypertension				
No	1.00	—	—	
Yes	0.964	0.733	1.268	0.796
Dyslipidemia				
No	1.00	—	—	
Yes	1.212	0.942	1.560	0.133
Intercept	214.839	63.435	727.609	0.000

[a]Insulin alone or in combination with non-insulin antidiabetics.

control, and also found both GP delivering increased glycaemic control (≤7.5%) and those with a lower number of patients at glycaemic risk (patients with HbA1c > 10%) was spending less in their overall prescribing costs for each patient with T2D.[22]

Furthermore, Oglesby et al also reported a significant increase in the annual diabetes-related costs from US$1505 in patients with HbA1c ≤ 7% to US$ 1871 amongst those with HbA1c > 9%.[18] Those reports as well as our own one clearly demonstrate that higher periodic medical costs in people with T2D management are associated with poor glycaemic control. Furthermore, abnormal glucose values even not attaining diabetes diagnostic threshold—such the case of IGT is associated with excess medical care costs relative to normoglycaemia.[26]

The strong association between poor glycemic control in T2D and healthcare resource use currently reported together with the already published,[19] merits identification of its underlying cause/s to implement an efficient strategy to cope with. This search is necessary because in our study except diabetes duration, the other factors significantly associated with increased treatment costs are preventable, thus an effective strategy to cope with might be centred in attaining target values for them. In this regard it has been shown a relationship between treatment adherence and health care costs. In fact several studies have reported that an increase in medication adherence (either to insulin or OGLD) was associated with a reduction in drugs costs: pharmacy costs were higher in poor treatment adherent patients.[17] Furthermore, a retrospective analysis performed in a large population of people with T2D showed that poor treatment adherence leads to increased health care resource utilisation and costs, including more frequent hospitalisations. Improved medication adherence also contributes to improvement in diabetes-related quality of life.[27]

Consistent with these findings but measuring not only drugs costs, results from a very large 5-year retrospective analysis of US veterans receiving insulin or OGLDs, showed a 41% lower inpatient-costs than the non-adherent ones.[28] Accordingly, we could assume that improvement in treatment adherence could facilitate achievement of better HbA1c levels—as well as blood pressure and lipid profile with the consequent decrease in drugs costs and resources use. The report that self-care group education in people with T2D and 12-week follow-up by a nurse using telephone, causes significant improvement in metabolic parameters and adherence to treatment recommendations support such assumption.[29] Studies performed implemented in Latin American countries and in Argentina by our group lend further support to the beneficial clinical, metabolic and costs savings outcomes on education in people with T2D.[30,31]

5 | CONCLUSIONS

We currently reported for the first time in a country with an emerging market economy, that the association of target HbA1c levels significantly decreases costs of drugs treatment in people with T2D. On account of these data and that previously published by others authors in developed countries, we could suggest that (a) attaining HbA1c recommended by international guidelines values can significantly decrease monthly/annual per capita costs of drugs treatment and health care resources, (b) this immediate lowering effect of good glucose metabolism control would also prevent long-term increase in care costs and resources use, (c) these favourable economic impact of these outcomes will be associated with improvement in quality of life of people with T2D and (d) improving adherence of treatment prescription accomplished by diabetes education would be an effective and cost-effective strategy to attain HbA1c levels suitable to reach optimise treatment of care costs and resources usage.

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ETHICAL APPROVAL

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For this type of study formal consent is not required.

DISCLOSURES

No potential conflict of interest relevant to this article was reported.

