Clinical Practice Guidelines on Type 1 Diabetes Mellitus

Short Version

Clinical Practice Guidelines in the Spanish National Health System

Ministry of Health

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1. Introduction

This Clinical Practice Guideline on Type 1 Diabetes Mellitus (T1D) aims to provide systematically developed, evidence-based recommendations based on the most relevant and current scientific evidence to support healthcare professionals and people with T1D in making decisions regarding the most appropriate care to deliver, integrating the various Spanish NHS healthcare facilities involved in a coordinated manner.

This version in English contains the following types of information:

- **Clinical questions**
- **Recommendations**
- **Rationale**
- **Complete clinical question** (link to the Spanish version)
- **References**

The full version (in layered format and PDF), the methodological material, the material for patients and other information are available in Spanish at the following link: https://portal.guiasalud.es/gpc/diabetes-mellitus-tipo-1/

2. Diagnosis

2.1. Use of Islet Autoantibodies

Question

- Should islet beta-cell autoantibodies be used for the diagnosis of clinical T1D? When and which autoantibodies should be used?

Recommendations

GOOD CLINICAL PRACTICE

1. Measurement of anti-glutamic acid decarboxylase (anti-GAD) and anti-tyrosine phosphatase (anti-IA2) autoantibodies is suggested, preferably at T1D diagnosis.

2. If anti-GAD and anti-IA2 autoantibodies are negative and T1D is still suspected, measurement of insulin autoantibodies (preferably prior to initiating insulin therapy) and zinc transporter 8 (ZnT8) autoantibodies is suggested.

3. It is suggested that blood samples for testing anti-GAD, anti-IA2, and ZnT8 autoantibodies be collected during a single venepuncture, preferably before starting insulin therapy. It is suggested to test anti-GAD and anti-IA2 autoantibodies first, storing a sample to perform the remaining autoantibody tests later on if the initial tests are negative.

Rationale

The Guideline Development Group (GDG) decided to formulate Good Clinical Practice (GCP) points because no direct scientific evidence was identified to answer the research question. These recommendations were developed to facilitate appropriate clinical management for individuals at risk of or living with T1D. Testing for anti-glutamic acid decarboxylase (anti-GAD) and anti-tyrosine phosphatase (anti-IA2) autoantibodies is suggested; if negative, testing for insulin and ZnT8 autoantibodies is recommended. Sufficient blood samples can be drawn during a single venepuncture, preferably before commencing insulin therapy. Despite the lack of direct evidence from empirical research, the GDG considered that the magnitude of the expected desirable effects is large. The GDG concluded that autoantibody determinations are useful alongside other clinical parameters for improving T1D diagnosis, with no adverse effects associated with ordering these tests.

Screening programmes for islet beta-cell autoantibodies before clinical T1D onset (Stage 3) currently exist, primarily within research frameworks. These programmes aim to identify individuals at risk who might benefit from targeted interventions to delay disease progression.

Growing evidence regarding early detection, alongside the recent FDA approval of teplizumab in the United States to delay the onset of clinical T1D, has prompted updates in several international guidelines (4). However, the systematic implementation of this strategy remains a subject of ongoing debate, as most current recommendations rely on indirect evidence and ongoing studies. In Spain, the consensus document on screening, staging, and monitoring preclinical T1D—developed by the Spanish scientific societies of Diabetes (SED), of Endocrinology and Nutrition (SEEN), and of

Pediatric Endocrinology (SEEP)—provides guidance on early identification of individuals at risk (98). Implementing screening and monitoring strategies require the active involvement of GPs, paediatricians, and primary care nurses, who play a key role in detection, monitoring, and education for patients and families.

Therefore, while early autoantibody detection may play an emerging role in risk stratification and potential therapeutic intervention, there is still not sufficient evidence to recommend its widespread use in routine clinical practice. Close monitoring of emerging evidence is suggested, with these strategies to be evaluated in future updates of this CPG.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-1

References

- Haller MJ, Bell KJ, Besser REJ, Casteels K, Couper JJ, Craig ME, et al. ISPAD Clinical Practice Consensus Guidelines 2024: Screening, Staging, and Strategies to Preserve Beta-Cell Function in Children and Adolescents with Type 1 Diabetes. Horm Res Paediatr. 11 de diciembre de 2024;97(6):529-45. DOI: 10.1159/000543035
- Conde Barreiro S, González Pelegrín B, Quevedo Beneyto B, Feja Solana C, Malo Aznar C, Rojo-Martínez G, et al. Estimación de incidencia y prevalencia de la diabetes mellitus tipo 1 en menores de 15 años en España. Endocrinol Diabetes Nutr. agosto de 2025;72(7):501591. DOI: 10.1016/j.endinu.2025.501591
- Libman I, Haynes A, Lyons S, Pradeep P, Rwagasor E, Tung JY, et al. Clinical Practice Consensus Guidelines 2022: Definition, epidemiology, and classification of diabetes in children and adolescents. Pediatr Diabetes. diciembre de 2022;23(8):1160-74. DOI: 10.1111/pedi.13454
- Ministerio de Sanidad Servicios Sociales e Igualdad. Estrategia en Diabetes del Sistema Nacional de Salud Actualización. Madrid: Ministerios de Sanidad, Servicios Sociales e Igualdad; 2012.
- Grupo de trabajo de la Guía Clínica sobre Diabetes mellitus tipo 1. Guía de Práctica Clínica sobre Diabetes mellitus Tipo 1. Plan de Calidad para el Sistema Nacional de Salud del Ministerio de Sanidad y Política Social. Agencia Evaluacion Tecnol Sanit País Vasco. 2012;345.
- Greeley SAW, Polak M, Njølstad PR, Barbetti F, Williams R, Castano L, et al. ISPAD Clinical Practice Consensus Guidelines 2022: The diagnosis and management of monogenic diabetes in children and adolescents. Pediatr Diabetes. diciembre de 2022;23(8):1188-211. DOI: 10.1111/pedi.13426
- Fyvie MJ, Gillespie KM. The importance of biomarker development for monitoring type 1 diabetes progression rate and therapeutic responsiveness. Front Immunol. 15 de mayo de 2023;14:1158278. DOI: 10.3389/fimmu.2023.1158278
- Rodríguez Escobedo R, Mozo Avellaned L, Delgado Álvarez E, Menéndez Torre E. Pancreatic autoimmunity in the diagnosis of type 1 diabetes: Usefulness of anti-zinc transporter 8 antibody and proposed stepwise assessment. Endocrinol Diabetes Nutr. abril de 2023;70(4):286-8. DOI: 10.1016/j.endien.2023.04.001
- Qian L, Zhu Y, Luo Y, Zhang M, Yu L, Liu Y, et al. Prevalence of antibodies targeting ubiquitin-conjugating enzyme 2L3 and eukaryote translation elongation factor 1 α1 in Chinese Han and

American Caucasian populations with type 1 diabetes. Endocr Connect. 1 de diciembre de 2022;11(12):e220325. DOI: 10.1530/EC-22-0325

- Williams CL, Fareed R, Mortimer GLM, Aitken RJ, Wilson IV, George G, et al. The longitudinal loss of islet autoantibody responses from diagnosis of type 1 diabetes occurs progressively over follow-up and is determined by low autoantibody titres, early-onset, and genetic variants. Clin Exp Immunol. 15 de diciembre de 2022;210(2):151-62. DOI: 10.1093/cei/uxac087
- Kawasaki E. Anti-Islet Autoantibodies in Type 1 Diabetes. Int J Mol Sci. 11 de junio de 2023;24(12):10012. DOI: 10.3390/ijms241210012
- Takehana N, Fukui T, Mori Y, Hiromura M, Terasaki M, Ohara M, et al. Comparison of positive rates between glutamic acid decarboxylase antibodies and ElisaRSRTM 3 Screen ICATM in recently obtained sera from patients who had been previously diagnosed with slowly progressive type 1 diabetes. J Diabetes Investig. julio de 2023;14(7):856-63. DOI: 10.1111/jdi.14016
- Thomas NJ, Walkey HC, Kaur A, Misra S, Oliver NS, Colclough K, et al. The relationship between islet autoantibody status and the genetic risk of type 1 diabetes in adult-onset type 1 diabetes. Diabetologia. febrero de 2023;66(2):310-20. DOI: 10.1007/s00125-022-05823-1
- Harsunen M, Kettunen JLT, Härkönen T, Dwivedi O, Lehtovirta M, Vähäsalo P, et al. Identification of monogenic variants in more than ten per cent of children without type 1 diabetes-related autoantibodies at diagnosis in the Finnish Pediatric Diabetes Register. Diabetologia. marzo de 2023;66(3):438-49. DOI: 10.1007/s00125-022-05834-y
- Besser REJ, Bell KJ, Couper JJ, Ziegler A, Wherrett DK, Knip M, et al. ISPAD Clinical Practice Consensus Guidelines 2022: Stages of type 1 diabetes in children and adolescents. Pediatr Diabetes. diciembre de 2022;23(8):1175-87. DOI: 10.1111/pedi.13410
- Williams CL, Aitken RJ, Wilson IV, Mortimer GLM, Long AE, Williams AJK, et al. The measurement of autoantibodies to insulin informs diagnosis of diabetes in a childhood population negative for other autoantibodies. Diabet Med. diciembre de 2022;39(12):e14979. DOI: 10.1111/dme.14979
- Cherubini V, Chiarelli F. Autoantibody test for type 1 diabetes in children: are there reasons to implement a screening program in the general population? A statement endorsed by the Italian Society for Paediatric Endocrinology and Diabetes (SIEDP-ISPED) and the Italian Society of Paediatrics (SIP). Ital J Pediatr. 19 de julio de 2023;49(1):87. DOI: 10.1186/s13052-023-01438-3
- Urrutia I, Martinez R, Calvo B, Marcelo I, Saso-Jimenez L, Martinez De Lapiscina I, et al. Risk for progression to type 1 diabetes in first-degree relatives under 50 years of age. Front Endocrinol. 12 de agosto de 2024;15:1411686. DOI: 10.3389/fendo.2024.1411686
- Terada H, Urakami T, Nagano N, Mine Y, Kuwabara R, Aoki M, et al. Difference in the early clinical course between children with type 1 diabetes having a single antibody and those having multiple antibodies against pancreatic β-cells. Endocr J. 2023;70(4):385-91. DOI: 10.1507/endocrj.EJ22-0432
- Martínez-Brocca MA, Bellido V, Cardona-Hernandez R, Castaño L, Conget I, Fernández A, et al. Resumen ejecutivo. Cribado, estadificación y seguimiento de la diabetes tipo 1 en estadios preclínicos: consenso de las sociedades científicas SED, SEEN y SEEP. Endocrinol Diabetes Nutr. noviembre de 2025;72(9):501639. DOI: 10.1016/j.endinu.2025.501639
- Serra E, Guanyabens E, Aguilera E. Diagnóstico y manejo del paciente adulto con diabetes tipo1A al inicio de la enfermedad. Av En Diabetol. marzo de 2013;29(2):36-43. DOI: 10.1016/j.avdiab.2013.01.001
- Schmidt KD, Valeri C, Leslie RDG. Autoantibodies in Type 1 diabetes. Clin Chim Acta. abril de 2005;354(1-2):35-40. DOI: 10.1016/j.cccn.2004.11.017

- Leslie D, Lipsky P, Notkins AL. Autoantibodies as predictors of disease. J Clin Invest. noviembre de 2001;108(10):1417-22. DOI: 10.1172/JCI14452
- Chen Y, Xie Y, Xia Y, Xie Z, Huang G, Fan L, et al. Prevalence, clinical characteristics and HLA genotypes of idiopathic type 1 diabetes: A cross-sectional study. Diabetes Metab Res Rev. septiembre de 2023;39(6):e3676. DOI: 10.1002/dmrr.3676
- Fabris M, Zago S, Liguori M, Trevisan MT, Zanatta M, Comici A, et al. Anti-zinc transporter protein 8 autoantibodies significantly improve the diagnostic approach to type 1 diabetes: an Italian multicentre study on paediatric patients. Autoimmun Highlights. agosto de 2015;6(1-2):17-22. DOI: 10.1007/s13317-015-0068-4
- Fuentes-Cantero S, González-Rodríguez C, Rodríguez-Chacón C, Galvan-Toribio R, Hermosín-Escudero J, Pérez-Pérez A, et al. Study of the diagnostic efficiency of anti-ZnT8 autoantibodies for type 1 diabetes in pediatric patients. Lab Med. 2 de mayo de 2024;55(3):299-303. DOI: 10.1093/labmed/lmad079
- Kawasaki E, Oikawa Y, Okada A, Kanatsuna N, Kawamura T, Kikuchi T, et al. Zinc transporter 8 autoantibodies complement glutamic acid decarboxylase and insulinoma-associated antigen-2 autoantibodies in the identification and characterization of Japanese type 1 diabetes. J Diabetes Investig. septiembre de 2020;11(5):1181-7. DOI: 10.1111/jdi.13251
- Niechciał E, Rogowicz-Frontczak A, Piłaciński S, Fichna M, Skowrońska B, Fichna P, et al. Autoantibodies against zinc transporter 8 are related to age and metabolic state in patients with newly diagnosed autoimmune diabetes. Acta Diabetol. marzo de 2018;55(3):287-94. DOI: 10.1007/s00592-017-1091-x
- Andersson C, Kolmodin M, Ivarsson SA, Carlsson A, Forsander G, Lindblad B, et al. Islet cell antibodies (ICA) identify autoimmunity in children with new onset diabetes mellitus negative for other islet cell antibodies: Solitary islet cell antibody positivity. Pediatr Diabetes. agosto de 2014;15(5):336-44. DOI: 10.1111/pedi.12093
- Garnier L, Marchand L, Benoit M, Nicolino M, Bendelac N, Wright C, et al. Screening of ZnT8 autoantibodies in the diagnosis of autoimmune diabetes in a large French cohort. Clin Chim Acta. marzo de 2018;478:162-5. DOI: 10.1016/j.cca.2017.12.043
- Grace SL, Cooper A, Jones AG, McDonald TJ. Zinc transporter 8 autoantibody testing requires age-related cut-offs. BMJ Open Diabetes Res Care. agosto de 2021;9(1):e002296. DOI: 10.1136/bmjdrc-2021-002296
- Rodríguez Escobedo R, Mozo Avellaned L, Delgado Álvarez E, Menéndez Torre E. Autoinmunidad pancreática en el diagnóstico de la diabetes mellitus tipo 1: utilidad del anticuerpo anti transportador 8 del zinc y propuesta de valoración escalonada. Endocrinol Diabetes Nutr. abril de 2023;70(4):286-8. DOI: 10.1016/j.endinu.2023.02.001
- Törn C, Mueller PW, Schlosser M, Bonifacio E, Bingley PJ, Participating Laboratories. Diabetes Antibody Standardization Program: evaluation of assays for autoantibodies to glutamic acid decarboxylase and islet antigen-2. Diabetologia. mayo de 2008;51(5):846-52. DOI: 10.1007/s00125-008-0967-2

2.2. Differential Diagnosis of Monogenic Diabetes

Question

- When is genetic testing recommended to rule out monogenic diabetes?

Recommendations

WEAK RECOMMENDATION, IN FAVOUR

1. In individuals diagnosed with diabetes after six months of age, genetic testing to rule out monogenic diabetes is suggested when they present with:

    - absence of islet autoantibodies, particularly if tested at diagnosis;
    - atypical clinical features, such as congenital anomalies;
    - a family history of early-onset diabetes mellitus (frequently before 25 years of age) across at least two generations; or
    - low insulin requirements and/or detectable C-peptide (in blood or urine) at least five years after diagnosis.

2. In infants diagnosed with diabetes under 6 months of age, genetic testing to rule out monogenic diabetes should always be considered, regardless of islet autoantibody positivity.

Rationale

The GDG formulated weak recommendations in favour of genetic testing in infants under six months of age (regardless of autoantibody status), as well as in individuals diagnosed after six months of age who are islet autoantibody-negative, present with congenital anomalies, have a family history of early-onset DM across at least two generations, or have low insulin requirements and/or measurable C-peptide at least five years post-diagnosis. The certainty of evidence was rated as very low.

Although no direct empirical evidence was identified regarding atypical presentations, the GDG also decided to include a good practice point on performing genetic testing to rule out monogenic diabetes in individuals diagnosed after six months of age who display atypical features, such as congenital defects.

Complete clinical question

For full information on this question (available in Spanish), please see: https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-1

References

- Greeley SAW, Polak M, Njølstad PR, Barbetti F, Williams R, Castano L, et al. ISPAD Clinical Practice Consensus Guidelines 2022: The diagnosis and management of monogenic diabetes in children and adolescents. Pediatr Diabetes. diciembre de 2022;23(8):1188-211. DOI: 10.1111/pedi.13426
- Harsunen M, Kettunen JLT, Härkönen T, Dwivedi O, Lehtovirta M, Vähäsalo P, et al. Identification of monogenic variants in more than ten per cent of children without type 1 diabetes-related autoantibodies at diagnosis in the Finnish Pediatric Diabetes Register. Diabetologia. marzo de 2023;66(3):438-49. DOI: 10.1007/s00125-022-05834-y
- Marucci A, Rutigliano I, Fini G, Pezzilli S, Menzaghi C, Di Paola R, et al. Role of Actionable Genes in Pursuing a True Approach of Precision Medicine in Monogenic Diabetes. Genes. 9 de enero de 2022;13(1):117. DOI: 10.3390/genes13010117

- Edensor S, Jones O, Chakera AJ. Diagnosis and Management of Monogenic Diabetes in Pregnancy. Curr Diabetes Rev. febrero de 2023;19(2):e140522204792. DOI: 10.2174/1573399818666220514153021
- Lepore C, Damaso E, Suazo V, Queiroz R, Junior RL, Moisés E. Molecular Changes in the Glucokinase Gene (GCK) Associated with the Diagnosis of Maturity Onset Diabetes of the Young (MODY) in Pregnant Women and Newborns. Curr Diabetes Rev. julio de 2022;18(6):e060821195358. DOI: 10.2174/1573399817666210806110633
- Bonnefond A, Semple RK. Achievements, prospects and challenges in precision care for monogenic insulin-deficient and insulin-resistant diabetes. Diabetologia. noviembre de 2022;65(11):1782-95. DOI: 10.1007/s00125-022-05720-7
- Redondo MJ, Hagopian WA, Oram R, Steck AK, Vehik K, Weedon M, et al. The clinical consequences of heterogeneity within and between different diabetes types. Diabetologia. octubre de 2020;63(10):2040-8. DOI: 10.1007/s00125-020-05211-7
- Naylor RN, Philipson LH. Diagnosis and Clinical Management of Monogenic Diabetes. En: Feingold KR, Anawalt B, Blackman MR, Boyce A, Chrousos G, Corpas E, et al., editores. Endotext [Internet]. South Dartmouth (MA): MDText.com, Inc.; 2000 [citado 5 de octubre de 2023]. Disponible en: http://www.ncbi.nlm.nih.gov/books/NBK563964/
- Barbetti F, Rapini N, Schiaffini R, Bizzarri C, Cianfarani S. The application of precision medicine in monogenic diabetes. Expert Rev Endocrinol Metab. 4 de marzo de 2022;17(2):111-29. DOI: 10.1080/17446651.2022.2035216
- Tamaroff J, Kilberg M, Pinney SE, McCormack S. Overview of Atypical Diabetes. Endocrinol Metab Clin North Am. diciembre de 2020;49(4):695-723. DOI: 10.1016/j.ecl.2020.07.004
- Harrington F, Greenslade M, Colclough K, Paul R, Jefferies C, Murphy R. Monogenic diabetes in New Zealand – An audit based revision of the monogenic diabetes genetic testing pathway in New Zealand. Front Endocrinol [Internet]. 2023 [citado 27 de noviembre de 2023];14. Disponible en: https://www.frontiersin.org/articles/10.3389/fendo.2023.1116880 DOI: 10.3389/fendo.2023.1116880
- Bowden TL, Letourneau-Freiberg LR, Kandasamy B, Sanyoura M, Tian P, Harris AG, et al. Insight on Diagnosis and Treatment From Over a Decade of Research Through the University of Chicago Monogenic Diabetes Registry. Front Clin Diabetes Healthc. 5 de noviembre de 2021;2:735548. DOI: 10.3389/fcdhc.2021.735548
- Misra S, Owen KR. Genetics of Monogenic Diabetes: Present Clinical Challenges. Curr Diab Rep. diciembre de 2018;18(12):141. DOI: 10.1007/s11892-018-1111-4
- Zhang H, Colclough K, Gloyn AL, Pollin TI. Monogenic diabetes: a gateway to precision medicine in diabetes. J Clin Invest. 1 de febrero de 2021;131(3):142244. DOI: 10.1172/JCI142244
- Gandica RG, Chung WK, Deng L, Goland R, Gallagher MP. Identifying monogenic diabetes in a pediatric cohort with presumed type 1 diabetes. Pediatr Diabetes. mayo de 2015;16(3):227-33. DOI: 10.1111/pedi.12150
- Bellanné-Chantelot C, Lévy DJ, Carette C, Saint-Martin C, Riveline JP, Larger E, et al. Clinical characteristics and diagnostic criteria of maturity-onset diabetes of the young (MODY) due to molecular anomalies of the HNF1A gene. J Clin Endocrinol Metab. agosto de 2011;96(8):E1346-1351. DOI: 10.1210/jc.2011-0268
- Karaoglan M, Nacarkahya G. Clinical and laboratory clues of maturity-onset diabetes of the young and determination of association with molecular diagnosis. J Diabetes. febrero de 2021;13(2):154-63. DOI: 10.1111/1753-0407.13097

- Tarantino RM, Abreu G de M, Fonseca ACP de, Kupfer R, Pereira M de FC, Campos Júnior M, et al. MODY probability calculator for GCK and HNF1A screening in a multiethnic background population. Arch Endocrinol Metab. febrero de 2020;64(1):17-23. DOI: 10.20945/2359-3997000000173
- Lemelman MB, Letourneau L, Greeley SAW. Neonatal Diabetes Mellitus: An Update on Diagnosis and Management. Clin Perinatol. marzo de 2018;45(1):41-59. DOI: 10.1016/j.clp.2017.10.006

2.3. Screening for Associated Autoimmune Diseases

Question

- Is screening for autoimmune diseases associated with T1D necessary? Which conditions should be screened, how, and at what frequency?

This question was divided into three specific sub-questions based on the associated autoimmune diseases identified in the literature according to the predefined selection criteria:

- *In people with T1D, should screening for autoimmune thyroid disease be performed?*
- *In people with T1D, should screening for coeliac disease be performed?*
- *In people with T1D, should screening for autoimmune atrophic gastritis be performed?*

2.3.1. Autoimmune Thyroid Disease

Sub-question

- In people with T1D, should screening for autoimmune thyroid disease be performed?

Recommendations

WEAK RECOMMENDATION, IN FAVOUR

1. In adults with T1D, routine measurement of thyroid-stimulating hormone (TSH) levels is suggested to exclude thyroid dysfunction.
2. In children, measurement of thyroid-stimulating hormone (TSH) levels and thyroid peroxidase autoantibodies (anti-TPO) is suggested at T1D diagnosis. In the presence of positive autoantibodies or a family history of thyroid disease, closer monitoring (annually or upon symptom onset) should be undertaken.
3. If thyroid function is altered in clinically unstable patients with T1D (e.g. during ketoacidosis or severe intercurrent illness), retesting thyroid function (TSH) is recommended once the individual is clinically stable.

Rationale

The GDG formulated a weak recommendation in favour of routine measurement of thyroid-stimulating hormone (TSH) levels to detect thyroid dysfunction in adults with T1D. A specific screening interval

(annual versus biennial) could not be recommended due to a lack of studies comparing different screening frequencies. The prevalence of hypothyroidism in people with T1D is approximately 9.8%, notably higher than in the general population of Europe (3.05%) and Spain (4.2%). Despite this higher prevalence, the desirable effects of the intervention were judged to be small, as no significant improvements in HbA1c levels or insulin requirements were identified following a diagnosis of hypothyroidism. However, individuals with subclinical hypothyroidism face a higher risk of symptomatic hypoglycaemic episodes, with a progressive risk increase from the point of diagnosis.

In children with T1D, a weak recommendation in favour of measuring TSH levels and anti-TPO autoantibodies at diagnosis is issued. Early detection is crucial due to the potential adverse effects of undetected thyroid disease on child development. Furthermore, closer monitoring is suggested for children with positive autoantibodies or a family history of autoimmune thyroid disease. This may involve annual checks or additional clinical evaluations if symptoms appear, as individuals with coexisting T1D and thyroid disease have a slightly increased risk of chronic vascular complications (such as diabetic nephropathy and retinopathy), although the overall effect size is small.

Furthermore, the GDG proposed a weak recommendation in favour of re-evaluating TSH levels in individuals with T1D who present with mild thyroid dysfunction during acute clinical instability (such as ketoacidosis or severe intercurrent illness). Retesting should occur once the patient has stabilised to confirm the diagnosis and adjust clinical management if necessary.

The overall certainty of evidence supporting these recommendations is very low, highlighting the need for further studies evaluating both the effectiveness and optimal frequency of screening interventions. Nevertheless, the GDG considered that the potential benefits of timely, targeted screening justify these weak recommendations despite the underlying evidence uncertainty.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-1

References

- Nederstigt C, Uitbeijerse BS, Janssen LGM, Corssmit EPM, de Koning EJP, Dekkers OM. Associated auto-immune disease in type 1 diabetes patients: A systematic review and meta-analysis. Eur J Endocrinol. 2019;180(2):135-44. DOI: 10.1530/EJE-18-0515
- Triolo TM, Armstrong TK, McFann K, Yu L, Rewers MJ, Klingensmith GJ, et al. Additional autoimmune disease found in 33% of patients at type 1 diabetes onset. Diabetes Care. 2011;34(5):1211-3. DOI: 10.2337/dc10-1756
- Kozhakhmetova A, Wyatt RC, Caygill C, Williams C, Long AE, Chandler K, et al. A quarter of patients with type 1 diabetes have co-existing non-islet autoimmunity: the findings of a UK population-based family study. Clin Exp Immunol. 25 de mayo de 2018;192(3):251-8. DOI: 10.1111/cei.13115
- Warncke K, Fröhlich-Reiterer EE, Thon A, Hofer SE, Wiemann D, Holl RW, et al. Polyendocrinopathy in Children, Adolescents, and Young Adults With Type 1 Diabetes. Diabetes Care. 1 de septiembre de 2010;33(9):2010-2. DOI: 10.2337/dc10-0404

- Dost A, Rohrer TR, Fröhlich-Reiterer E, Bollow E, Karges B, Böckmann A, et al. Hyperthyroidism in 276 Children and Adolescents with Type 1 Diabetes from Germany and Austria. Horm Res Paediatr. 2015;84(3):190-8. DOI: 10.1159/000436964
- ElSayed NA, Aleppo G, Aroda VR, Bannuru RR, Brown FM, Bruemmer D, et al. 14. Children and Adolescents: Standards of Care in Diabetes-2023. Diabetes Care. 1 de enero de 2023;46(Supplement_1):S230-53. DOI: 10.2337/dc23-S014
- Diabetes Canada. Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. Can J Diabetes. 2018;42:Supplement 1. DOI: 10.1080/00945718308059306
- Fröhlich-Reiterer E, Elbarbary NS, Simmons K, Buckingham B, Humayun KN, Johannsen J, et al. ISPAD Clinical Practice Consensus Guidelines 2022: Other complications and associated conditions in children and adolescents with type 1 diabetes. Pediatr Diabetes. diciembre de 2022;23(8):1451-67. DOI: 10.1111/pedi.13445
- Mohn A, Di Michele S, Di Luzio R, Tumini S, Chiarelli F. The effect of subclinical hypothyroidism on metabolic control in children and adolescents with Type 1 diabetes mellitus. Diabet Med. enero de 2002;19(1):70-3. DOI: 10.1046/j.1464-5491.2002.00635.x
- Rogowicz-Frontczak A, Falkowski B, Grzelka-Wozniak A, Uruska A, Araszkiewicz A, Zozulinska-Ziolkiewicz D. Does autoimmune hypothyroidism increase the risk of neurovascular complications in type 1 diabetes? J Endocrinol Invest. junio de 2020;43(6):833-9. DOI: 10.1007/s40618-019-01171-x

2.3.2. Coeliac Disease

Sub-question

- Should screening for coeliac disease be performed in people with T1D?

Recommendations

WEAK RECOMMENDATION, AGAINST

1. In adults with T1D, routine screening for coeliac disease is not suggested in the absence of clinical or laboratory features raising suspicion.

WEAK RECOMMENDATION, IN FAVOUR

2. Screening to rule out coeliac disease is recommended within the first year following T1D diagnosis in children and adolescents.

3. If the screening test for coeliac disease is positive in an asymptomatic person with T1D, repeating the autoantibody test is suggested before proceeding with further diagnostic evaluation for coeliac disease.

GOOD CLINICAL PRACTICE

4. It is suggested that screening to rule out coeliac disease in children and adolescents be performed every 2 to 5 years.

Rationale

Considering the desirable effects and the International Society for Pediatric and Adolescent Diabetes (ISPAD) recommendations, the GDG formulated weak recommendations in favour of ruling out coeliac disease within the first year after T1D diagnosis. Blood samples can be drawn at the time of T1D diagnosis in children and adolescents to avoid additional venepunctures. In cases where the screening test for coeliac disease is positive in asymptomatic individuals, the GDG issued a weak recommendation in favour of repeating the autoantibody test prior to continuing diagnostic evaluation for coeliac disease. In adults, the GDG formulated a weak recommendation against routine screening for coeliac disease in the absence of clinical or laboratory features raising suspicion, in alignment with American Diabetes Association (ADA) recommendations (137). The certainty of evidence was rated as very low.

Taking into account ISPAD guidelines (134), the GDG also decided to formulate a GCP point regarding screening to rule out coeliac disease in children and adolescents every two to five years.

Complete clinical question

For further information on this question, please consult the full guideline (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-1

References

- Nederstigt C, Uitbeijerse BS, Janssen LGM, Corssmit EPM, de Koning EJP, Dekkers OM. Associated auto-immune disease in type 1 diabetes patients: A systematic review and meta-analysis. Eur J Endocrinol. 2019;180(2):135-44. DOI: 10.1530/EJE-18-0515
- Kozhakhmetova A, Wyatt RC, Caygill C, Williams C, Long AE, Chandler K, et al. A quarter of patients with type 1 diabetes have co-existing non-islet autoimmunity: the findings of a UK population-based family study. Clin Exp Immunol. 25 de mayo de 2018;192(3):251-8. DOI: 10.1111/cei.13115
- Warncke K, Fröhlich-Reiterer EE, Thon A, Hofer SE, Wiemann D, Holl RW, et al. Polyendocrinopathy in Children, Adolescents, and Young Adults With Type 1 Diabetes. Diabetes Care. 1 de septiembre de 2010;33(9):2010-2. DOI: 10.2337/dc10-0404
- ElSayed NA, Aleppo G, Aroda VR, Bannuru RR, Brown FM, Bruemmer D, et al. 14. Children and Adolescents: Standards of Care in Diabetes-2023. Diabetes Care. 1 de enero de 2023;46(Supplement_1):S230-53. DOI: 10.2337/dc23-S014
- Fröhlich-Reiterer E, Elbarbary NS, Simmons K, Buckingham B, Humayun KN, Johannsen J, et al. ISPAD Clinical Practice Consensus Guidelines 2022: Other complications and associated conditions in children and adolescents with type 1 diabetes. Pediatr Diabetes. diciembre de 2022;23(8):1451-67. DOI: 10.1111/pedi.13445
- ElSayed NA, Aleppo G, Aroda VR, Bannuru RR, Brown FM, Bruemmer D, et al. 4. Comprehensive Medical Evaluation and Assessment of Comorbidities: Standards of Care in Diabetes—2023. Diabetes Care. 12 de diciembre de 2022;46(Supplement_1):s49-s67. DOI: 10.2337/dc23-S004
- Elfström P, Sundström J, Ludvigsson JF. Systematic review with meta-analysis: associations between coeliac disease and type 1 diabetes. Aliment Pharmacol Ther. noviembre de 2014;40(10):1123-32. DOI: 10.1111/apt.12973

- Tittel SR, Dunstheimer D, Hilgard D, Knauth B, Fröhlich-Reiterer E, Galler A, et al. Coeliac disease is associated with depression in children and young adults with type 1 diabetes: results from a multicentre diabetes registry. Acta Diabetol. mayo de 2021;58(5):623-31. DOI: 10.1007/s00592-020-01649-8
- Tokatly Latzer I, Rachmiel M, Zuckerman Levin N, Mazor-Aronovitch K, Landau Z, Ben-David RF, et al. Increased prevalence of disordered eating in the dual diagnosis of type 1 diabetes mellitus and celiac disease. Pediatr Diabetes. junio de 2018;19(4):749-55. DOI: 10.1111/pedi.12653
- Husby S, Koletzko S, Korponay-Szabó I, Kurppa K, Mearin ML, Ribes-Koninckx C, et al. European Society Paediatric Gastroenterology, Hepatology and Nutrition Guidelines for Diagnosing Coeliac Disease 2020. J Pediatr Gastroenterol Nutr. enero de 2020;70(1):141-56. DOI: 10.1097/MPG.0000000000002497
- Castellaneta S, Piccinno E, Oliva M, Cristofori F, Vendemiale M, Ortolani F, et al. High rate of spontaneous normalization of celiac serology in a cohort of 446 children with type 1 diabetes: a prospective study. Diabetes Care. mayo de 2015;38(5):760-6. DOI: 10.2337/dc14-2890
- Unal E, Demiral M, Baysal B, Ağın M, Devecioğlu EG, Demirbilek H, et al. Frequency of Celiac Disease and Spontaneous Normalization Rate of Celiac Serology in Children and Adolescent Patients with Type 1 Diabetes. J Clin Res Pediatr Endocrinol. 26 de febrero de 2021;13(1):72-9. DOI: 10.4274/jcrpe.galenos.2020.2020.0108
- Parkkola A, Härkönen T, Ryhänen SJ, Uibo R, Ilonen J, Knip M, et al. Transglutaminase antibodies and celiac disease in children with type 1 diabetes and in their family members. Pediatr Diabetes. marzo de 2018;19(2):305-13. DOI: 10.1111/pedi.12563
- Hopper AD, Cross SS, Hurlstone DP, McAlindon ME, Lobo AJ, Hadjivassiliou M, et al. Pre-endoscopy serological testing for coeliac disease: evaluation of a clinical decision tool. BMJ. 7 de abril de 2007;334(7596):729. DOI: 10.1136/bmj.39133.668681.BE
- Burgin-Wolff A, Gaze H, Hadziselimovic F, Huber H, Lentze MJ, Nussle D, et al. Antigliadin and antiendomysium antibody determination for coeliac disease. Arch Dis Child. 1 de agosto de 1991;66(8):941-7. DOI: 10.1136/adc.66.8.941

2.3.3. Autoimmune Atrophic Gastritis

Sub-question

- Should screening for autoimmune atrophic gastritis be performed in people with T1D?

Recommendations

WEAK RECOMMENDATION, AGAINST

1. Based on currently available evidence, routine screening for autoimmune atrophic gastritis is not suggested in people with T1D in the absence of clinical or laboratory features raising suspicion.

Rationale

Considering the lack of clarity regarding desirable and undesirable effects, alongside moderate costs, the GDG formulated a weak recommendation against screening for autoimmune atrophic gastritis in people with T1D. The certainty of evidence was rated as low.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-1

References

- Fröhlich-Reiterer E, Elbarbary NS, Simmons K, Buckingham B, Humayun KN, Johannsen J, et al. ISPAD Clinical Practice Consensus Guidelines 2022: Other complications and associated conditions in children and adolescents with type 1 diabetes. Pediatr Diabetes. diciembre de 2022;23(8):1451-67. DOI: 10.1111/pedi.13445
- de Graaff LCG, Smit JWA, Radder JK. Prevalence and clinical significance of organ-specific autoantibodies in type 1 diabetes mellitus. Neth J Med. 2007;65(7):235-47.
- Lahner E, Norman GL, Severi C, Encabo S, Shums Z, Vannella L, et al. Reassessment of Intrinsic Factor and Parietal Cell Autoantibodies in Atrophic Gastritis With Respect to Cobalamin Deficiency. Am J Gastroenterol. agosto de 2009;104(8):2071-9. DOI: 10.1038/ajg.2009.231

3. Glycaemic Management

3.1. Glycated Haemoglobin (HbA1c) Targets

Question

- What are the target glycated haemoglobin (HbA1c) levels in people with T1D?

Recommendations

STRONG RECOMMENDATION, IN FAVOUR

1. Supporting people with T1D to achieve glycated haemoglobin levels between 6.1% and 6.9%, or even below 6.1%, is recommended to minimise the risk of mortality and chronic complications of the disease.

2. Aiming to achieve glycated haemoglobin targets from the point of T1D diagnosis is recommended.

GOOD CLINICAL PRACTICE

3. It is suggested that glycated haemoglobin targets be individualised according to age, presence of comorbidities, and degree of frailty, and agreed with the person with T1D by weighing up benefits and risks while minimising the risk of hypoglycaemia.

4. Supporting people with T1D to achieve glycated haemoglobin levels between 6.1% and 6.9%, or even below 6.1%, is suggested to minimise the risk of ketoacidosis.

Rationale

Achieving lower target HbA1c levels yields greater health benefits for people with T1D, although attainment of these targets has traditionally been limited by the risk of severe hypoglycaemia. Advances in clinical management and technological developments have reduced the risk of hypoglycaemia, meaning that efforts to reach lower HbA1c values now entail lower clinical risks.

Complete clinical question

For further information on this question, please consult the full guideline (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-2

References

- American Diabetes Association. Standards of Care in Diabetes-2025. Diabetes Care [Internet]. 2025;48(Supplement_1). Disponible en: https://diabetesjournals.org/care/issue/48/Supplement_1
- Sims EK, Besser REJ, Dayan C, Geno Rasmussen C, Greenbaum C, Griffin KJ, et al. Screening for Type 1 Diabetes in the General Population: A Status Report and Perspective. Diabetes. 1 de abril de 2022;71(4):610-23. DOI: 10.2337/dbi20-0054

- Ministerio de Sanidad, Servicios Sociales e Igualdad. Estrategia en Diabetes del Sistema Nacional de Salud Actualización. Madrid: Ministerios de Sanidad, Servicios Sociales e Igualdad; 2012.
- Barquilla García A, Sánchez Vega J, Romero Vigara JC, Fernández L, Gamero Samino MJ, Buitrago F. Prevalence of diabetes and frequency of glycated haemoglobin monitoring in Extremadura (Spain) during 2012, 2013 and 2014: An observational study. Prim Care Diabetes. agosto de 2019;13(4):324-9. DOI: 10.1016/j.pcd.2018.12.006
- DiMeglio LA, Evans-Molina C, Oram RA. Type 1 diabetes. The Lancet. 16 de junio de 2018;391(10138):2449-62. DOI: 10.1016/S0140-6736(18)31320-5
- Hsu CR, Chen YT, Sheu WHH. Glycemic variability and diabetes retinopathy: a missing link. J Diabetes Complications. marzo de 2015;29(2):302-6. DOI: 10.1016/j.jdiacomp.2014.11.013
- Ishibashi F, Taniguchi M, Kosaka A, Uetake H, Tavakoli M. Improvement in Neuropathy Outcomes With Normalizing HbA1c in Patients With Type 2 Diabetes. Diabetes Care. enero de 2019;42(1):110-8. DOI: 10.2337/dc18-1560
- American Diabetes Association. 5. Glycemic Targets-2016. Diabetes Care. enero de 2016;39 Suppl 1:S39-46. DOI: 10.2337/dc16-S008
- Groeneveld Y, Petri H, Hermans J, Springer MP. Relationship between blood glucose level and mortality in type 2 diabetes mellitus: a systematic review. Diabet Med. enero de 1999;16(1):2-13. DOI: 10.1046/j.1464-5491.1999.00003.x
- National Institute for Health and Care Excellence (NICE). Type 1 diabetes in adults: diagnosis and management (NG17) [Internet]. 2018 p. 1-87. Report No.: August 2015. Disponible en: www.nice.org.uk/guidance/ng17
- Shankar A, Klein R, Klein BEK, Moss SE. Association between glycosylated hemoglobin level and cardiovascular and all-cause mortality in type 1 diabetes. Am J Epidemiol. 15 de agosto de 2007;166(4):393-402. DOI: 10.1093/aje/kwm096
- Schoenaker DAJM, Simon D, Chaturvedi N, Fuller JH, Soedamah-Muthu SS, EURODIAB Prospective Complications Study Group. Glycemic control and all-cause mortality risk in type 1 diabetes patients: the EURODIAB prospective complications study. J Clin Endocrinol Metab. marzo de 2014;99(3):800-7. DOI: 10.1210/jc.2013-2824
- Lind M, Svensson AM, Kosiborod M, Gudbjörnsdottir S, Pivodic A, Wedel H, et al. Glycemic control and excess mortality in type 1 diabetes. N Engl J Med. 20 de noviembre de 2014;371(21):1972-82. DOI: 10.1056/NEJMoa1408214
- Samuelsson U, Steineck I, Gubbjornsdottir S. A high mean-HbA1c value 3-15 months after diagnosis of type 1 diabetes in childhood is related to metabolic control, macroalbuminuria, and retinopathy in early adulthood–a pilot study using two nation-wide population based quality registries. Pediatr Diabetes. mayo de 2014;15(3):229-35. DOI: 10.1111/pedi.12085

3.2. Glucose Monitoring

Question

- Which glucose monitoring methods are most effective and safe in people with T1D?