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REFERENCES

1. International Diabetes Federation. *IDF Diabetes Atlas*, 8th edn. Brussels, Belgium: International Diabetes Federation; 2017. http://www.diabetesatlas.org
2. Pan American Health Organization/World Health Organization (PAHO/WHO). Health Information and Analysis Project (HSD/HA). Health Situation in the Americas: Basic Indicators 2012. Washington, DC. 2012. http://www.paho.org/rho
3. Williams R, VanGaal L, Lucioni C; CODE-2 Advisory Board. Assessing the impact of complications on the costs of type II diabetes. *Diabetologia*. 2002;45:S13-S17.
4. Morsanutto A, Berto P, Lopatriello S, et al. Major complications have an impact on total annual medical costs of diabetes: results of a database analysis. *J Diabetes Complications*. 2006;20:163-169. https://doi.org/10.1016/j.jdiacomp.2005.06.011
5. Elgart JF, Asteazarán S, De La Fuente JL, Camillucci C, Brown JB, Gagliardino JJ. Direct and indirect costs associated to type 2 diabetes and its complications measured in a social security institution of Argentina. *Int J Public Health*. 2014;59:851-857.
6. UK Prospective Diabetes Study Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet*. 1998;352:837-853. https://doi.org/10.1016/S0140-6736(98)07019-6
7. Gaede P, Vedel P, Larsen N, Jensen GV, Parving HH, Pedersen O. Multifactorial intervention and cardiovascular disease in patients with Type 2 diabetes. *N Engl J Med*. 2003;348:383-393. https://doi.org/10.1056/NEJMoa021778
8. Gray A, Clarke P, Farmer A, Holman R; United Kingdom Prospective Diabetes Study (UKPDS) Group. Implementing intensive control of blood glucose concentration and blood pressure in type 2 diabetes in England: cost analysis (UKPDS 63). *BMJ*, 2002;325:860–860. https://doi.org/10.1136/bmj.325.7369.860
9. Karter AJ, Stevens MR, Herman WH, et al; Translating Research Into Action for Diabetes Study Group. Out-of-pocket costs and diabetes preventive services: the translating research into action for diabetes (TRIAD) study. *Diabetes Care*. 2003;26:2294-2299. https://doi.org/10.2337/diacare.26.8.2294
10. Renders CM, Valk GD, de Sonnaville JJ, et al. Quality of care for patients with type 2 diabetes mellitus—a long-term comparison of two quality improvement programmes in the Netherlands. *Diabet Med*. 2003;20:846-852. https://doi.org/10.1046/j.1464-5491.2003.01009.x
11. McGlynn EA, Asch SM, Adams J, et al. The quality of health care delivered to adults in the United States. *N Engl J Med*. 2003;348:2635-2645. https://doi.org/10.1056/NEJMsa022615.
12. American Diabetes Association. Clinical practice recommendations. *Diabetes Care*. 2005;28:S1-S79.
13. Commendatore V, Dieuzeide G, Faingold C, et al; DIFAR Academic Committee. Registry of people with diabetes in three Latin American countries: a suitable approach to evaluate the quality of health care provided to people with type 2 diabetes. *Int J Clin Pract*. 2013;67:1261-1266. https://doi.org/10.1111/ijcp.12208
14. Meng J, Casciano R, Lee YC, et al. Effect of diabetes treatment-related attributes on costs to type 2 diabetes patients in a real-world population. *J Manag Care Spec Pharm*. 2017;23:446-452. http://dx.doi.org/10.18553/jmcp.2017.23.4.446
15. Wagner EH, Sandhu N, Newton KM, McCulloch DK, Ramsey SD, Grothaus LC. Effect of improved glycemic control on health care costs and utilization. *JAMA*. 2001;285:182-189.
16. Menzin J, Langley-Hawthorne C, Friedman M, Boulanger L, Cavanaugh R. Potential short-term economic benefits of improved glycemic control: a managed care perspective. *Diabetes Care*. 2001;24:51-55.
17. Shetty S, Secnik K, Oglesby AK. Relationship of glycemic control to total diabetes-related costs for managed care health plan members with type 2 diabetes. *J Manag Care Pharm*. 2005;11:559-564.
18. Oglesby AK, Secnik K, Barron J, Al-Zakwani I, Lage MJ. The association between diabetes-related medical costs and glycemic control: a retrospective analysis. *Cost Eff Resour Alloc*. 2006;4:1. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1369002/pdf/1478-7547-4-1.pdf
19. Menzin J, Korn JR, Cohen J, et al. Relationship between glycemic control and diabetes-related hospital costs in patients with type 1 or type 2 diabetes mellitus. *J Manag Care Pharm*. 2010;16:264-275. https://doi.org/10.18553/jmcp.2010.16.4.264
20. Juarez D, Goo R, Tokumaru S, Sentell T, Davis J, Mau M. Association between sustained glycated hemoglobin control and healthcare costs. *Am J Pharm Benefits*. 2013;5:59-64.
21. Banerji MA, Dunn JD. Impact of glycemic control on healthcare resource utilization and costs of type 2 diabetes: current and future pharmacologic approaches to improving outcomes. *Am Health Drug Benefits*. 2013;6:382-392.
22. Heald AH, Livingston M, Malipatil N, et al. Improving type 2 diabetes mellitus glycaemic outcomes is possible without spending more on medication: lessons from the UK National Diabetes Audit. *Diabetes Obes Metab*. 2018;20:185-194.
23. Gagliardino JJ, de la Hera M, Siri F; Grupo de Investigación de la Red QUALIDIAB. Evaluation of the quality of care for diabetic patients in Latin America. *Rev Panam Salud Publica*. 2001;10:309-317.
24. Inzucchi SE, Bergenstal RM, Buse JB, et al. Management of hyperglycemia in type 2 diabetes, 2015: a patient-centered approach: update to a position statement of the American Diabetes Association and the European Association for the Study of Diabetes. *Diabetes Care*. 2015;38:140-149. https://doi.org/10.2337/dc14-2441

25. Mogyorosy Z, Smith P. *The main methodological issues in costing health care services: a literature review*. CHE Research Paper Nr. 7. York: Centre for Health Economics, University of York; 2005.
26. Nichols GA, Arondekar B, Herman WH. Medical care costs one year after identification of hyperglycemia below the threshold for diabetes. *Med Care*. 2008;46:287-292. https://doi.org/10.1097/MLR.0b013e31815b9772
27. Brunton SA, Polonsky WH. Hot topics in primary care: medication adherence in type 2 diabetes mellitus: real-world strategies for addressing a common problem. *J Fam Pract*. 2017;66:S46-S51.
28. Ford ES. Trends in the control of risk factors for cardiovascular disease among adults with diagnosed diabetes: findings from the National Health and Nutrition Examination Survey 1999–2008. *J Diabetes*. 2011;3:337-347. https://doi.org/10.1111/j.1753-0407.2011.00148.x
29. Aliha JM, Asgari M, Khayeri F, Ramazani M, Farajzadegan Z, Javaheri J. Group education and nurse-telephone follow-up effects on blood glucose control and adherenceto treatment in type 2 diabetes patients. *Int J Prev Med*. 2013;4:797-802.
30. Gagliardino JJ, Etchegoyen G. PEDNID-LA Research Group. A model educational program for people with type 2 diabetes: a cooperative Latin American implementation study (PEDNID-LA). *Diabetes Care*. 2001;24:1001-1007.
31. Gagliardino JJ, Lapertosa S, Pfirter G, et al. metabolic and psychological outcomes and treatment costs of a prospective randomized trial based on different educational strategies to improve diabetes care (PRODIACOR). *Diabet Med*. 2013;30:1102-1111. https://doi.org/10.1111/dme.12230

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