This question was divided into two specific sub-questions based on the comparisons identified in the scientific literature according to the predefined selection criteria:

- *Should real-time continuous interstitial glucose monitoring be used instead of self-monitoring of blood glucose in people with T1D?*
- *Should intermittently scanned (Flash) continuous glucose monitoring be used instead of self-monitoring of blood glucose in people with T1D?*

3.2.1. Real-Time Continuous Interstitial Glucose Monitoring (rtCGM) Systems

Sub-question

- Should real-time continuous interstitial glucose monitoring be used instead of self-monitoring of blood glucose in people with T1D?

Recommendations

WEAK RECOMMENDATION, IN FAVOUR

1. In people with T1D, the use of real-time continuous glucose monitoring is suggested instead of self-monitoring of capillary blood glucose.

STRONG RECOMMENDATION, IN FAVOUR

2. In people with T1D at risk of severe hypoglycaemia, the use of real-time continuous glucose monitoring is recommended instead of self-monitoring of capillary blood glucose.
3. In pregnant women with T1D, the use of real-time continuous glucose monitoring is recommended instead of self-monitoring of capillary blood glucose.

Rationale

A weak recommendation in favour of real-time continuous glucose monitoring (rtCGM) over self-monitoring of capillary blood glucose was issued for people with T1D, regardless of age or prior glycaemic control, based on available evidence suggesting clinically meaningful benefits without significant additional risks. However, the certainty of evidence was rated as very low, which justifies the weak strength of the recommendation.

The GDG recognises that in the Spanish NHS, different types of interstitial monitoring (rtCGM and Flash/IsCGM systems) are available and publicly funded, with the choice being individualised based on clinical characteristics and patient preferences.

Conversely, for individuals at risk of severe hypoglycaemia and for pregnant women, a strong recommendation in favour of rtCGM was issued. In these specific populations, the certainty of evidence is high, providing robust support for the recommendation as the potential benefits clearly outweigh the risks. The distinction between rtCGM and Flash/IsCGM systems is maintained because the evidence base supporting these recommendations is derived predominantly from studies conducted using rtCGM devices.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-3

References

- Holt RIG, DeVries JH, Hess-Fischl A, Hirsch IB, Kirkman MS, Klupa T, et al. The management of type 1 diabetes in adults. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetologia. diciembre de 2021;64(12):2609-52. DOI: 10.1007/s00125-021-05568-3
- Perestelo-Pérez L, Rivero-Santana A, Castilla-Rodríguez I, Álvarez-Pérez Y, Ramos-García V, García-Pérez L, et al. Efectividad, seguridad y coste-efectividad de los sistemas de monitorización continua de glucosa intersticial en tiempo real (MCG-TR) para la Diabetes Mellitus tipo 1 y 2. Actualización. Ministerio de Sanidad. Servicio de Evaluación del Servicio Canario de la Salud; 2020.
- Gandhi GY, Kovalaske M, Kudva Y, Walsh K, Elamin MB, Beers M, et al. Efficacy of Continuous Glucose Monitoring in Improving Glycemic Control and Reducing Hypoglycemia: A Systematic Review and Meta-Analysis of Randomized Trials. J Diabetes Sci Technol. julio de 2011;5(4):952-65. DOI: 10.1177/193229681100500419
- Delgado E, Franch J, Sarria A. Sistema flash de monitorización de glucosa y su aplicación a la realidad clínica española. Madrid: Alianza General de Pacientes; 2015.
- Klonoff DC, Ahn D, Drincic A. Continuous glucose monitoring: A review of the technology and clinical use. Diabetes Res Clin Pract. noviembre de 2017;133:178-92. DOI: 10.1016/j.diabres.2017.08.005
- Beck RW, Riddlesworth T, Ruedy K, Ahmann A, Bergenstal R, Haller S, et al. Effect of Continuous Glucose Monitoring on Glycemic Control in Adults With Type 1 Diabetes Using Insulin Injections: The DIAMOND Randomized Clinical Trial. JAMA. 24 de enero de 2017;317(4):371. DOI: 10.1001/jama.2016.19975
- Lind M, Polonsky W, Hirsch IB, Heise T, Bolinder J, Dahlqvist S, et al. Continuous Glucose Monitoring vs Conventional Therapy for Glycemic Control in Adults With Type 1 Diabetes Treated With Multiple Daily Insulin Injections: The GOLD Randomized Clinical Trial. JAMA. 24 de enero de 2017;317(4):379. DOI: 10.1001/jama.2016.19976
- Battelino T, Conget I, Olsen B, Schütz-Fuhrmann I, Hommel E, Hoogma R, et al. The use and efficacy of continuous glucose monitoring in type 1 diabetes treated with insulin pump therapy: a randomised controlled trial. The SWITCH Study Group. Diabetologia. diciembre de 2012;55(12):3155-62. DOI: 10.1007/s00125-012-2708-9
- Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Study Group, Beck RW, Hirsch IB, Laffel L, Tamborlane WV, Bode BW, et al. The effect of continuous glucose monitoring in well-controlled type 1 diabetes. Diabetes Care. agosto de 2009;32(8):1378-83. DOI: 10.2337/dc09-0108
- Aleppo G, Ruedy KJ, Riddlesworth TD, Kruger DF, Peters AL, Hirsch I, et al. REPLACE-BG: A Randomized Trial Comparing Continuous Glucose Monitoring With and Without Routine Blood Glucose Monitoring in Adults With Well-Controlled Type 1 Diabetes. Diabetes Care. abril de 2017;40(4):538-45. DOI: 10.2337/dc16-2482

- Van Beers CAJ, DeVries JH, Kleijer SJ, Smits MM, Geelhoed-Duijvestijn PH, Kramer MHH, et al. Continuous glucose monitoring for patients with type 1 diabetes and impaired awareness of hypoglycaemia (IN CONTROL): a randomised, open-label, crossover trial. Lancet Diabetes Endocrinol. noviembre de 2016;4(11):893-902. DOI: 10.1016/S2213-8587(16)30193-0
- Heinemann L, Freckmann G, Ehrmann D, Faber-Heinemann G, Guerra S, Waldenmaier D, et al. Real-time continuous glucose monitoring in adults with type 1 diabetes and impaired hypoglycaemia awareness or severe hypoglycaemia treated with multiple daily insulin injections (HypoDE): a multicentre, randomised controlled trial. The Lancet. abril de 2018;391(10128):1367-77. DOI: 10.1016/S0140-6736(18)30297-6
- The SWITCH Study Group, Hommel E, Olsen B, Battelino T, Conget I, Schütz-Fuhrmann I, et al. Impact of continuous glucose monitoring on quality of life, treatment satisfaction, and use of medical care resources: analyses from the SWITCH study. Acta Diabetol. octubre de 2014;51(5):845-51. DOI: 10.1007/s00592-014-0598-7
- Burckhardt MA, Roberts A, Smith GJ, Abraham MB, Davis EA, Jones TW. The Use of Continuous Glucose Monitoring With Remote Monitoring Improves Psychosocial Measures in Parents of Children With Type 1 Diabetes: A Randomized Crossover Trial. Diabetes Care. 1 de diciembre de 2018;41(12):2641-3. DOI: 10.2337/dc18-0938
- Feig DS, Donovan LE, Corcoy R, Murphy KE, Amiel SA, Hunt KF, et al. Continuous glucose monitoring in pregnant women with type 1 diabetes (CONCEPTT): a multicentre international randomised controlled trial. The Lancet. noviembre de 2017;390(10110):2347-59. DOI: 10.1016/S0140-6736(17)32400-5
- Burckhardt M -A., Fried L, Bebbington K, Hancock M, Nicholas JA, Roberts A, et al. Use of remote monitoring with continuous glucose monitoring in young children with Type 1 diabetes: the parents' perspective. Diabet Med. noviembre de 2019;36(11):1453-9. DOI: 10.1111/dme.14061
- Boucher S, Blackwell M, Galland B, De Bock M, Crocket H, Wiltshire E, et al. Initial experiences of adolescents and young adults with type 1 diabetes and high-risk glycemic control after starting flash glucose monitoring – a qualitative study. J Diabetes Metab Disord. junio de 2020;19(1):37-46. DOI: 10.1007/s40200-019-00472-5
- Elbalshy M, Boucher S, Crocket H, Galland B, MacKenzie C, De Bock MI, et al. Exploring Parental Experiences of Using a Do-It-Yourself Solution for Continuous Glucose Monitoring Among Children and Adolescents With Type 1 Diabetes: A Qualitative Study. J Diabetes Sci Technol. septiembre de 2020;14(5):844-53. DOI: 10.1177/1932296819895290
- Sørgård B, Iversen M, Mårtensson J. Continuous glucose monitoring in adults with type 1 diabetes: A balance between benefits and barriers: A critical incident study. J Clin Nurs. 2019;28(17-18). DOI: 10.1111/jocn.14911

3.2.2. Intermittently Scanned Continuous Glucose Monitoring (isCGM / Flash) Systems

Sub-question

- Should intermittently scanned (Flash) continuous glucose monitoring be used instead of self-monitoring of blood glucose in people with T1D?

Recommendations

WEAK RECOMMENDATION, IN FAVOUR

1. In people with T1D, the use of sensor-based glucose monitoring (Flash type) is suggested instead of self-monitoring of capillary blood glucose.

Rationale

A weak recommendation in favour of sensor-based glucose monitoring (Flash type) over self-monitoring of capillary blood glucose was made for people with T1D. Available evidence suggests clinically meaningful benefits across certain outcomes, such as a reduction in time spent in hypoglycaemia alongside improved convenience and treatment satisfaction, without an increase in adverse effects. However, findings regarding HbA1c and other clinical outcomes remain uncertain or modest in magnitude, and the overall certainty of evidence is low to very low, primarily due to methodological limitations in available studies and the use of early device versions lacking hypoglycaemia alarms.

The GDG considered that, although the effect magnitude is moderate and risks are minimal, the uncertainty regarding evidence robustness justifies a weak recommendation. Furthermore, Flash monitoring is publicly funded in the Spanish NHS, its implementation is feasible, and its use is well accepted by people with T1D and healthcare professionals alike.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-3

References

- Holt RIG, DeVries JH, Hess-Fischl A, Hirsch IB, Kirkman MS, Klupa T, et al. The management of type 1 diabetes in adults. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetologia. diciembre de 2021;64(12):2609-52. DOI: 10.1007/s00125-021-05568-3
- Perestelo-Pérez L, Rivero-Santana A, García-Lorenzo B, Castilla-Rodríguez I, Vallejo-Torres L, García-Pérez L, et al. Efectividad, seguridad y coste-efectividad del sistema flash de monitorización de glucosa en líquido intersticial (FreeStyle Libre®) para la Diabetes Mellitus tipo 1 y 2. Ministerio de Sanidad, Servicios Sociales e Igualdad. Servicio de Evaluación del Servicio Canario de la Salud; 2016.
- González-Pacheco H, Ramallo-Fariña Y, Rivero-Santana A, Valcárcel-Nazco C, Toledo-Chávarr A, García-Pérez L, et al. Sistema de Monitorización de Glucosa mediante sensores (tipo Flash) para la diabetes mellitus tipo 1 en la infancia y adolescencia. Servicio de Evaluación del Servicio Canario de la Salud; 2021.
- Gandhi GY, Kovalaske M, Kudva Y, Walsh K, Elamin MB, Beers M, et al. Efficacy of Continuous Glucose Monitoring in Improving Glycemic Control and Reducing Hypoglycemia: A Systematic Review and Meta-Analysis of Randomized Trials. J Diabetes Sci Technol. julio de 2011;5(4):952-65. DOI: 10.1177/193229681100500419

- Delgado E, Franch J, Sarria A. Sistema flash de monitorización de glucosa y su aplicación a la realidad clínica española. Madrid: Alianza General de Pacientes; 2015.
- Klonoff DC, Ahn D, Drincic A. Continuous glucose monitoring: A review of the technology and clinical use. Diabetes Res Clin Pract. noviembre de 2017;133:178-92. DOI: 10.1016/j.diabres.2017.08.005
- Elbalshy M, Boucher S, Crocket H, Galland B, MacKenzie C, De Bock MI, et al. Exploring Parental Experiences of Using a Do-It-Yourself Solution for Continuous Glucose Monitoring Among Children and Adolescents With Type 1 Diabetes: A Qualitative Study. J Diabetes Sci Technol. septiembre de 2020;14(5):844-53. DOI: 10.1177/1932296819895290
- Sørgård B, Iversen M, Mårtensson J. Continuous glucose monitoring in adults with type 1 diabetes: A balance between benefits and barriers: A critical incident study. J Clin Nurs. 2019;28(17-18). DOI: 10.1111/jocn.14911
- Boscari F, Ferretto S, Cavallin F, Fadini GP, Avogaro A, Bruttomesso D. Effectiveness of adding alarms to flash glucose monitoring in adults with type 1 diabetes under routine care. Acta Diabetol. julio de 2022;59(7):921-8. DOI: 10.1007/s00592-022-01884-1
- Franceschi R, Scotton C, Leonardi L, Cauvin V, Maines E, Angriman M, et al. Impact of intermittently scanned continuous glucose monitoring with alarms on sleep and metabolic outcomes in children and adolescents with type 1 diabetes. Acta Diabetol. julio de 2022;59(7):911-9. DOI: 10.1007/s00592-022-01882-3
- Bolinder J, Antuna R, Geelhoed-Duijvestijn P, Kröger J, Weitgasser R. Novel glucose-sensing technology and hypoglycaemia in type 1 diabetes: a multicentre, non-masked, randomised controlled trial. The Lancet. noviembre de 2016;388(10057):2254-63. DOI: 10.1016/S0140-6736(16)31535-5
- Tumminia A, Milluzzo A, Festa C, Fresa R, Pintaudi B, Scavini M, et al. Efficacy of flash glucose monitoring in pregnant women with poorly controlled pregestational diabetes (FlashMom): A randomized pilot study. Nutr Metab Cardiovasc Dis. junio de 2021;31(6):1851-9. DOI: 10.1016/j.numecd.2021.03.013
- Perea V, Picón MJ, Megia A, Goya M, Wägner AM, Vega B, et al. Addition of intermittently scanned continuous glucose monitoring to standard care in a cohort of pregnant women with type 1 diabetes: effect on glycaemic control and pregnancy outcomes. Diabetologia. agosto de 2022;65(8):1302-14. DOI: 10.1007/s00125-022-05717-2
- Oyagüez I, Merino-Torres JF, Brito M, Bellido V, Cardona-Hernandez R, Gomez-Peralta F, et al. Cost analysis of the flash monitoring system (FreeStyle Libre 2) in adults with type 1 diabetes mellitus. BMJ Open Diabetes Res Care. julio de 2020;8(1):e001330. DOI: 10.1136/bmjdrc-2020-001330

3.3. Insulin Administration and Dosing

The primary challenge of insulin therapy in T1D is to mimic endogenous insulin secretion—which is virtually non-existent in people with the condition—in order to achieve glucose levels as close to normal as possible. Insulin is usually administered via the subcutaneous route, although inhaled (183) and intraperitoneal (184) routes have also been used, albeit less clinically established.

There is strong evidence that more physiological insulin therapy and tighter glycaemic control reduce the incidence of chronic diabetes complications (46). Insulin administration is delivered either via a multiple daily injection (MDI) regimen combining 1–2 daily injections of intermediate- or long-acting

insulin (basal insulin) with a rapid- or ultra-rapid-acting insulin injection (prandial bolus) before each meal, or via continuous subcutaneous insulin infusion (CSII) using an insulin pump. Pump devices are programmed to deliver insulin continuously at a predetermined rate that can be manually adjusted; prior to meals, the user administers a bolus based on measured glucose levels and planned carbohydrate intake. More recently, continuous insulin delivery (outside mealtimes) can be automated using a control algorithm that adjusts the infusion rate based on sensor-augmented interstitial glucose readings and predicted glucose concentrations over the subsequent minutes. These systems, known as hybrid closed-loop (HCL) systems or automated insulin delivery (AID) systems, are being progressively implemented in routine clinical practice (185,186).

To date, the efficacy and safety of these administration methods have not been adequately documented across all sub-populations with T1D. This section evaluates insulin administration and dosing methods in people with T1D.

Several intervention-focused comparisons and sub-questions were developed to evaluate these methods.

Question

- Which insulin administration and dosing methods are most effective and safe in people with T1D?

This question was divided into four specific sub-questions based on the comparisons identified in the scientific literature according to the predefined selection criteria:

- *Is the use of CSII recommended over MDI in pregnant women with T1D?*
- *Is the use of MDI + self-monitoring of blood glucose (SMBG) + bolus calculator recommended over MDI + SMBG in people with T1D?*
- *Is the use of hybrid closed-loop systems recommended over CSII or sensor-augmented pump (SAP) therapy in people of any age and pregnant women with T1D?*
- *Is needle reuse for insulin injections recommended in people with T1D?*

3.3.1. Continuous Subcutaneous Insulin Infusion (CSII) in Pregnant Women

Sub-question

- Is the use of CSII recommended over MDI in pregnant women with T1D?

Recommendations

STRONG RECOMMENDATION, AGAINST

1. In pregnant women with T1D, the use of continuous subcutaneous insulin infusion (CSII) is recommended against unless it is used in conjunction with a glucose sensor as part of a hybrid closed-loop or automated insulin delivery system.

Rationale

A strong recommendation against the use of stand-alone CSII in pregnant women with T1D was made unless combined with a continuous glucose sensor as part of a hybrid closed-loop system. The GDG considered the expected desirable effects to be trivial, as CSII alone does not reduce HbA1c or blood glucose levels, while the undesirable effects are moderate. The use of CSII increases rates of neonatal hypoglycaemia compared with MDI (11 additional cases per 1,000). Furthermore, CSII compared with MDI does not reduce rates of caesarean section, preterm birth, length of postnatal hospital stay, perinatal mortality, severe hypoglycaemia, hyperglycaemia, neonatal hyperbilirubinaemia, or congenital anomaly rates.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-4

References

- Diabetes Control and Complications Trial Research Group; Nathan DM, Genuth S, Lachin J, Cleary P, Crofford O, Davis M, Rand L, Siebert C. The Effect of Intensive Treatment of Diabetes on the Development and Progression of Long-Term Complications in Insulin-Dependent Diabetes Mellitus. N Engl J Med. 1993;329(14):977-86. DOI: 10.1056/NEJM199309303291401
- Grupo de trabajo de la Guía Clínica sobre Diabetes mellitus tipo 1. Guía de Práctica Clínica sobre Diabetes mellitus Tipo 1. Plan de Calidad para el Sistema Nacional de Salud del Ministerio de Sanidad y Política Social. Agencia Evaluación Tecnol Sanit País Vasco. 2012;345.
- McGill JB, Weiss D, Grant M, Jones MC, Kendall DM, Hoogwerf BJ. Understanding inhaled Technosphere Insulin: Results of an early randomized trial in type 1 diabetes mellitus. J Diabetes. febrero de 2021;13(2):164-72. DOI: 10.1111/1753-0407.13099
- Dirnena-Fusini I, Åm MK, Fougner AL, Carlsen SM, Christiansen SC. Physiological effects of intraperitoneal versus subcutaneous insulin infusion in patients with diabetes mellitus type 1: A systematic review and meta-analysis. Fürnsinn C, editor. PLOS ONE. 13 de abril de 2021;16(4):e0249611. DOI: 10.1371/journal.pone.0249611
- Griffin TP, Gallen G, Hartnell S, Crabtree T, Holloway M, Gibb FW, et al. UK's Association of British Clinical Diabetologist's Diabetes Technology Network (ABCD-DTN): Best practice guide for hybrid closed-loop therapy. Diabet Med. julio de 2023;40(7):e15078. DOI: 10.1111/dme.15078
- ElSayed NA, Aleppo G, Aroda VR, Bannuru RR, Brown FM, Bruemmer D, et al. Summary of Revisions: Standards of Care in Diabetes—2023. Diabetes Care. 1 de enero de 2023;46(Supplement_1):S5-9. DOI: 10.2337/dc23-Srev
- Apablaza P, Soto N, Codner E. De la bomba de insulina y el monitoreo continuo de glucosa al páncreas artificial. Rev Médica Chile. 145(5):630-40. DOI: 10.4067/S0034-98872017000500011
- Jaffar F, Laycock K, Huda MSB. Type 1 Diabetes in Pregnancy: A Review of Complications and Management. Curr Diabetes Rev. septiembre de 2022;18(7):e051121197761. DOI: 10.2174/1573399818666211105124829
- Bahíllo-Curieses MP, Matías Del Pozo V, Álvarez Colomo C, Díaz-Soto G. Tratamiento insulínico, requerimientos de insulina y resultados perinatales en una cohorte de embarazadas con diabetes tipo 1. An Pediatría. febrero de 2021;94(2):107-9. DOI: 10.1016/j.anpedi.2020.03.008

- Trossarelli GF, Cavallo-Perin P, Meriggi E, Menato G, Dolfin G, Carta Q. Metabolic and obstetrical results in type 1 (insulin dependent) diabetic pregnancy: pump versus optimized conventional insulin therapy. Diabetologia. 1984;27(2):340A.
- Carta Q, Meriggi E, Trossarelli GF, Catella G, Dal Molin V, Menato G, et al. Continuous subcutaneous insulin infusion versus intensive conventional insulin therapy in type I and type II diabetic pregnancy. Diabete Metab. junio de 1986;12(3):121-9.
- Botta RM, Sinagra D, Angelico MC, Bompiani GD. [Comparison of intensified traditional insulin therapy and micropump therapy in pregnant women with type 1 diabetes mellitus]. Minerva Med. 21 de abril de 1986;77(17):657-61.
- Nosari I, Maglio ML, Lepore G, Cortinovis F, Pagani G. Is continuous subcutaneous insulin infusion more effective than intensive conventional insulin therapy in the treatment of pregnant diabetic women? Diabetes Nutr Metab – Clin Exp. 1993;6(1):33-7.
- Feig DS, Corcoy R, Donovan LE, Murphy KE, Barrett JFR, Sanchez JJ, et al. Pumps or Multiple Daily Injections in Pregnancy Involving Type 1 Diabetes: A Prespecified Analysis of the CONCEPTT Randomized Trial. Diabetes Care. diciembre de 2018;41(12):2471-9. DOI: 10.2337/dc18-1437
- Gajewska KA, Biesma R, Bennett K, Sreenan S. Barriers and facilitators to accessing insulin pump therapy by adults with type 1 diabetes mellitus: a qualitative study. Acta Diabetol. 2021;58(1):93-105. DOI: 10.1007/s00592-020-01595-5

3.3.2. Multiple Daily Injections (MDI) + Self-Monitoring of Blood Glucose (SMBG) + Bolus Calculator

Sub-question

- Is the use of MDI + SMBG + bolus calculator recommended over MDI + SMBG in people with T1D?

Recommendation

STRONG RECOMMENDATION, IN FAVOUR

1. In children and adults with T1D, the use of a bolus calculator to calculate prandial insulin doses in multiple daily injection therapy and glucose monitoring is recommended.

Rationale

A strong recommendation in favour of MDI + SMBG + bolus calculator was made for both children and adults with T1D, despite the primary evidence base derived from adult populations. The GDG considered the expected desirable effects to be moderate, demonstrating a mean HbA1c reduction of 1.57% (95% CI: -2.51 to -0.64) alongside a favourable impact on quality of life. Furthermore, MDI + SMBG + bolus calculator does not increase the risk of severe hypoglycaemia or diabetic ketoacidosis, and the overall certainty of evidence was rated as moderate. The GDG concluded that this benefit-harm balance is likely to be similar in children.

Furthermore, the GDG considers that the clinical benefits observed with MDI + SMBG + bolus calculator are attributable to the optimisation of prandial insulin calculations, regardless of the glucose

monitoring method used. Continuous glucose monitoring (CGM) and sensor-based (Flash) glucose monitoring are expected to deliver equivalent or more comprehensive glucose data, thereby maintaining the favourable effects on HbA1c reduction and quality of life. Although specific evidence regarding the combination of bolus calculators with CGM or Flash glucose monitoring is limited, the GDG judged it reasonable to extrapolate the benefits observed with SMBG, given that all these strategies enable improved insulin dose adjustment and real-time decision-making.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-4

References

- Diabetes Control and Complications Trial Research Group; Nathan DM, Genuth S, Lachin J, Cleary P, Crofford O, Davis M, Rand L, Siebert C. The Effect of Intensive Treatment of Diabetes on the Development and Progression of Long-Term Complications in Insulin-Dependent Diabetes Mellitus. N Engl J Med. 1993;329(14):977-86. DOI: 10.1056/NEJM199309303291401
- Grupo de trabajo de la Guía Clínica sobre Diabetes mellitus tipo 1. Guía de Práctica Clínica sobre Diabetes mellitus Tipo 1. Plan de Calidad para el Sistema Nacional de Salud del Ministerio de Sanidad y Política Social. Agencia Evaluación Tecnol Sanit País Vasco. 2012;345.
- McGill JB, Weiss D, Grant M, Jones MC, Kendall DM, Hoogwerf BJ. Understanding inhaled Technosphere Insulin: Results of an early randomized trial in type 1 diabetes mellitus. J Diabetes. febrero de 2021;13(2):164-72. DOI: 10.1111/1753-0407.13099
- Dirnena-Fusini I, Åm MK, Fougner AL, Carlsen SM, Christiansen SC. Physiological effects of intraperitoneal versus subcutaneous insulin infusion in patients with diabetes mellitus type 1: A systematic review and meta-analysis. Fürnsinn C, editor. PLOS ONE. 13 de abril de 2021;16(4):e0249611. DOI: 10.1371/journal.pone.0249611
- Griffin TP, Gallen G, Hartnell S, Crabtree T, Holloway M, Gibb FW, et al. UK's Association of British Clinical Diabetologist's Diabetes Technology Network (ABCD-DTN): Best practice guide for hybrid closed-loop therapy. Diabet Med. julio de 2023;40(7):e15078. DOI: 10.1111/dme.15078
- ElSayed NA, Aleppo G, Aroda VR, Bannuru RR, Brown FM, Bruemmer D, et al. Summary of Revisions: Standards of Care in Diabetes—2023. Diabetes Care. 1 de enero de 2023;46(Supplement_1):S5-9. DOI: 10.2337/dc23-Srev
- Boukhors Y, Rabasa-Lhoret R, Langelier H, Soultan M, Lacroix A, Chiasson JL. The use of information technology for the management of intensive insulin therapy in type 1 diabetes mellitus. Diabetes Metab. 2003;29(6):619-27. DOI: 10.1016/S1262-3636(07)70078-2
- Charpentier G, Benhamou PY, Dardari D, Clergeot A, Franc S, Schaepelynck-Belicar P, et al. The Diabeo software enabling individualized insulin dose adjustments combined with telemedicine support improves HbA1c in poorly controlled type 1 diabetic patients: a 6-month, randomized, open-label, parallel-group, multicenter trial (TeleDiab 1 Study). Diabetes Care. 2011;34(3):233-9. DOI: 10.2337/DC10-1259
- Gonzalez C, Picón MJ, Tomé M, Pujol I, Fernández-García JC, Chico A. Expert Study: Utility of an Automated Bolus Advisor System in Patients with Type 1 Diabetes Treated with Multiple Daily Injections of Insulin-A Crossover Study. Diabetes Technol Ther. mayo de 2016;18(5):282-7. DOI: 10.1089/DIA.2015.0383

- Maurizi AR, Lauria A, Maggi D, Palermo A, Fioriti E, Manfrini S, et al. A novel insulin unit calculator for the management of type 1 diabetes. Diabetes Technol Ther. abril de 2011;13(4):425-8. DOI: 10.1089/DIA.2010.0190
- Schmidt S, Meldgaard M, Serifovski N, Storm C, Christensen TM, Gade-Rasmussen B, et al. Use of an automated bolus calculator in MDI-treated type 1 diabetes: the BolusCal Study, a randomized controlled pilot study. Diabetes Care. mayo de 2012;35(5):984-90. DOI: 10.2337/DC11-2044
- Schrezenmeir J, Dirting K, Papazov P. Controlled multicenter study on the effect of computer assistance in intensive insulin therapy of type 1 diabetics. Comput Methods Programs Biomed. 2002;69(2):97-114. DOI: 10.1016/S0169-2607(02)00034-2
- Garg SK, Bookout TR, McFann KK, Kelly WC, Beatson C, Ellis SL, et al. Improved glycemic control in intensively treated adult subjects with type 1 diabetes using insulin guidance software. Diabetes Technol Ther. octubre de 2008;10(5):369-75. DOI: 10.1089/DIA.2007.0303
- Vallejo-Mora M del R, Carreira-Soler M, Linares-Parrado F, Olveira G, Rojo-Martínez G, Domínguez-López M, et al. The Calculating Boluses on Multiple Daily Injections (CBMDI) study: A randomized controlled trial on the effect on metabolic control of adding a bolus calculator to multiple daily injections in people with type 1 diabetes. J Diabetes. enero de 2017;9(1):24-33. DOI: 10.1111/1753-0407.12382

3.3.3. Hybrid Closed-Loop Systems

Sub-question

- Is the use of hybrid closed-loop systems (automated insulin delivery systems) recommended over CSII or sensor-augmented pump (SAP) therapy in people of any age and pregnant women with T1D?

Recommendations

STRONG RECOMMENDATION, IN FAVOUR

1. In children, adolescents, adults, and pregnant women with T1D, the use of hybrid closed-loop systems is recommended over open-loop continuous subcutaneous insulin infusion.

GOOD CLINICAL PRACTICE

2. It is suggested to consider the use of hybrid closed-loop systems in people with T1D receiving multiple daily injection therapy who remain outside target glycaemic levels—including those at risk of severe hypoglycaemia—despite the use of continuous or intermittently scanned (Flash) interstitial glucose monitoring.

Rationale

A strong recommendation in favour of hybrid closed-loop (HCL) systems was formulated for people of any age and pregnant women with T1D. The GDG considered the expected desirable effects to be moderate, demonstrating a reduction in HbA1c levels and time spent in hypoglycaemia, alongside an increase in time in range (TIR). Furthermore, the use of HCL systems does not increase the risk of hypoglycaemic episodes, and the certainty of evidence was rated as moderate.

Additionally, the GDG formulated a GCP point in favour of using HCL systems in individuals with T1D who fail to achieve therapeutic targets despite using multiple daily injections and CGM. Although there are no direct randomised controlled trials comparing closed-loop systems with multiple daily injection regimens, favourable evidence exists from comparisons between progressively advanced stages of insulin delivery automation. Therefore, the greatest clinical benefit is expected when transitioning from multiple daily injections directly to an HCL system. This recommendation aligns with guidance issued by NICE (204).

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-4

References

- Diabetes Control and Complications Trial Research Group; Nathan DM, Genuth S, Lachin J, Cleary P, Crofford O, Davis M, Rand L, Siebert C. The Effect of Intensive Treatment of Diabetes on the Development and Progression of Long-Term Complications in Insulin-Dependent Diabetes Mellitus. N Engl J Med. 1993;329(14):977-86. DOI: 10.1056/NEJM199309303291401
- McGill JB, Weiss D, Grant M, Jones MC, Kendall DM, Hoogwerf BJ. Understanding inhaled Technosphere Insulin: Results of an early randomized trial in type 1 diabetes mellitus. J Diabetes. febrero de 2021;13(2):164-72. DOI: 10.1111/1753-0407.13099
- Dirnena-Fusini I, Åm MK, Fougner AL, Carlsen SM, Christiansen SC. Physiological effects of intraperitoneal versus subcutaneous insulin infusion in patients with diabetes mellitus type 1: A systematic review and meta-analysis. Fürnsinn C, editor. PLOS ONE. 13 de abril de 2021;16(4):e0249611. DOI: 10.1371/journal.pone.0249611
- Griffin TP, Gallen G, Hartnell S, Crabtree T, Holloway M, Gibb FW, et al. UK's Association of British Clinical Diabetologist's Diabetes Technology Network (ABCD-DTN): Best practice guide for hybrid closed-loop therapy. Diabet Med. julio de 2023;40(7):e15078. DOI: 10.1111/dme.15078
- ElSayed NA, Aleppo G, Aroda VR, Bannuru RR, Brown FM, Bruemmer D, et al. Summary of Revisions: Standards of Care in Diabetes—2023. Diabetes Care. 1 de enero de 2023;46(Supplement_1):S5-9. DOI: 10.2337/dc23-Srev
- Asgharzadeh A, Patel M, Connock M, Damery S, Ghosh I, Jordan M, et al. Hybrid closed-loop systems for managing blood glucose levels in type 1 diabetes: a systematic review and economic modelling. Health Technol Assess. diciembre de 2024;1-190. DOI: 10.3310/JYPL3536
- Peyser T, Dassau E, Breton M, Skyler JS. The artificial pancreas: current status and future prospects in the management of diabetes. Ann N Y Acad Sci. abril de 2014;1311(1):102-23. DOI: 10.1111/nyas.12431
- Thabit H, Tauschmann M, Allen JM, Leelarathna L, Hartnell S, Wilinska ME, et al. Home Use of an Artificial Beta Cell in Type 1 Diabetes. N Engl J Med. noviembre de 2015;373(22):2129-40. DOI: 10.1056/nejmoa1509351
- Thabit H, Lubina-Solomon A, Stadler M, Leelarathna L, Walkinshaw E, Pernet A, et al. Home use of closed-loop insulin delivery for overnight glucose control in adults with type 1 diabetes: A 4-week, multicentre, randomised crossover study. Lancet Diabetes Endocrinol. septiembre de 2014;2(9):701-9. DOI: 10.1016/S2213-8587(14)70114-7

- Kropff J, Del Favero S, Place J, Toffanin C, Visentin R, Monaro M, et al. 2 month evening and night closed-loop glucose control in patients with type 1 diabetes under free-living conditions: A randomised crossover trial. Lancet Diabetes Endocrinol. diciembre de 2015;3(12):939-47. DOI: 10.1016/S2213-8587(15)00335-6
- De Bock MI, Roy A, Cooper MN, Dart JA, Berthold CL, Retterath AJ, et al. Feasibility of outpatient 24-Hour Closed-Loop insulin delivery. Diabetes Care. noviembre de 2015;38(11):e186-7. DOI: 10.2337/dc15-1047
- Del Favero S, Boscari F, Messori M, Rabbone I, Bonfanti R, Sabbion A, et al. Randomized summer camp crossover trial in 5-to 9-year-old children: Outpatient wearable artificial pancreas is feasible and safe. Diabetes Care. julio de 2016;39(7):1180-5. DOI: 10.2337/dc15-2815
- El-Khatib FH, Balliro C, Hillard MA, Magyar KL, Ekhlaspour L, Sinha M, et al. Home use of a bihormonal bionic pancreas versus insulin pump therapy in adults with type 1 diabetes: a multicentre randomised crossover trial. The Lancet. enero de 2017;389(10067):369-80. DOI: 10.1016/S0140-6736(16)32567-3
- Kovatchev BP, Renard E, Cobelli C, Zisser HC, Keith-Hynes P, Anderson SM, et al. Safety of outpatient closed-loop control: First randomized crossover trials of a wearable artificial pancreas. Diabetes Care. abril de 2014;37(7):1789-96. DOI: 10.2337/dc13-2076
- Ly TT, Roy A, Grosman B, Shin J, Campbell A, Monirabbasi S, et al. Day and night closed-loop control using the integrated Medtronic hybrid closed-loop system in type 1 diabetes at diabetes camp. Diabetes Care. julio de 2015;38(7):1205-11. DOI: 10.2337/dc14-3073
- Russell SJ, El-Khatib FH, Sinha M, Magyar KL, McKeon K, Goergen LG, et al. Outpatient Glycemic Control with a Bionic Pancreas in Type 1 Diabetes. N Engl J Med. julio de 2014;371(4):313-25. DOI: 10.1056/nejmoa1314474
- Russell SJ, Hillard MA, Balliro C, Magyar KL, Selagamsetty R, Sinha M, et al. Day and night glycaemic control with a bionic pancreas versus conventional insulin pump therapy in preadolescent children with type 1 diabetes: A randomised crossover trial. Lancet Diabetes Endocrinol. marzo de 2016;4(3):233-43. DOI: 10.1016/S2213-8587(15)00489-1
- Ly TT, Breton MD, Keith-Hynes P, De Salvo D, Clinton P, Benassi K, et al. Overnight glucose control with an automated, unified safety system in children and adolescents with type 1 diabetes at diabetes camp. Diabetes Care. 2014;37(8):2310-6. DOI: 10.2337/dc14-0147
- Sharifi A, De Bock MI, Jayawardene D, Loh MM, Horsburgh JC, Berthold CL, et al. Glycemia, Treatment Satisfaction, Cognition, and Sleep Quality in Adults and Adolescents with Type 1 Diabetes When Using a Closed-Loop System Overnight Versus Sensor-Augmented Pump with Low-Glucose Suspend Function: A Randomized Crossover Study. Diabetes Technol Ther. diciembre de 2016;18(12):772-83. DOI: 10.1089/dia.2016.0288
- Phillip M, Battelino T, Atlas E, Kordonouri O, Bratina N, Miller S, et al. Nocturnal glucose control with an artificial pancreas at a diabetes camp. N Engl J Med. mayo de 2013;(9):824-33. DOI: 10.1056/nejmoa1206881
- Nimri R, Muller I, Atlas E, Miller S, Kordonouri O, Bratina N, et al. Night glucose control with MD-Logic artificial pancreas in home setting: A single blind, randomized crossover trial-interim analysis. Pediatr Diabetes. 2014;15(2):91-9. DOI: 10.1111/pedi.12071
- Nimri R, Muller I, Atlas E, Miller S, Fogel A, Bratina N, et al. MD-logic overnight control for 6 weeks of home use in patients with type 1 diabetes: Randomized crossover trial. Diabetes Care. noviembre de 2014;37(11):3025-32. DOI: 10.2337/dc14-0835

- Ly TT, Keenan DB, Roy A, Han J, Grosman B, Cantwell M, et al. Automated Overnight Closed-Loop Control Using a Proportional-Integral-Derivative Algorithm with Insulin Feedback in Children and Adolescents with Type 1 Diabetes at Diabetes Camp. Diabetes Technol Ther. junio de 2016;18(6):377-84. DOI: 10.1089/dia.2015.0431
- Hovorka R, Elleri D, Thabit H, Allen JM, Leelarathna L, El-Khairi R, et al. Overnight closed-loop insulin delivery in young people with type 1 diabetes: A free-living, randomized clinical trial. Diabetes Care. 2014;37(5):1204-11. DOI: 10.2337/dc13-2644
- Haidar A, Legault L, Matteau-Pelletier L, Messier V, Dallaire M, Ladouceur M, et al. Outpatient overnight glucose control with dual-hormone artificial pancreas, single-hormone artificial pancreas, or conventional insulin pump therapy in children and adolescents with type 1 diabetes: An open-label, randomised controlled trial. Lancet Diabetes Endocrinol. agosto de 2015;3(8):595-604. DOI: 10.1016/S2213-8587(15)00141-2
- Haidar A, Rabasa-Lhoret R, Legault L, Lovblom LE, Rakheja R, Messier V, et al. Single- and dual-hormone artificial pancreas for overnight glucose control in type 1 diabetes. J Clin Endocrinol Metab. enero de 2016;101(1):214-23. DOI: 10.1210/jc.2015-3003
- Brown SA, Kovatchev BP, Breton MD, Anderson SM, Keith-Hynes P, Patek SD, et al. Multinight «Bedside» closed-loop control for patients with type 1 diabetes. Diabetes Technol Ther. marzo de 2015;17(3):203-9. DOI: 10.1089/dia.2014.0259
- Tauschmann M, Allen JM, Wilinska ME, Thabit H, Stewart Z, Cheng P, et al. Day-and-night hybrid closed-loop insulin delivery in adolescents with type 1 diabetes: A free-living, randomized clinical trial. En: Diabetes Care [Internet]. American Diabetes Association Inc.; 2016. p. 1168-74. Disponible en: https://pubmed.ncbi.nlm.nih.gov/26740634/ DOI: 10.2337/dc15-2078
- Tauschmann M, Allen JM, Wilinska ME, Thabit H, Acerini CL, Dunger DB, et al. Home use of day-and-night hybrid closed-loop insulin delivery in suboptimally controlled adolescents with type 1 diabetes: A 3-week, free-living, randomized crossover trial. En: Diabetes Care [Internet]. American Diabetes Association Inc.; 2016. p. 2019-25. Disponible en: https://pubmed.ncbi.nlm.nih.gov/27612500/DOI: 10.2337/dc16-1094
- Leelarathna L, Dellweg S, Mader JK, Allen JM, Benesch C, Doll W, et al. Day and night home closed-loop insulin delivery in adults with type 1 diabetes: Three-center randomized crossover study. Diabetes Care. 2014;37(7):1931-7. DOI: 10.2337/dc13-2911
- Blauw H, van Bon AC, Koops R, DeVries JH. Performance and safety of an integrated bihormonal artificial pancreas for fully automated glucose control at home. Diabetes Obes Metab. julio de 2016;18(7):671-7. DOI: 10.1111/dom.12663
- Lee TTM, Collett C, Bergford S, Hartnell S, Scott EM, Lindsay RS, et al. Automated Insulin Delivery in Women with Pregnancy Complicated by Type 1 Diabetes. N Engl J Med. 26 de octubre de 2023;389(17):1566-78. DOI: 10.1056/NEJMoa2303911
- Stewart ZA, Wilinska ME, Hartnell S, O'Neil LK, Rayman G, Scott EM, et al. Day-and-Night Closed-Loop Insulin Delivery in a Broad Population of Pregnant Women With Type 1 Diabetes: A Randomized Controlled Crossover Trial. Diabetes Care. julio de 2018;41(7):1391-9. DOI: 10.2337/dc17-2534
- Stewart ZA, Wilinska ME, Hartnell S, Temple RC, Rayman G, Stanley KP, et al. Closed-Loop Insulin Delivery during Pregnancy in Women with Type 1 Diabetes. N Engl J Med. 18 de agosto de 2016;375(7):644-54. DOI: 10.1056/NEJMoa1602494
- Jendle J, Pöhlmann J, de Portu S, Smith-Palmer J, Roze S. Cost-Effectiveness Analysis of the MiniMed 670G Hybrid Closed-Loop System Versus Continuous Subcutaneous Insulin Infusion for

Treatment of Type 1 Diabetes. Diabetes Technol Ther. marzo de 2019;21(3):110-8. DOI: 10.1089/dia.2018.0328

- Sherr JL, Heinemann L, Fleming GA, Bergenstal RM, Bruttomesso D, Hanaire H, et al. Automated insulin delivery: benefits, challenges, and recommendations. A Consensus Report of the Joint Diabetes Technology Working Group of the European Association for the Study of Diabetes and the American Diabetes Association. Diabetologia. 2022; DOI: 10.1007/s00125-022-05744-z
- Farrington C, Stewart ZA, Barnard K, Hovorka R, Murphy HR. Experiences of closed-loop insulin delivery among pregnant women with Type 1 diabetes. Diabet Med. 2017;34(10):1461-9. DOI: 10.1111/dme.13406

3.3.4. Needle reuse

Sub-question

- Is needle reuse for insulin injection recommended in people with T1D?

Recommendations

WEAK RECOMMENDATION, IN FAVOUR

1. Needle reuse for insulin injections is not recommended in people with T1D.

Rationale

A weak recommendation in favour of single-use needle policy (against needle reuse) in people with T1D was formulated. The GDG considered the expected desirable effects to be moderate. Single-use needle practice compared with needle reuse reduces the risk of lipodystrophy (135 fewer cases per 1,000). The certainty of evidence was rated as very low.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-4

References

- Mobasseri M, Shirmohammadi M, Amiri T, Vahed N, Hosseini Fard H, Ghojazadeh M. Prevalence and incidence of type 1 diabetes in the world: a systematic review and meta-analysis. Health Promot Perspect. 2020;10(2):98-115. DOI: 10.34172/hpp.2020.18
- Ministerio de Sanidad Servicios Sociales e Igualdad. Estrategia en Diabetes del Sistema Nacional de Salud Actualización. Madrid: Ministerio de Sanidad, Servicios Sociales e Igualdad; 2012.
- Diabetes Control and Complications Trial Research Group; Nathan DM, Genuth S, Lachin J, Cleary P, Crofford O, Davis M, Rand L, Siebert C. The Effect of Intensive Treatment of Diabetes on the Development and Progression of Long-Term Complications in Insulin-Dependent Diabetes Mellitus. N Engl J Med. 1993;329(14):977-86. DOI: 10.1056/NEJM199309303291401

- Grupo de trabajo de la Guia Clínica sobre Diabetes mellitus tipo 1. Guía de Práctica Clínica sobre Diabetes mellitus Tipo 1. Plan de Calidad para el Sistema Nacional de Salud del Ministerio de Sanidad y Política Social. Agencia Evaluacion Tecnol Sanit País Vasco. 2012;345.
- Serra E, Guanyabens E, Aguilera E. Diagnóstico y manejo del paciente adulto con diabetes tipo1A al inicio de la enfermedad. Av En Diabetol. marzo de 2013;29(2):36-43. DOI: 10.1016/j.avdiab.2013.01.001
- McGill JB, Weiss D, Grant M, Jones MC, Kendall DM, Hoogwerf BJ. Understanding inhaled Technosphere Insulin: Results of an early randomized trial in type 1 diabetes mellitus. J Diabetes. febrero de 2021;13(2):164-72. DOI: 10.1111/1753-0407.13099
- Dirnena-Fusini I, Åm MK, Fougner AL, Carlsen SM, Christiansen SC. Physiological effects of intraperitoneal versus subcutaneous insulin infusion in patients with diabetes mellitus type 1: A systematic review and meta-analysis. Fürnsinn C, editor. PLOS ONE. 13 de abril de 2021;16(4):e0249611. DOI: 10.1371/journal.pone.0249611
- Griffin TP, Gallen G, Hartnell S, Crabtree T, Holloway M, Gibb FW, et al. UK's Association of British Clinical Diabetologist's Diabetes Technology Network (ABCD-DTN): Best practice guide for hybrid closed-loop therapy. Diabet Med. julio de 2023;40(7):e15078. DOI: 10.1111/dme.15078
- ElSayed NA, Aleppo G, Aroda VR, Bannuru RR, Brown FM, Bruemmer D, et al. Summary of Revisions: Standards of Care in Diabetes—2023. Diabetes Care. 1 de enero de 2023;46(Supplement_1):S5-9. DOI: 10.2337/dc23-Srev
- Barreiro SC, Rigual MR, Lozano GB, Siguero JPL, Pelegrín BG, Val MPR, et al. Epidemiología de la diabetes mellitus tipo 1 en menores de 15 años en España. An Pediatr. 2014;81(3). DOI: 10.1016/j.anpedi.2013.12.010
- Crouch M, Jones A, Kleinbeck E. Reuse of disposable syringe-needle units in the diabetic patient. Diabetes Care. 1979;2(5):418-20. DOI: 10.2337/DIACARE.2.5.418
- Bosquet F, Grimaldi A, Pennaforte S, Blumberg-Tick J, Thervet F. Innocuousness of the limited reuse of injection materials by insulin-dependent diabetics. Ann Endocrinol. 1986;47(2):124-7.
- Poteet GW, Reinert B, Ptak HE. Outcome of multiple usage of disposable syringes in the insulin-requiring diabetic. Nurs Res. 1987;36(6):350-2. DOI: 10.1097/00006199-198711000-00008
- Misnikova I, Dreval A, Gubkina V, Rusanova E. The Risks of Repeated Use of Insulin Pen Needles in Patients with Diabetes Mellitus. J Diabetol. 2021;2(1):2. DOI: 10.4103/2078-7685.197782
- van Munster HE, van de Sande CP, Voorhoeve PG, van Alfen-van der Velden JA. Dermatological complications of insulin therapy in children with type 1 diabetes. Eur Diabetes Nurs. noviembre de 2014;11(3):79-84. DOI: 10.1002/EDN.255
- Vardar B, Kizilci S. Incidence of lipohypertrophy in diabetic patients and a study of influencing factors. Diabetes Res Clin Pract. agosto de 2007;77(2):231-6. DOI: 10.1016/J.DIABRES.2006.12.023
- Schmeisl GW, Drobinski E. Association between Injection Technique, Blood Glucose Excursions and Lipohypertrophy. Diabetes Stoffwechs Herz. 2009;18(4):251-8.
- De Coninck C, Frid A, Gaspar R, Hicks D, Hirsch L, Kreugel G, et al. Results and analysis of the 2008-2009 Insulin Injection Technique Questionnaire survey. J Diabetes. septiembre de 2010;2(3):168-79. DOI: 10.1111/J.1753-0407.2010.00077.X
- Blanco M, Hernández MT, Strauss KW, Amaya M. Prevalence and risk factors of lipohypertrophy in insulin-injecting patients with diabetes. Diabetes Metab. octubre de 2013;39(5):445-53. DOI: 10.1016/J.DIABET.2013.05.006

- Ginsberg BH, Parkes JL, Sparacino C. The kinetics of insulin administration by insulin pens. Horm Metab Res. diciembre de 1994;26(12):584-7. DOI: 10.1055/s-2007-1001764
- Annersten M, Frid A. Insulin pens dribble from the tip of the needle after injection. Pract Diabetes Int. junio de 2000;17(4):109-11. DOI: 10.1002/1528-252X(200006)17:4%3C109::AID-PDI42%3E3.0.CO;2-N
- Chantelau E, Spraul M, Mühlhauser I, Gause R, Berger M. Long-term safety, efficacy and side-effects of continuous subcutaneous insulin infusion treatment for type 1 (insulin-dependent) diabetes mellitus: a one centre experience. Diabetologia. julio de 1989;32(7):421-6. DOI: 10.1007/BF00271261
- Frid AH, Kreugel G, Grassi G, Halimi S, Hicks D, Hirsch LJ, et al. New Insulin Delivery Recommendations. Mayo Clin Proc. septiembre de 2016;91(9):1231-55. DOI: 10.1016/j.mayocp.2016.06.010
- Schuler-Lüttmann S, Mönnig G, Enbergs A, Schulte H, Breithardt G, Assmann G, et al. Insulin-Like Growth Factor–Binding Protein-3 Is Associated With the Presence and Extent of Coronary Arteriosclerosis. Arterioscler Thromb Vasc Biol [Internet]. abril de 2000 [citado 4 de diciembre de 2023];20(4). Disponible en: https://www.ahajournals.org/doi/10.1161/01.ATV.20.4.e10 DOI: 10.1161/01.ATV.20.4.e10
- Johansson G. Insulin resistance and IGF-I sensitivity in vascular cells – impact of hybrid receptors: with special regard to diabetes. Linköping: Linköping University, Faculty of Health Sciences; 2009. DOI: 978-91-7393-597-5
- Chowdhury TA, Escudier V. Poor glycaemic control caused by insulin induced lipohypertrophy. BMJ. 16 de agosto de 2003;327(7411):383-4. DOI: 10.1136/bmj.327.7411.383
- Torrance T, Franklin V, Greene S. Insulin pumps. Arch Dis Child. noviembre de 2003;88(11):949-53. DOI: 10.1136/adc.88.11.949
- Strauss K, Gols HD, Hannet I, Partanen T, Frid A. A pan-European epidemiologic study of insulin injection technique in patients with diabetes. Pract Diabetes Int. abril de 2002;19(3):71-6. DOI: 10.1002/pdi.314
- Cefalu WT, Mathieu C, Davidson J, Freemantle N, Gough S, Canovatchel W, et al. Patients' perceptions of subcutaneous insulin in the OPTIMIZE study: a multicenter follow-up study. Diabetes Technol Ther. febrero de 2008;10(1):25-38. DOI: 10.1089/dia.2008.0249
- ter Braak EW, Woodworth JR, Bianchi R, Cerimele B, Erkelens DW, Thijssen JH, et al. Injection site effects on the pharmacokinetics and glucodynamics of insulin lispro and regular insulin. Diabetes Care. diciembre de 1996;19(12):1437-40. DOI: 10.2337/diacare.19.12.1437

3.4. Non-Insulin Glucose-Lowering Agents

Insulin replacement therapy is the cornerstone of treatment in people with T1D (257). Despite advancements in insulin delivery systems and continuous glucose monitoring, glycaemic management in this population frequently fails to achieve therapeutic targets, with less than one-third of individuals (and only 21% of the paediatric population) maintaining an HbA1c level below 7.0%, which is considered optimal control (258). The clinical potential of intensive insulin therapy is constrained by an increased risk of hypoglycaemia (259) and weight gain, both of which are associated with elevated cardiovascular risk. Furthermore, glycaemic variability—defined as daily fluctuations in blood glucose levels—is an independent risk factor for hypoglycaemia in T1D (260), and severe hypoglycaemic episodes can cause seizures, coma, or death. Obesogenic trends and insulin resistance are increasingly prevalent among people with T1D (261).

Consequently, improving glycaemic management without increasing the risk of hypoglycaemia or other associated comorbidities is a major goal in T1D management. To address these limitations, the adjuvant use of non-insulin oral or subcutaneous agents with various mechanisms of action is currently under investigation in T1D (262).

These non-insulin glucose-lowering agents include:

- **Glucagon-like peptide-1 (GLP-1) receptor agonists / analogues:** exenatide, liraglutide, semaglutide, dulaglutide
- **Biguanides:** metformin
- **Thiazolidinediones:** rosiglitazone, pioglitazone
- **Sulfonylureas:** glibenclamide, glipizide, gliclazide, glimepiride
- **Meglitinides / Glinides:** nateglinide, repaglinide, mitiglinide
- **Dipeptidyl peptidase-4 (DPP-4) inhibitors:** alogliptin, anagliptin, emigliptin, linagliptin, saxagliptin, sitagliptin, eneligliptin, vildagliptin
- **Sodium-glucose cotransporter-2 (SGLT2) inhibitors:** canagliflozin, dapagliflozin, empagliflozin

Emerging drug classes also include dual peroxisome proliferator-activated receptor (PPAR) agonists, amylin analogues, bromocriptine, and GPR40 / free fatty acid receptor 1 (FFAR1) agonists.

To date, the efficacy and safety of these adjunct therapies have not been adequately established in people with T1D. This section evaluates the clinical utility of adding non-insulin glucose-lowering agents to insulin therapy in people with T1D.

In order to structure this evaluation, four specific sub-questions were developed based on the pharmacological classes identified in the scientific literature according to the predefined selection criteria.

Question

- Is adding non-insulin glucose-lowering agents to insulin therapy recommended in people with T1D?

This question was divided into four specific sub-questions:

- *Is adding a GLP-1 receptor agonist to insulin therapy recommended in people with T1D?*
- *Is adding a DPP-4 inhibitor to insulin therapy recommended in people with T1D?*
- *Is adding metformin to insulin therapy recommended in people with T1D?*
- *Is adding a sodium-glucose cotransporter-2 inhibitor to insulin therapy recommended in people with T1D?*

3.4.1. Glucagon-Like Peptide-1 (GLP-1) Receptor Agonists

Sub-question

- Is adding a GLP-1 receptor agonist to insulin therapy recommended in people with T1D?

Recommendations

WEAK RECOMMENDATION, AGAINST

1. In adults with T1D, adding GLP-1 receptor agonists to insulin therapy to improve glycaemic control is not suggested.

GOOD CLINICAL PRACTICE

2. Although case-by-case clinical evaluation is recommended, in adults with T1D and obesity who have high cardiovascular risk, adding a GLP-1 receptor agonist to insulin therapy may be considered to reduce body weight and associated cardiometabolic comorbidities.

Rationale

A weak recommendation against adding GLP-1 receptor agonists to insulin therapy in adults with T1D was formulated. The GDG considered the moderate magnitude of adverse effects, including an increased risk of nausea (273 additional cases per 1,000 individuals), dyspepsia (136 additional cases per 1,000 individuals), and diarrhoea (89 additional cases per 1,000 individuals). GLP-1 receptor agonist use does not alter the overall risk of hypoglycaemia. The GDG also noted that desirable glycaemic effects were modest, with a mean HbA1c reduction of only 0.21% (95% CI: -0.40% to -0.02%) and a mean weight reduction of 3.5 kg (95% CI: -4.86 kg to -2.19 kg). The certainty of evidence was rated as very low.

Additionally, the GDG issued a GCP point to consider GLP-1 receptor agonists on an individual basis for adults with T1D, obesity, and high cardiovascular risk—particularly in secondary cardiovascular prevention—extrapolating from robust evidence established in populations with obesity (with or without Type 2 Diabetes Mellitus). However, these agents are not currently publicly funded in the Spanish NHS for the primary indication of obesity in T1D, which may limit clinical applicability.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-5

References

- Mobasseri M, Shirmohammadi M, Amiri T, Vahed N, Hosseini Fard H, Ghojazadeh M. Prevalence and incidence of type 1 diabetes in the world: a systematic review and meta-analysis. Health Promot Perspect. 2020;10(2):98-115. DOI: 10.34172/hpp.2020.18
- Ministerio de Sanidad Servicios Sociales e Igualdad. Estrategia en Diabetes del Sistema Nacional de Salud Actualización. Madrid: Ministerio de Sanidad, Servicios Sociales e Igualdad; 2012.

- Grupo de trabajo de la Guia Clínica sobre Diabetes mellitus tipo 1. Guía de Práctica Clínica sobre Diabetes mellitus Tipo 1. Plan de Calidad para el Sistema Nacional de Salud del Ministerio de Sanidad y Política Social. Agencia Evaluacion Tecnol Sanit País Vasco. 2012;345.
- Serra E, Guanyabens E, Aguilera E. Diagnóstico y manejo del paciente adulto con diabetes tipo1A al inicio de la enfermedad. Av En Diabetol. marzo de 2013;29(2):36-43. DOI: 10.1016/j.avdiab.2013.01.001
- Barreiro SC, Rigual MR, Lozano GB, Siguero JPL, Pelegrín BG, Val MPR, et al. Epidemiología de la diabetes mellitus tipo 1 en menores de 15 años en España. An Pediatr. 2014;81(3). DOI: 10.1016/j.anpedi.2013.12.010
- Janež A, Guja C, Mitrakou A, Lalic N, Tankova T, Czupryniak L, et al. Insulin Therapy in Adults with Type 1 Diabetes Mellitus: a Narrative Review. Diabetes Ther. febrero de 2020;11(2):387-409. DOI: 10.1007/s13300-019-00743-7
- Cardona-Hernandez R, Schwandt A, Alkandari H, Bratke H, Chobot A, Coles N, et al. Glycemic Outcome Associated With Insulin Pump and Glucose Sensor Use in Children and Adolescents With Type 1 Diabetes. Data From the International Pediatric Registry SWEET. Diabetes Care. 1 de mayo de 2021;44(5):1176-84. DOI: 10.2337/dc20-1674
- Szadkowska A, Czyżewska K, Pietrzak I, Mianowska B, Jarosz-Chobot P, Myśliwiec M. Hypoglycaemia unawareness in patients with type 1 diabetes. Pediatr Endocrinol Diabetes Metab. 2018;2018(3):126-34. DOI: 10.5114/pedm.2018.80994
- Yapanis M, James S, Craig ME, O'Neal D, Ekinci EI. Complications of Diabetes and Metrics of Glycemic Management Derived From Continuous Glucose Monitoring. J Clin Endocrinol Metab. 17 de mayo de 2022;107(6):e2221-36. DOI: 10.1210/clinem/dgac034
- Van der Schueren B, Ellis D, Faradji RN, Al-Ozairi E, Rosen J, Mathieu C. Obesity in people living with type 1 diabetes. Lancet Diabetes Endocrinol. noviembre de 2021;9(11):776-85. DOI: 10.1016/S2213-8587(21)00246-1
- Nally LM, Sherr JL, Van Name MA, Patel AD, Tamborlane WV. Pharmacologic treatment options for type 1 diabetes: what's new? Expert Rev Clin Pharmacol. mayo de 2019;12(5):471-9. DOI: 10.1080/17512433.2019.1597705
- Kielgast U, Holst JJ, Madsbad S. Antidiabetic actions of endogenous and exogenous GLP-1 in type 1 diabetic patients with and without residual β-cell function. Diabetes. mayo de 2011;60(5):1599-607. DOI: 10.2337/db10-1790
- Kjems LL, Holst JJ, Vølund A, Madsbad S. The influence of GLP-1 on glucose-stimulated insulin secretion: effects on beta-cell sensitivity in type 2 and nondiabetic subjects. Diabetes. febrero de 2003;52(2):380-6. DOI: 10.2337/diabetes.52.2.380
- Kuhadiya ND, Dhindsa S, Ghanim H, Mehta A, Makdissi A, Batra M, et al. Addition of Liraglutide to Insulin in Patients With Type 1 Diabetes: A Randomized Placebo-Controlled Clinical Trial of 12 Weeks. Diabetes Care. junio de 2016;39(6):1027-35. DOI: 10.2337/dc15-1136
- Rother KI, Spain LM, Wesley RA, Digon BJ 3rd, Baron A, Chen K, et al. Effects of exenatide alone and in combination with daclizumab on beta-cell function in long-standing type 1 diabetes. Diabetes Care. diciembre de 2009;32(12):2251-7. DOI: 10.2337/dc09-0773
- Sarkar G, Alattar M, Brown RJ, Quon MJ, Harlan DM, Rother KI. Exenatide treatment for 6 months improves insulin sensitivity in adults with type 1 diabetes. Diabetes Care. 2014;37(3):666-70. DOI: 10.2337/dc13-1473
- Frandsen CS, Dejgaard TF, Holst JJ, Andersen HU, Thorsteinsson B, Madsbad S. Twelve-Week Treatment With Liraglutide as Add-on to Insulin in Normal-Weight Patients With Poorly Controlled

Type 1 Diabetes: A Randomized, Placebo-Controlled, Double-Blind Parallel Study. Diabetes Care. diciembre de 2015;38(12):2250-7. DOI: 10.2337/dc15-1037

- Dejgaard TF, Frandsen CS, Hansen TS, Almdal T, Urhammer S, Pedersen-Bjergaard U, et al. Efficacy and safety of liraglutide for overweight adult patients with type 1 diabetes and insufficient glycaemic control (Lira-1): a randomised, double-blind, placebo-controlled trial. Lancet Diabetes Endocrinol. marzo de 2016;4(3):221-32. DOI: 10.1016/S2213-8587(15)00436-2
- Hari Kumar KVS, Shaikh A, Prusty P. Addition of exenatide or sitagliptin to insulin in new onset type 1 diabetes: a randomized, open label study. Diabetes Res Clin Pract. mayo de 2013;100(2):e55-8. DOI: 10.1016/j.diabres.2013.01.020
- Hamamoto Y, Mori K, Honjo S, et al. One-year effects of liraglutide on pancreatic beta cell function and glycemic control in Japanese type 1 diabetes with residual insulin secretion. Diabetologia. 2012;55:S300.
- Del Olmo-Garcia MI, Merino-Torres JF. GLP-1 Receptor Agonists and Cardiovascular Disease in Patients with Type 2 Diabetes. J Diabetes Res. 2 de abril de 2018;2018:1-12. DOI: 10.1155/2018/4020492
- Ferhatbegović L, Mršić D, Macić-Džanković A. The benefits of GLP1 receptors in cardiovascular diseases. Front Clin Diabetes Healthc. 8 de diciembre de 2023;4:1293926. DOI: 10.3389/fcdhc.2023.1293926

3.4.2. Dipeptidyl Peptidase-4 (DPP-4) Inhibitors

Sub-question

- Is adding a dipeptidyl peptidase-4 (DPP-4) inhibitor to insulin therapy recommended in people with T1D?

Recommendations

WEAK RECOMMENDATION, AGAINST

1. In people with T1D, adding dipeptidyl peptidase-4 inhibitors (vildagliptin, sitagliptin, saxagliptin) to insulin therapy is not suggested.

Rationale

A weak recommendation against adding DPP-4 inhibitors in people with T1D was made. The GDG considered the expected desirable effects to be trivial, as these agents do not produce meaningful changes in mean HbA1c levels or the risk of severe hypoglycaemia. Furthermore, the overall certainty of evidence was rated as low.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish) https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-5

References

- American Diabetes Association. Standards of Care in Diabetes-2025. Diabetes Care [Internet]. 2025;48(Supplement_1). Disponible en: https://diabetesjournals.org/care/issue/48/Supplement_1
- Mobasseri M, Shirmohammadi M, Amiri T, Vahed N, Hosseini Fard H, Ghojazadeh M. Prevalence and incidence of type 1 diabetes in the world: a systematic review and meta-analysis. Health Promot Perspect. 2020;10(2):98-115. DOI: 10.34172/hpp.2020.18
- Ministerio de Sanidad Servicios Sociales e Igualdad. Estrategia en Diabetes del Sistema Nacional de Salud Actualización. Madrid: Ministerio de Sanidad, Servicios Sociales e Igualdad; 2012.
- Grupo de trabajo de la Guía Clínica sobre Diabetes mellitus tipo 1. Guía de Práctica Clínica sobre Diabetes mellitus Tipo 1. Plan de Calidad para el Sistema Nacional de Salud del Ministerio de Sanidad y Política Social. Agencia Evaluación Tecnol Sanit País Vasco. 2012;345.
- Janež A, Guja C, Mitrakou A, Lalic N, Tankova T, Czupryniak L, et al. Insulin Therapy in Adults with Type 1 Diabetes Mellitus: a Narrative Review. Diabetes Ther. febrero de 2020;11(2):387-409. DOI: 10.1007/s13300-019-00743-7
- Cardona-Hernandez R, Schwandt A, Alkandari H, Bratke H, Chobot A, Coles N, et al. Glycemic Outcome Associated With Insulin Pump and Glucose Sensor Use in Children and Adolescents With Type 1 Diabetes. Data From the International Pediatric Registry SWEET. Diabetes Care. 1 de mayo de 2021;44(5):1176-84. DOI: 10.2337/dc20-1674
- Szadkowska A, Czyżewska K, Pietrzak I, Mianowska B, Jarosz-Chobot P, Myśliwiec M. Hypoglycaemia unawareness in patients with type 1 diabetes. Pediatr Endocrinol Diabetes Metab. 2018;2018(3):126-34. DOI: 10.5114/pedm.2018.80994
- Yapanis M, James S, Craig ME, O'Neal D, Ekinci EI. Complications of Diabetes and Metrics of Glycemic Management Derived From Continuous Glucose Monitoring. J Clin Endocrinol Metab. 17 de mayo de 2022;107(6):e2221-36. DOI: 10.1210/clinem/dgac034
- Van der Schueren B, Ellis D, Faradji RN, Al-Ozairi E, Rosen J, Mathieu C. Obesity in people living with type 1 diabetes. Lancet Diabetes Endocrinol. noviembre de 2021;9(11):776-85. DOI: 10.1016/S2213-8587(21)00246-1
- Nally LM, Sherr JL, Van Name MA, Patel AD, Tamborlane WV. Pharmacologic treatment options for type 1 diabetes: what's new? Expert Rev Clin Pharmacol. mayo de 2019;12(5):471-9. DOI: 10.1080/17512433.2019.1597705
- Hari Kumar KVS, Shaikh A, Prusty P. Addition of exenatide or sitagliptin to insulin in new onset type 1 diabetes: a randomized, open label study. Diabetes Res Clin Pract. mayo de 2013;100(2):e55-8. DOI: 10.1016/j.diabres.2013.01.020
- Seguí Díaz M. Uso de inhibidores de la dipeptidil peptidasa 4 en pacientes con diabetes en situaciones especiales. Med Fam SEMERGEN. junio de 2018;44:18-25. DOI: 10.1016/S1138-3593(18)30371-X
- National Institute for Health and Care Excellence. Type 2 diabetes in adults: management. NICE guideline [NG28]. NICE; 2022.
- Garber AJ, Abrahamson MJ, Barzilay JI, Blonde L, Bloomgarden ZT, Bush MA, et al. Consensus Statement by the American Association of Clinical Endocrinologists and American College of

Endocrinology on the Comprehensive type 2 Diabetes Management Algorithm – 2017 Executive Summary. Endocr Pract. febrero de 2017;23(2):207-38. DOI: 10.4158/EP161682.CS

- Scottish Intercollegiate Guidelines Network. Pharmacological management of glycaemic control in people with type 2 diabetes. Edinburgh: SIGN; 2017.
- CADTH. New drugs for type 2 diabetes: second-line therapy – science report. Ottawa: CADTH; 2017.
- Farngren J, Persson M, Schweizer A, Foley JE, Ahrén B. Vildagliptin reduces glucagon during hyperglycemia and sustains glucagon counterregulation during hypoglycemia in type 1 diabetes. J Clin Endocrinol Metab. octubre de 2012;97(10):3799-806. DOI: 10.1210/jc.2012-2332
- George PS, McCrimmon RJ. Saxagliptin co-therapy in C-peptide negative Type 1 diabetes does not improve counter-regulatory responses to hypoglycaemia. Diabet Med. septiembre de 2016;33(9):1283-90. DOI: 10.1111/dme.13046
- Garg SK, Moser EG, Bode BW, Klaff LJ, Hiatt WR, Beatson C, et al. Effect of sitagliptin on post-prandial glucagon and GLP-1 levels in patients with type 1 diabetes: investigator-initiated, double-blind, randomized, placebo-controlled trial. Endocr Pract. 2013;19(1):19-28. DOI: 10.4158/EP12100.OR
- Zhao Y, Yang L, Xiang Y, Liu L, Huang G, Long Z, et al. Dipeptidyl peptidase 4 inhibitor sitagliptin maintains β-cell function in patients with recent-onset latent autoimmune diabetes in adults: one year prospective study. J Clin Endocrinol Metab. mayo de 2014;99(5):E876-80. DOI: 10.1210/jc.2013-3633
- Ellis SL, Moser EG, Snell-Bergeon JK, Rodionova AS, Hazenfield RM, Garg SK. Effect of sitagliptin on glucose control in adult patients with Type 1 diabetes: a pilot, double-blind, randomized, crossover trial. Diabet Med. octubre de 2011;28(10):1176-81. DOI: 10.1111/j.1464-5491.2011.03331.x

3.4.3. Metformin

Sub-question

- Is adding metformin to insulin therapy recommended in people with T1D?

Recommendations

1. Due to the low level of certainty in the available evidence, no recommendation for or against the routine combined use of metformin and insulin in people with T1D can be made. It is suggested to consider this combination on an individualised basis following shared decision-making with the person, weighing up the risks and benefits in each case.

Rationale

The GDG was unable to make a recommendation for or against the use of metformin in people with T1D due to the low certainty of the available evidence. The magnitude of the expected desirable effects is small, with mean reductions in HbA1c levels of 0.26% (95% CI: -0.47% to -0.05%), total cholesterol of 41.87 mg/dL (95% CI: -57.10 mg/dL to -26.65 mg/dL), LDL cholesterol of 72.33 mg/dL (95% CI: -110.39 mg/dL to -34.26 mg/dL), carotid intima-media thickness (CIMT) of 0.06 mm (95%

CI: -0.08 mm to -0.03 mm), systolic blood pressure of 2.47 mmHg (95% CI: -4.30 mmHg to -0.62 mmHg), and BMI of 0.6 kg/m² (95% CI: -0.68 kg/m² to -0.52 kg/m²).

Furthermore, adding metformin to insulin therapy does not appear to alter the risk of severe hypoglycaemia, lactic acidosis, or diabetic ketoacidosis compared with insulin alone. However, recognising that certain individuals with T1D might derive specific clinical benefits, the GDG suggests evaluating its use on a case-by-case basis through shared decision-making with the patient, carefully balancing potential risks and benefits.

It should be noted that prescribing metformin in people with T1D represents off-label use; therefore, it requires informed consent and individual clinical evaluation within the appropriate care setting.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-5

References

- Mobasseri M, Shirmohammadi M, Amiri T, Vahed N, Hosseini Fard H, Ghojazadeh M. Prevalence and incidence of type 1 diabetes in the world: a systematic review and meta-analysis. Health Promot Perspect. 2020;10(2):98-115. DOI: 10.34172/hpp.2020.18
- Ministerio de Sanidad Servicios Sociales e Igualdad. Estrategia en Diabetes del Sistema Nacional de Salud Actualización. Madrid: Ministerios de Sanidad, Servicios Sociales e Igualdad; 2012.
- Grupo de trabajo de la Guia Clínica sobre Diabetes mellitus tipo 1. Guía de Práctica Clínica sobre Diabetes mellitus Tipo 1. Plan de Calidad para el Sistema Nacional de Salud del Ministerio de Sanidad y Política Social. Agencia Evaluacion Tecnol Sanit País Vasco. 2012;345.
- Serra E, Guanyabens E, Aguilera E. Diagnóstico y manejo del paciente adulto con diabetes tipo1A al inicio de la enfermedad. Av En Diabetol. marzo de 2013;29(2):36-43. DOI: 10.1016/j.avdiab.2013.01.001
- Barreiro SC, Rigual MR, Lozano GB, Siguero JPL, Pelegrín BG, Val MPR, et al. Epidemiología de la diabetes mellitus tipo 1 en menores de 15 años en España. An Pediatr. 2014;81(3). DOI: 10.1016/j.anpedi.2013.12.010
- Janež A, Guja C, Mitrakou A, Lalic N, Tankova T, Czupryniak L, et al. Insulin Therapy in Adults with Type 1 Diabetes Mellitus: a Narrative Review. Diabetes Ther. febrero de 2020;11(2):387-409. DOI: 10.1007/s13300-019-00743-7
- Cardona-Hernandez R, Schwandt A, Alkandari H, Bratke H, Chobot A, Coles N, et al. Glycemic Outcome Associated With Insulin Pump and Glucose Sensor Use in Children and Adolescents With Type 1 Diabetes. Data From the International Pediatric Registry SWEET. Diabetes Care. 1 de mayo de 2021;44(5):1176-84. DOI: 10.2337/dc20-1674
- Szadkowska A, Czyżewska K, Pietrzak I, Mianowska B, Jarosz-Chobot P, Myśliwiec M. Hypoglycaemia unawareness in patients with type 1 diabetes. Pediatr Endocrinol Diabetes Metab. 2018;2018(3):126-34. DOI: 10.5114/pedm.2018.80994
- Yapanis M, James S, Craig ME, O'Neal D, Ekinci EI. Complications of Diabetes and Metrics of Glycemic Management Derived From Continuous Glucose Monitoring. J Clin Endocrinol Metab. 17 de mayo de 2022;107(6):e2221-36. DOI: 10.1210/clinem/dgac034

- Van der Schueren B, Ellis D, Faradji RN, Al-Ozairi E, Rosen J, Mathieu C. Obesity in people living with type 1 diabetes. Lancet Diabetes Endocrinol. noviembre de 2021;9(11):776-85. DOI: 10.1016/S2213-8587(21)00246-1
- Nally LM, Sherr JL, Van Name MA, Patel AD, Tamborlane WV. Pharmacologic treatment options for type 1 diabetes: what's new? Expert Rev Clin Pharmacol. mayo de 2019;12(5):471-9. DOI: 10.1080/17512433.2019.1597705
- LaMoia TE, Shulman GI. Cellular and Molecular Mechanisms of Metformin Action. Endocr Rev. 28 de enero de 2021;42(1):77-96. DOI: 10.1210/endrev/bnaa023
- Maruthur NM, Tseng E, Hutfless S, Wilson LM, Suarez-Cuervo C, Berger Z, et al. Diabetes Medications as Monotherapy or Metformin-Based Combination Therapy for Type 2 Diabetes: A Systematic Review and Meta-analysis. Ann Intern Med. 7 de junio de 2016;164(11):740-51. DOI: 10.7326/M15-2650
- Gomez-Peralta F, Escalada San Martín FJ, Menéndez Torre E, Mata Cases M, Ferrer García JC, Ezkurra Loiola P, et al. Recomendaciones de la Sociedad Española de Diabetes (SED) para el tratamiento farmacológico de la hiperglucemia en la diabetes tipo 2: Actualización 2018. Endocrinol Diabetes Nutr. diciembre de 2018;65(10):611-24. DOI: 10.1016/j.endinu.2018.08.004
- Anderson JJA, Couper JJ, Giles LC, Leggett CE, Gent R, Coppin B, et al. Effect of Metformin on Vascular Function in Children With Type 1 Diabetes: A 12-Month Randomized Controlled Trial. J Clin Endocrinol Metab. diciembre de 2017;102(12):4448-56. DOI: 10.1210/jc.2017-00781
- Bjornstad P, Schäfer M, Truong U, Cree-Green M, Laura P, Baumgartner A, et al. Metformin improves insulin sensitivity and vascular health in youth with type 1 diabetes mellitus: randomized controlled trial. Circulación. 2018; DOI: 10.1161/CIRCULATIONAHA.118.035525
- Codner E, Iñíguez G, López P, Mujica V, Eyzaguirre FC, Asenjo S, et al. Metformin for the treatment of hyperandrogenism in adolescents with type 1 diabetes mellitus. Horm Res Paediatr. 2013;80(5):343-9. DOI: 10.1159/000355513
- Cree-Green M, Bergman BC, Cengiz E, Fox LA, Hannon TS, Miller K, et al. Metformin Improves Peripheral Insulin Sensitivity in Youth With Type 1 Diabetes. J Clin Endocrinol Metab. agosto de 2019;104(8):3265-78. DOI: 10.1210/jc.2019-00129
- Hamilton J, Cummings E, Zdravkovic V, Finegood D, Daneman D. Metformin as an adjunct therapy in adolescents with type 1 diabetes and insulin resistance: a randomized controlled trial. Diabetes Care. enero de 2003;26(1):138-43. DOI: 10.2337/diacare.26.1.138
- Libman IM, Miller KM, DiMeglio LA, Bethin KE, Katz ML, Shah A, et al. Effect of Metformin Added to Insulin on Glycemic Control Among Overweight/Obese Adolescents With Type 1 Diabetes: A Randomized Clinical Trial. JAMA. diciembre de 2015;314(21):2241-50. DOI: 10.1001/jama.2015.16174
- Nadeau KJ, Chow K, Alam S, Lindquist K, Campbell S, McFann K, et al. Effects of low dose metformin in adolescents with type I diabetes mellitus: a randomized, double-blinded placebo-controlled study. Pediatr Diabetes. mayo de 2015;16(3):196-203. DOI: 10.1111/pedi.12140
- Nwosu BU, Maranda L, Cullen K, Greenman L, Fleshman J, McShea N, et al. A Randomized, Double-Blind, Placebo-Controlled Trial of Adjunctive Metformin Therapy in Overweight/Obese Youth with Type 1 Diabetes. PLOS ONE. 2015;10(9):e0137525. DOI: 10.1371/journal.pone.0137525
- Särnblad S, Kroon M, Aman J. Metformin as additional therapy in adolescents with poorly controlled type 1 diabetes: randomised placebo-controlled trial with aspects on insulin sensitivity. Eur J Endocrinol. octubre de 2003;149(4):323-9. DOI: 10.1530/eje.0.1490323

- Burchardt P, Zawada A, Kaczmarek J, Marcinkaniec J, Wysocki H, Wierusz-Wysocka B, et al. Association between adjunctive metformin therapy in young type 1 diabetes patients with excess body fat and reduction of carotid intima-media thickness. Pol Arch Intern Med. agosto de 2016;126(7-8):514-20. DOI: 10.20452/pamw.3527
- Burchardt P, Zawada A, Tabaczewski P, Naskr\c et D, Kaczmarek J, Marcinkaniec J, et al. Metformin added to intensive insulin therapy reduces plasma levels of glycated but not oxidized low-density lipoprotein in young patients with type 1 diabetes and obesity in comparison with insulin alone: a pilot study. Pol Arch Intern Med. 2013;123(10):526-32. DOI: 10.20452/pamw.1925
- Jacobsen IB, Henriksen JE, Beck-Nielsen H. The effect of metformin in overweight patients with type 1 diabetes and poor metabolic control. Basic Clin Pharmacol Toxicol. septiembre de 2009;105(3):145-9. DOI: 10.1111/j.1742-7843.2009.00380.x
- Khan ASA, McLoughney CR, Ahmed AB. The effect of metformin on blood glucose control in overweight patients with Type 1 diabetes. Diabet Med. octubre de 2006;23(10):1079-84. DOI: 10.1111/j.1464-5491.2006.01966.x
- Lund SS, Tarnow L, Astrup AS, Hovind P, Jacobsen PK, Alibegovic AC, et al. Effect of adjunct metformin treatment in patients with type-1 diabetes and persistent inadequate glycaemic control. A randomized study. PLOS ONE. 2008;3(10):e3363. DOI: 10.1371/journal.pone.0003363
- Lund SS, Tarnow L, Astrup AS, Hovind P, Jacobsen PK, Alibegovic AC, et al. Effect of adjunct metformin treatment on levels of plasma lipids in patients with type 1 diabetes. Diabetes Obes Metab. octubre de 2009;11(10):966-77. DOI: 10.1111/j.1463-1326.2009.01079.x
- Meyer L, Bohme P, Delbachian I, Lehert P, Cugnardey N, Drouin P, et al. The benefits of metformin therapy during continuous subcutaneous insulin infusion treatment of type 1 diabetic patients. Diabetes Care. diciembre de 2002;25(12):2153-8. DOI: 10.2337/diacare.25.12.2153
- Petrie JR, Chaturvedi N, Ford I, Brouwers MCGJ, Greenlaw N, Tillin T, et al. Cardiovascular and metabolic effects of metformin in patients with type 1 diabetes (REMOVAL): a double-blind, randomised, placebo-controlled trial. Lancet Diabetes Endocrinol. agosto de 2017;5(8):597-609. DOI: 10.1016/S2213-8587(17)30194-8304.
- Zawada A, Naskr\c et D, Burchardt P, Niedźwiecki P, Pi\laciński S, Wierusz-Wysocka B, et al. Metformin added to intensive insulin therapy improves metabolic control in patients with type 1 diabetes and excess body fat. Pol Arch Intern Med. mayo de 2018;128(5):294-300. DOI: 10.20452/pamw.4241

3.4.4. Sodium-Glucose Cotransporter-2 (SGLT2) Inhibitors

Sub-question

- Is adding a sodium-glucose cotransporter-2 (SGLT2) inhibitor to insulin therapy recommended in people with T1D?

Recommendations

WEAK RECOMMENDATION, AGAINST

1. In adolescents and adults with T1D, adding sodium-glucose cotransporter-2 inhibitors to insulin therapy is not recommended.

Rationale

The GDG issued a weak recommendation against the use of SGLT2 inhibitors in combination with insulin in adolescents and adults with T1D. This decision is based on an assessment of the balance between benefits and harms, as well as the availability and quality of evidence.

Regarding expected desirable effects, a mean increase in time in range (TIR) of 10.78% (95% CI: 9.33% to 12.23%) was observed, which may indicate improved daily glycaemic control. A slight reduction in HbA1c levels was also identified; however, this reduction did not reach the threshold for clinical relevance (0.40%).

Conversely, the GDG judged the magnitude of undesirable effects to be substantial. Although no differences were observed in the incidence of severe hypoglycaemia, moderate-certainty evidence indicates an increased risk of diabetic ketoacidosis (DKA) events, with 15 additional cases per 1,000 people with T1D (RR: 2.79; 95% CI: 1.48 to 5.48).

Furthermore, no evidence was available for other critical outcomes—such as adverse events, lactic acidosis/hyperlactataemia, and cardiovascular morbidity—that might otherwise strengthen the rationale for this intervention.

Overall, the clinical benefit is modest and restricted to specific parameters, whereas the risk of adverse events is significant and well documented. Consequently, the GDG concluded that SGLT2 inhibitor use exhibits an unfavourable benefit-harm balance, justifying a weak recommendation against its use in adults with T1D. Nevertheless, it is recognised that in specific individual contexts, its use might be considered following shared decision-making with the patient, taking into account individual preferences, risk profile, and their capability to manage potential diabetic ketoacidosis.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-5

References

- Mobasseri M, Shirmohammadi M, Amiri T, Vahed N, Hosseini Fard H, Ghojazadeh M. Prevalence and incidence of type 1 diabetes in the world: a systematic review and meta-analysis. Health Promot Perspect. 2020;10(2):98-115. DOI: 10.34172/hpp.2020.18
- Ministerio de Sanidad Servicios Sociales e Igualdad. Estrategia en Diabetes del Sistema Nacional de Salud Actualización. Madrid: Ministerios de Sanidad, Servicios Sociales e Igualdad; 2012.
- Grupo de trabajo de la Guía Clínica sobre Diabetes mellitus tipo 1. Guía de Práctica Clínica sobre Diabetes mellitus Tipo 1. Plan de Calidad para el Sistema Nacional de Salud del Ministerio de Sanidad y Política Social. Agencia Evaluación Tecnol Sanit País Vasco. 2012;345.
- Serra E, Guanyabens E, Aguilera E. Diagnóstico y manejo del paciente adulto con diabetes tipo1A al inicio de la enfermedad. Av En Diabetol. marzo de 2013;29(2):36-43. DOI: 10.1016/j.avdiab.2013.01.001
- Barreiro SC, Rigual MR, Lozano GB, Siguero JPL, Pelegrín BG, Val MPR, et al. Epidemiología de la diabetes mellitus tipo 1 en menores de 15 años en España. An Pediatr. 2014;81(3). DOI: 10.1016/j.anpedi.2013.12.010

- Janež A, Guja C, Mitrakou A, Lalic N, Tankova T, Czupryniak L, et al. Insulin Therapy in Adults with Type 1 Diabetes Mellitus: a Narrative Review. Diabetes Ther. febrero de 2020;11(2):387-409. DOI: 10.1007/s13300-019-00743-7
- Cardona-Hernandez R, Schwandt A, Alkandari H, Bratke H, Chobot A, Coles N, et al. Glycemic Outcome Associated With Insulin Pump and Glucose Sensor Use in Children and Adolescents With Type 1 Diabetes. Data From the International Pediatric Registry SWEET. Diabetes Care. 1 de mayo de 2021;44(5):1176-84. DOI: 10.2337/dc20-1674
- Szadkowska A, Czyżewska K, Pietrzak I, Mianowska B, Jarosz-Chobot P, Myśliwiec M. Hypoglycaemia unawareness in patients with type 1 diabetes. Pediatr Endocrinol Diabetes Metab. 2018;2018(3):126-34. DOI: 10.5114/pedm.2018.80994
- Yapanis M, James S, Craig ME, O'Neal D, Ekinci EI. Complications of Diabetes and Metrics of Glycemic Management Derived From Continuous Glucose Monitoring. J Clin Endocrinol Metab. 17 de mayo de 2022;107(6):e2221-36. DOI: 10.1210/clinem/dgac034
- Van der Schueren B, Ellis D, Faradji RN, Al-Ozairi E, Rosen J, Mathieu C. Obesity in people living with type 1 diabetes. Lancet Diabetes Endocrinol. noviembre de 2021;9(11):776-85. DOI: 10.1016/S2213-8587(21)00246-1
- Nally LM, Sherr JL, Van Name MA, Patel AD, Tamborlane WV. Pharmacologic treatment options for type 1 diabetes: what's new? Expert Rev Clin Pharmacol. mayo de 2019;12(5):471-9. DOI: 10.1080/17512433.2019.1597705
- Li M, Liu Z, Yang X, Zhang J, Han M, Zhang Y, et al. The effect of sodium-glucose cotransporter 2 inhibitors as an adjunct to insulin in patients with type 1 diabetes assessed by continuous glucose monitoring: A systematic review and meta-analysis. J Diabetes Complications. diciembre de 2023;37(12):108632. DOI: 10.1016/j.jdiacomp.2023.108632
- Popovic DS, Karakasis P, Koufakis T, Fragakis N, Papanas N, Mitrovic M, et al. Effect of sodium-glucose cotransporter-2 inhibitors on continuous glucose monitoring metrics, as adjunctive to insulin in adults with type 1 diabetes mellitus: a meta-analysis of randomized controlled trials. Metab – Clin Exp [Internet]. 1 de abril de 2024 [citado 29 de julio de 2024];153. Disponible en: https://www.metabolismjournal.com/article/S0026-0495(24)00017-9/abstract DOI: 10.1016/j.metabol.2024.155791
- Rao L, Ren C, Luo S, Huang C, Li X. Sodium-glucose cotransporter 2 inhibitors as an add-on therapy to insulin for type 1 diabetes mellitus: Meta-analysis of randomized controlled trials. Acta Diabetol. julio de 2021;58(7):869-80. DOI: 10.1007/s00592-021-01686-x

4. Therapeutic Diabetes Education

4.1. Structured Educational Programmes

Question

- When, how, by whom, and with what content should structured educational programmes be delivered to people with T1D and their families?

Recommendations

STRONG RECOMMENDATION, IN FAVOUR

1. It is recommended to offer structured diabetes education programmes to people with T1D.
    - For adults, a programme with proven benefits is suggested.
    - For children and adolescents, including their parents in the education programme is also suggested.

GOOD CLINICAL PRACTICE

2. Participation of people with T1D in structured diabetes educational programmes is suggested at the beginning of the diagnosis process, annually, when HbA1c targets are not achieved, during life transitions (adolescence, pregnancy, etc.), upon treatment modification, or following the onset of complications.
3. Delivery of structured diabetes educational programmes by personnel with specific T1D training and educational skills is suggested.
4. Regular evaluation of outcomes from structured diabetes programmes delivered to people with T1D is suggested to ensure effectiveness and enable iterative adjustments.
5. Delivering structured diabetes educational programmes preferably in group settings, while accommodating individual capabilities, is suggested. Programmes should adapt to individual needs, offering both face-to-face and online formats.

Rationale

A strong recommendation in favour of providing structured diabetes educational programmes was made. The GDG considered the magnitude of expected desirable effects—indicating increased knowledge and skills in T1D management among adults participating in structured educational programmes—with trivial expected undesirable effects and moderate certainty of evidence.

Conversely, the GDG formulated GCP points to address aspects where direct empirical trial evidence was absent regarding timing, delivery modality, educational methodology, and provider roles. These recommendations aim to support effective diabetes therapeutic education that empowers people with T1D to make informed decisions regarding their self-management.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-6

References

- American Diabetes Association. Standards of Care in Diabetes-2025. Diabetes Care [Internet]. 2025;48(Supplement_1). Disponible en: https://diabetesjournals.org/care/issue/48/Supplement_1
- López-Bastida J, López-Siguero JP, Oliva-Moreno J, Perez-Nieves M, Villoro R, Dilla T, et al. Social economic costs of type 1 diabetes mellitus in pediatric patients in Spain: CHRYSTAL observational study. Diabetes Res Clin Pract. mayo de 2017;127:59-69. DOI: 10.1016/j.diabres.2017.02.033
- Holt RIG, DeVries JH, Hess-Fischl A, Hirsch IB, Kirkman MS, Klupa T, et al. The management of type 1 diabetes in adults. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetologia. diciembre de 2021;64(12):2609-52. DOI: 10.1007/s00125-021-05568-3
- Schmidt S, Meldgaard M, Serifovski N, Storm C, Christensen TM, Gade-Rasmussen B, et al. Use of an automated bolus calculator in MDI-treated type 1 diabetes: the BolusCal Study, a randomized controlled pilot study. Diabetes Care. mayo de 2012;35(5):984-90. DOI: 10.2337/DC11-2044
- Livingstone SJ, Looker HC, Hothersall EJ, Wild SH, Lindsay RS, Chalmers J, et al. Risk of cardiovascular disease and total mortality in adults with type 1 diabetes: Scottish registry linkage study. PLOS Med. 2012;9(10):e1001321. DOI: 10.1371/journal.pmed.1001321
- Chiang JL, Kirkman MS, Laffel LMB, Peters AL. Type 1 diabetes through the life span: a position statement of the American Diabetes Association. Diabetes Care. julio de 2014;37(7):2034-54. DOI: 10.2337/dc14-1140
- Barrett EJ, Liu Z, Khamaisi M, King GL, Klein R, Klein BEK, et al. Diabetic Microvascular Disease: An Endocrine Society Scientific Statement. J Clin Endocrinol Metab. 1 de diciembre de 2017;102(12):4343-410. DOI: 10.1210/jc.2017-01922
- Bjornstad P, Donaghue KC, Maahs DM. Macrovascular disease and risk factors in youth with type 1 diabetes: time to be more attentive to treatment? Lancet Diabetes Endocrinol. octubre de 2018;6(10):809-20. DOI: 10.1016/S2213-8587(18)30035-4
- Nicolaas C. Schaper, Jaap J. van Netten, Jan Apelqvist, Sicco A. Bus, Robert Fitridge, Fran Game, Matilde Monteiro-Soares, Eric Senneville, on behalf of the IWGDF Editorial Board. Practical Guidelines on the prevention and management of diabetes-related foot disease. IWGDF 2023 update. [Internet]. Disponible en: https://iwgdfguidelines.org/wp-content/uploads/2023/07/IWGDF-2023-01-Practical-Guidelines.pdf
- Smith-Palmer J, Bae JP, Boye KS, Norrbacka K, Hunt B, Valentine WJ. Evaluating health-related quality of life in type 1 diabetes: a systematic literature review of utilities for adults with type 1 diabetes. Clin Outcomes Res CEOR. 2016;8:559-71. DOI: 10.2147/CEOR.S114699
- Morgan E, Cardwell CR, Black CJ, McCance DR, Patterson CC. Excess mortality in Type 1 diabetes diagnosed in childhood and adolescence: a systematic review of population-based cohorts. Acta Diabetol. agosto de 2015;52(4):801-7. DOI: 10.1007/s00592-014-0702-z

- Bächle C, Icks A, Straßburger K, Flechtner-Mors M, Hungele A, Beyer P, et al. Direct diabetes-related costs in young patients with early-onset, long-lasting type 1 diabetes. PLOS ONE. 2013;8(8):e70567. DOI: 10.1371/journal.pone.0070567
- Pendley JS. Peer and Family Support in Children and Adolescents With Type 1 Diabetes. J Pediatr Psychol. 1 de julio de 2002;27(5):429-38. DOI: 10.1093/jpepsy/27.5.429
- Marathe PH, Gao HX, Close KL. American Diabetes Association Standards of Medical Care in Diabetes 2017. J Diabetes. abril de 2017;9(4):320-4. DOI: 10.1111/1753-0407.12524
- Alvarado-Martel D, Ruiz Fernández MÁ, Cuadrado Vigaray M, Carrillo A, Boronat M, Expósito Montesdeoca A, et al. Identification of Psychological Factors Associated with Adherence to Self-Care Behaviors amongst Patients with Type 1 Diabetes. J Diabetes Res. 14 de agosto de 2019;2019:1-9. DOI: 10.1155/2019/6271591
- Bandura A. Social cognitive theory of self-regulation. Organ Behav Hum Decis Process. diciembre de 1991;50(2):248-87. DOI: 10.1016/0749-5978(91)90022-L
- Funnell MM, Brown TL, Childs BP, Haas LB, Hosey GM, Jensen B, et al. National Standards for Diabetes Self-Management Education. Diabetes Care. 1 de enero de 2010;33(Supplement_1):S89-96. DOI: 10.2337/dc10-S089
- American Diabetes Association. 5. Facilitating Behavior Change and Well-being to Improve Health Outcomes: Standards of Medical Care in Diabetes-2022. Diabetes Care. enero de 2022;45(Supplement_1):S60-82. DOI: 10.2337/dc22-S005
- Chrvala CA, Sherr D, Lipman RD. Diabetes self-management education for adults with type 2 diabetes mellitus: A systematic review of the effect on glycemic control. Patient Educ Couns. junio de 2016;99(6):926-43. DOI: 10.1016/j.pec.2015.11.003
- Montilla-Pérez M, Mena-López N, López-de-Andrés A. Efectividad de la educación diabetológica sistematizada en niños que debutan con Diabetes Mellitus tipo 1. Index Enferm. junio de 2012;21(1-2):18-22. DOI: 10.4321/S1132-12962012000100005
- Sherifali D, Berard LD, Gucciardi E, MacDonald B, MacNeill G. Self-Management Education and Support. Can J Diabetes. abril de 2018;42:S36-41. DOI: 10.1016/j.jcjd.2017.10.006
- Pillay J, Armstrong MJ, Butalia S, Donovan LE, Sigal RJ, Vandermeer B, et al. Behavioral Programs for Type 2 Diabetes Mellitus: A Systematic Review and Network Meta-analysis. Ann Intern Med. 1 de diciembre de 2015;163(11):848-60. DOI: 10.7326/M15-1400
- Worswick J, Wayne SC, Bennett R, Fiander M, Mayhew A, Weir MC, et al. Improving quality of care for persons with diabetes: an overview of systematic reviews – what does the evidence tell us? Syst Rev. diciembre de 2013;2(1):26. DOI: 10.1186/2046-4053-2-26
- O'Hara MC, Hynes L, O'Donnell M, Nery N, Byrne M, Heller SR, et al. A systematic review of interventions to improve outcomes for young adults with Type 1 diabetes. Diabet Med. junio de 2017;34(6):753-69. DOI: 10.1111/dme.13276
- Viana LV, Gomes MB, Zajdenverg L, Pavin EJ, Azevedo MJ. Interventions to improve patients' compliance with therapies aimed at lowering glycated hemoglobin (HbA1c) in type 1 diabetes: systematic review and meta-analyses of randomized controlled clinical trials of psychological, telecare, and educational interventions. Trials. diciembre de 2016;17(1):94. DOI: 10.1186/s13063-016-1207-6
- Davis J, Fischl AH, Beck J, Browning L, Carter A, Condon JE, et al. 2022 National Standards for Diabetes Self-Management Education and Support. Sci Diabetes Self-Manag Care. febrero de 2022;48(1):44-59. DOI: 10.1177/26350106211072203

- National Institute for Health and Care Excellence. Type 1 diabetes in adults: Quality standard [Internet]. 2023 p. 1-37. Report No.: QS208. Disponible en: www.nice.org.uk/guidance/qs208 ©
- Federación Española de Diabetes. Informe sobre el impacto económico de la diabetes tipo 2 en España. 2021.
- The Community Preventive Services Task Force. Task Force Recommends Team-Based Care for Diabetes Management. [Internet]. 2018. Disponible en: https://www.thecommunityguide.org/content/task-force-recommends-team-based-care-diabetes-management
- Beck J, Greenwood DA, Blanton L, Bollinger ST, Butcher MK, Condon JE, et al. 2017 National Standards for Diabetes Self-Management Education and Support. Diabetes Educ. febrero de 2020;46(1):46-61. DOI: 10.1177/0145721719897952
- Sánchez-Hernández RM, Alvarado-Martel D, López-Plasencia Y, Carrillo-Domínguez A, Jiménez-Rodríguez A, Rodríguez-Cordero J, et al. Assessment of Alimentación Normal con Ajuste de Insulina (ANAIS), a Spanish version of the DAFNE programme, in people with Type 1 diabetes: a randomized controlled parallel trial. Diabet Med. agosto de 2019;36(8):1037-45. DOI: 10.1111/dme.13984
- Dobson R, Whittaker R, Jiang Y, Maddison R, Shepherd M, McNamara C, et al. Effectiveness of text message based, diabetes self management support programme (SMS4BG): two arm, parallel randomised controlled trial. BMJ. 17 de mayo de 2018;k1959. DOI: 10.1136/bmj.k1959
- Trento M, Trinetta A, Kucich C, Grassi G, Passera P, Gennari S, et al. Carbohydrate counting improves coping ability and metabolic control in patients with Type 1 diabetes managed by Group Care. J Endocrinol Invest. febrero de 2011;34(2):101-5. DOI: 10.1007/BF03347038
- Coates V, Chaney D, Bunting B, Shorter G, Shevlin M, McDougal A, et al. Evaluation of the Effectiveness of a Structured Diabetes Education Programme (CHOICE) on Clinical Outcomes for Adolescents with Type 1 Diabetes: A Randomised Controlled Trial. J Diabetes Metab [Internet]. 2013 [citado 15 de noviembre de 2023];04(06). Disponible en: https://www.omicsonline.org/2155-6156/2155-6156-4-280.php?aid=16557 DOI: 10.4172/2155-6156.1000280
- Price KJ, Knowles JA, Fox M, Wales JKH, Heller S, Eiser C, et al. Effectiveness of the Kids in Control of Food (KICk-OFF) structured education course for 11–16 year olds with Type 1 diabetes. Diabet Med. febrero de 2016;33(2):192-203. DOI: 10.1111/dme.12881
- Christie D, Thompson R, Sawtell M, Allen E, Cairns J, Smith F, et al. Structured, intensive education maximising engagement, motivation and long-term change for children and young people with diabetes: A cluster randomised controlled trial with integral process and economic evaluation – The CASCADE study. Health Technol Assess. 2014;18(20):1-202. DOI: 10.3310/hta18200
- Gregory JW, Townson J, Channon S, Cohen D, Longo M, Davies J, et al. Effectiveness of home or hospital initiation of treatment at diagnosis for children with type 1 diabetes (DECIDE trial): a multicentre individually randomised controlled trial. BMJ Open. diciembre de 2019;9(12):e032317. DOI: 10.1136/bmjopen-2019-032317
- Katz ML, Volkening LK, Butler DA, Anderson BJ, Laffel LM. Family-based psychoeducation and care ambassador intervention to improve glycemic control in youth with type 1 diabetes: a randomized trial. Pediatr Diabetes. marzo de 2014;15(2):142-50. DOI: 10.1111/pedi.12065
- Murphy HR, Wadham C, Hassler-Hurst J, Rayman G, Skinner TC, on behalf of Families and Adolescents Communication and Teamwork Study (FACTS) Group. Randomized trial of a diabetes self-management education and family teamwork intervention in adolescents with Type

1 diabetes. Diabet Med [Internet]. agosto de 2012 [citado 15 de noviembre de 2023];29(8). Disponible en: https://onlinelibrary.wiley.com/doi/10.1111/j.1464-5491.2012.03683.x DOI: 10.1111/j.1464-5491.2012.03683.x

- Grey M, Whittemore R, Jeon S, Murphy K, Faulkner MS, Delamater A, et al. Internet Psycho-Education Programs Improve Outcomes in Youth With Type 1 Diabetes. Diabetes Care. 1 de septiembre de 2013;36(9):2475-82. DOI: 10.2337/dc12-2199
- Geremia C, Fornari A, Tschiedel B. Comparison of the effect of a compact vs a conventional, long-term education program on metabolic control in children and adolescents with type 1 diabetes: A pilot, randomized clinical trial. Pediatr Diabetes. septiembre de 2019;20(6):778-84. DOI: 10.1111/pedi.12879
- Brorsson AL, Leksell J, Andersson Franko M, Lindholm Olinder A. A person-centered education for adolescents with type 1 diabetes—A randomized controlled trial. Pediatr Diabetes. noviembre de 2019;20(7):986-96. DOI: 10.1111/pedi.12888
- Husted GR, Thorsteinsson B, Esbensen BA, Gluud C, Winkel P, Hommel E, et al. Effect of guided self-determination youth intervention integrated into outpatient visits versus treatment as usual on glycemic control and life skills: a randomized clinical trial in adolescents with type 1 diabetes. Trials. agosto de 2014;15:321. DOI: 10.1186/1745-6215-15-321
- Henkemans OAB, Bierman BPB, Janssen J, Looije R, Neerincx MA, Van Dooren MMM, et al. Design and evaluation of a personal robot playing a self-management education game with children with diabetes type 1. Int J Hum-Comput Stud. octubre de 2017;106:63-76. DOI: 10.1016/j.ijhcs.2017.06.001
- Majumdar I, Bethin K, Quattrin T. Weight trajectory of youth with new-onset type 1 diabetes comparing standard and enhanced dietary education. Endocrine. mayo de 2015;49(1):155-62. DOI: 10.1007/s12020-014-0469-6
- Dłużniak-Gołaska K, Panczyk M, Szypowska A, Sińska B, Szostak-Węgierek D. Interactive Nutrition Education Is More Effective in Terms of Improved Levels of Glycated Hemoglobin in Adolescent Patients with Poorly Controlled Type 1 Diabetes – A Randomized Study. Diabetes Metab Syndr Obes Targets Ther. diciembre de 2019;Volume 12:2619-31. DOI: 10.2147/DMSO.S229246
- Dinneen SF, O'Hara MC, Byrne M, Smith D, Courtney CH, McGurk C, et al. Group follow-up compared to individual clinic visits after structured education for type 1 diabetes: A cluster randomised controlled trial. Diabetes Res Clin Pract. abril de 2013;100(1):29-38. DOI: 10.1016/j.diabres.2013.01.017
- DAFNE Study Group. Training in flexible, intensive insulin management to enable dietary freedom in people with type 1 diabetes: dose adjustment for normal eating (DAFNE) randomised controlled trial. BMJ. 5 de octubre de 2002;325(7367):746. DOI: 10.1136/bmj.325.7367.746
- Holmes CS, Chen R, Mackey E, Grey M, Streisand R. Randomized Clinical Trial of Clinic-Integrated, Low-Intensity Treatment to Prevent Deterioration of Disease Care in Adolescents With Type 1 Diabetes. Diabetes Care. 1 de junio de 2014;37(6):1535-43. DOI: 10.2337/dc13-1053
- Noyes J, Allen D, Carter C, Edwards D, Edwards RT, Russell D, et al. Standardised self-management kits for children with type 1 diabetes: pragmatic randomised trial of effectiveness and cost-effectiveness. BMJ Open. marzo de 2020;10(3):e032163. DOI: 10.1136/bmjopen-2019-032163

- Hermanns N, Kulzer B, Ehrmann D, Bergis-Jurgan N, Haak T. The effect of a diabetes education programme (PRIMAS) for people with type 1 diabetes: Results of a randomized trial. Diabetes Res Clin Pract. diciembre de 2013;102(3):149-57. DOI: 10.1016/j.diabres.2013.10.009
- Fisher L, Hessler D, Polonsky WH, Masharani U, Guzman S, Bowyer V, et al. T1-REDEEM: A Randomized Controlled Trial to Reduce Diabetes Distress Among Adults With Type 1 Diabetes. Diabetes Care. 1 de septiembre de 2018;41(9):1862-9. DOI: 10.2337/dc18-0391
- Grey M, Jaser SS, Whittemore R, Jeon S, Lindemann E. Coping Skills Training for Parents of Children With Type 1 Diabetes: 12-Month Outcomes. Nurs Res. mayo de 2011;60(3):173-81. DOI: 10.1097/NNR.0b013e3182159c8f
- Albanese-O'Neill A, Schatz DA, Thomas N, Bernhardt JM, Cook CL, Haller MJ, et al. Designing online and mobile diabetes education for fathers of children with type 1 diabetes: Mixed methods study. J Med Internet Res Diabetes. 2019;4(3):1-12. DOI: 10.2196/13724
- Cai RA, Holt RIG, Casdagli L, Viner RM, Thompson R, Barnard K, et al. Development of an acceptable and feasible self-management group for children, young people and families living with Type 1 diabetes. Diabet Med. 2017;34(6):813-20. DOI: 10.1111/dme.13341
- Coates V, Horigan G, Carey M, Davies M. Using qualitative data to enhance our understanding of the reasons young people decline Structured Diabetes Education programmes. J Clin Nurs. 2018;27(15-16):3139-47. DOI: 10.1111/jocn.14508
- Casey D, O'Hara MC, Meehan B, Byrne M, Dinneen SF, Murphy K. A Mixed Methods Study Exploring the Factors and Behaviors That Affect Glycemic Control Following a Structured Education Program: The Irish DAFNE Study. J Mix Methods Res. 2014;10(2):182-203. DOI: 10.1177/1558689814547579
- Snow R, Humphrey C, Sandall J. What happens When patients know more than their doctors? Experiences of health interactions after diabetes patient education: A qualitative patient-led study. BMJ Open. 2013;3(11):1-8. DOI: 10.1136/bmjopen-2013-003583
- Harris S, Miller A, Amiel S, Mulnier H. Characterization of Adults With Type 1 Diabetes Not Attending Self-Management Education Courses: The Barriers to Uptake of Type 1 Diabetes Education (BUD1E) Study. Qual Health Res. 2019;29(8):1174-85. DOI: 10.1177/1049732318823718
- Murphy K, Casey D, Dinneen S, Lawton J, Brown F. Participants' perceptions of the factors that influence Diabetes Self-Management Following a Structured Education (DAFNE) programme. J Clin Nurs. 2011;20(9-10):1282-92. DOI: 10.1111/j.1365-2702.2010.03564.x
- Rankin D, Cooke DD, Clark M, Heller S, Elliott J, Lawton J. How and why do patients with Type1 diabetes sustain their use of flexible intensive insulin therapy? A qualitative longitudinal investigation of patients' self-management practices following attendance at a Dose Adjustment for Normal Eating (DAFNE) course. Diabet Med. 2011;28(5):532-8. DOI: 10.1111/j.1464-5491.2011.03243.x
- Shuttlewood E, De Zoysa N, Rankin D, Amiel S. A qualitative evaluation of DAFNE-HART: A psychoeducational programme to restore hypoglycaemia awareness. Diabetes Res Clin Pract. 2015;109(2):347-54. DOI: 10.1016/j.diabres.2015.05.034
- Taha N, Mesbah N, Rahme Z, Omar D, Sukkar F. Piloting a Culturally Adapted Arabic Structured Small-Group Education Program for Adolescents with Type 1 Diabetes. Med Princ Pract. 2020;29(2):142-9. DOI: 10.1159/000503084

- Xie Y, Liu F, Huang F, Lan C, Guo J, He J, et al. Establishment of a type 1 diabetes structured education programme suitable for Chinese patients: Type 1 diabetes education in lifestyle and self adjustment (TELSA). BMC Endocr Disord. 2020;20(1):1-10. DOI: 10.1186/s12902-020-0514-9
- Casey D, Murphy K, Lawton J, White F, Dineen S. A longitudinal qualitative study examining the factors impacting on the ability of persons with T1DM to assimilate the Dose Adjustment for Normal Eating (DAFNE) principles into daily living and how these factors change over time. BMC Public Health. 2011;11(1):672. DOI: 10.1186/1471-2458-11-672
- Ng AH, Greenwood DA, Iacob E, Allen NA, Ferrer M, Rodriguez B, et al. Examining a Continuous Glucose Monitoring Plus Online Peer Support Community Intervention to Support Hispanic Adults With Type 2 Diabetes: Protocol for a Mixed Methods Feasibility Study. J Med Internet Res Res Protoc. 24 de febrero de 2022;11(2):e31595. DOI: 10.2196/31595
- Nicholas DB, Fellner KD, Frank M, Small M, Hetherington R, Slater R, et al. Evaluation of an Online Education and Support Intervention for Adolescents With Diabetes. Soc Work Health Care. 2012;51(9):815-27. DOI: 10.1080/00981389.2012.699507
- Fredrix M, Byrne M, Dinneen S, McSharry J. 'It's an important part, but I am not quite sure that it is working': educators' perspectives on the implementation of goal-setting within the 'DAFNE' diabetes structured education programme. Diabet Med. 2019;36(1):80-7. DOI: 10.1111/dme.13813
- Horigan G, Davies M, Findlay-White F, Chaney D, Coates V. Reasons why patients referred to diabetes education programmes choose not to attend: a systematic review. Diabet Med. 2017;34(1):14-26. DOI: 10.1111/dme.13120
- Rankin D, Harden J, Waugh N, Noyes K, Barnard KD, Lawton J. Parents' information and support needs when their child is diagnosed with type 1 diabetes: A qualitative study. Health Expect. 2016;19(3):580-91. DOI: 10.1111/hex.12244
- Rankin D, Cooke DD, Elliott J, Heller SR, Lawton J. Supporting self-management after attending a structured education programme: A qualitative longitudinal investigation of type 1 diabetes patients experiences and views. BMC Public Health. 2012;12(1):1. DOI: 10.1186/1471-2458-12-652
- Sanders T, Elliott J, Norman P, Johnson B, Heller S. Experiences of self-management among young adults with Type 1 diabetes in the context of a structured education programme: a qualitative study. Diabet Med. 2018;35(11):1531-7. DOI: 10.1111/dme.13784
- Serlachius A, Northam E, Frydenberg E, Cameron F. Adapting a generic coping skills programme for adolescents with type 1 diabetes: A qualitative study. J Health Psychol. 2012;17(3):313-23. DOI: 10.1177/1359105311415559
- Snow R, Sandall J, Humphrey C. Use of clinical targets in diabetes patient education: Qualitative analysis of the expectations and impact of a structured self-management programme in type 1 diabetes. Diabet Med. 2014;31(6):733-8. DOI: 10.1111/dme.12401
- Sawtell M, Jamieson L, Wiggins M, Smith F, Ingold A, Hargreaves K, et al. Implementing a structured education program for children with diabetes: Lessons learnt from an integrated process evaluation. BMJ Open Diabetes Res Care. 2015;3(1):1-8. DOI: 10.1136/bmjdrc-2014-000065
- Ramchandani N, Johnson K, Cullen K, Hamm T, Bisordi J, Sullivan-Bolyai S. CDE Perspectives of Providing New-Onset Type 1 Diabetes Education Using Formal Vignettes and Simulation. Diabetes Educ. 2017;43(1):97-104. DOI: 10.1177/0145721716676893

- Lawton J, Rankin D, Cooke DD, Elliott J, Amiel S, Heller S. Self-treating hypoglycaemia: A longitudinal qualitative investigation of the experiences and views of people with Type 1 diabetes. Diabet Med. 2013;30(2):209-15. DOI: 10.1111/dme.12007

4.2. Community and Non-Healthcare Support

Question

- Do community or non-healthcare support modalities aimed at people with T1D (schools, diabetes patient associations, etc.) improve health outcomes?

Recommendations

1. Based on currently available evidence, no recommendation for or against community or non-healthcare support interventions aimed at people with T1D can be made.

Rationale

The GDG was unable to make a recommendation for or against community or non-healthcare support interventions for people with T1D. The GDG noted an absence of clear desirable or undesirable effect sizes, with no demonstrated impact on HbA1c levels, quality of life, or hypoglycaemia rates. The overall certainty of evidence was rated as low.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-6

References

- Holt RIG, DeVries JH, Hess-Fischl A, Hirsch IB, Kirkman MS, Klupa T, et al. The management of type 1 diabetes in adults. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetologia. diciembre de 2021;64(12):2609-52. DOI: 10.1007/s00125-021-05568-3
- National Institute for Health and Care Excellence (NICE). Type 1 diabetes in adults: diagnosis and management (NG17) [Internet]. 2018 p. 1-87. Report No.: August 2015. Disponible en: www.nice.org.uk/guidance/ng17
- Livingstone SJ, Looker HC, Hothersall EJ, Wild SH, Lindsay RS, Chalmers J, et al. Risk of cardiovascular disease and total mortality in adults with type 1 diabetes: Scottish registry linkage study. PLOS Med. 2012;9(10):e1001321. DOI: 10.1371/journal.pmed.1001321
- Chiang JL, Kirkman MS, Laffel LMB, Peters AL. Type 1 diabetes through the life span: a position statement of the American Diabetes Association. Diabetes Care. julio de 2014;37(7):2034-54. DOI: 10.2337/dc14-1140
- Smith-Palmer J, Bae JP, Boye KS, Norrbacka K, Hunt B, Valentine WJ. Evaluating health-related quality of life in type 1 diabetes: a systematic literature review of utilities for adults with type 1 diabetes. Clin Outcomes Res CEOR. 2016;8:559-71. DOI: 10.2147/CEOR.S114699

- Bächle C, Icks A, Straßburger K, Flechtner-Mors M, Hungele A, Beyer P, et al. Direct diabetes-related costs in young patients with early-onset, long-lasting type 1 diabetes. PLOS ONE. 2013;8(8):e70567. DOI: 10.1371/journal.pone.0070567
- Pendley JS. Peer and Family Support in Children and Adolescents With Type 1 Diabetes. J Pediatr Psychol. 1 de julio de 2002;27(5):429-38. DOI: 10.1093/jpepsy/27.5.429
- Bisio A, Gamarra E, Broglio F, Grassi G. Coping strategies in people with type 1 diabetes on insulin pump treatment. Minerva Endocrinol [Internet]. enero de 2020 [citado 22 de noviembre de 2023];44(4). Disponible en: https://www.minervamedica.it/index2.php?show=R07Y2019N04A0336 DOI: 10.23736/S0391-1977.19.03024-4
- Song Y, Nam S, Park S, Shin IS, Ku BJ. The Impact of Social Support on Self-care of Patients With Diabetes: What Is the Effect of Diabetes Type? Systematic Review and Meta-analysis. Diabetes Educ. agosto de 2017;43(4):396-412. DOI: 10.1177/0145721717712457
- Strom JL, Egede LE. The impact of social support on outcomes in adult patients with type 2 diabetes: a systematic review. Curr Diab Rep. diciembre de 2012;12(6):769-81. DOI: 10.1007/s11892-012-0317-0
- Lee LT, Bowen PG, Mosley MK, Turner CC. Theory of Planned Behavior: Social Support and Diabetes Self-Management. J Nurse Pract. abril de 2017;13(4):265-70. DOI: 10.1016/j.nurpra.2016.07.013
- Tan CCL, Cheng KKF, Wang W. Self-care management programme for older adults with diabetes: An integrative literature review. Int J Nurs Pract. mayo de 2015;21(S2):115-24. DOI: 10.1111/ijn.12388
- Plataforma de organizaciones de pacientes. Impacto y retos de las organizaciones de pacientes en España [Internet]. 2021. Disponible en: https://www.plataformadepacientes.org
- Fullerton B, Jeitler K, Seitz M, Horvath K, Berghold A, Siebenhofer A. Intensive glucose control versus conventional glucose control for type 1 diabetes mellitus. Cochrane Database Syst Rev. febrero de 2014;2014(2):CD009122. DOI: 10.1002/14651858.CD009122.pub2
- Edraki M, Zarei A, Soltanian M, Moravej H. The Effect of Peer Education on Self-Care Behaviors and the Mean of Glycosylated Hemoglobin in Adolescents with Type 1 Diabetes: A Randomized Controlled Clinical Trial. Int J Community Based Nurs Midwifery. julio de 2020;8(3):209-19. DOI: 10.30476/ijcbnm.2020.82296.1051
- Linden K, Berg M, Adolfsson A, Sparud-Lundin C. Person-centred, web-based support in pregnancy and early motherhood for women with Type 1 diabetes mellitus: a randomized controlled trial. Diabet Med. febrero de 2018;35(2):232-41. DOI: 10.1111/dme.13552
- Hanberger L, Ludvigsson J, Nordfeldt S. Use of a web 2.0 portal to improve education and communication in young patients with families: randomized controlled trial. J Med Internet Res. agosto de 2013;15(8):e175. DOI: 10.2196/jmir.2425
- Suh S, Jean C, Koo M, Lee SY, Cho MJ, Sim KH, et al. A randomized controlled trial of an internet-based mentoring program for type 1 diabetes patients with inadequate glycemic control. Diabetes Metab. abril de 2014;38(2):134-42. DOI: 10.4093/dmj.2014.38.2.134
- Biglar Chopoghlo S, Hosseinkhani A, Khedmat L, Zaki-Nejad M, Puryaghoob M. The self-efficacy improvement in adolescent girls with type 1 diabetes mellitus with self-care education through mobile-based social networking. Int J Diabetes Dev Ctries. 2021;41(4):676-82. DOI: 10.1007/s13410-021-00929-5

- Walker RJ, Smalls BL, Campbell JA, Strom Williams JL, Egede LE. Impact of social determinants of health on outcomes for type 2 diabetes: a systematic review. Endocrine. septiembre de 2014;47(1):29-48. DOI: 10.1007/s12020-014-0195-0
- Ellis DA, Carcone AI, Naar-King S, Rajkumar D, Palmisano G, Moltz K. Adaptation of an Evidence-Based Diabetes Management Intervention for Delivery in Community Settings: Findings From a Pilot Randomized Effectiveness Trial. J Pediatr Psychol. enero de 2019;44(1):110-25. DOI: 10.1093/jpepsy/jsx144
- De Wit M, Trief PM, Huber JW, Willaing I. State of the art: understanding and integration of the social context in diabetes care. Diabet Med. marzo de 2020;37(3):473-82. DOI: 10.1111/dme.14226
- Smith KJ, Béland M, Clyde M, Gariépy G, Pagé V, Badawi G, et al. Association of diabetes with anxiety: A systematic review and meta-analysis. J Psychosom Res. febrero de 2013;74(2):89-99. DOI: 10.1016/j.jpsychores.2012.11.013

5. Nutrition

Question

- What should the nutritional recommendations be in people with T1D?

This question was divided into two specific sub-questions:

- *What dietary patterns should be recommended in people with T1D?*
- *How should carbohydrate counting be done in people with T1D?*

5.1. Dietary Patterns

Sub-question

- What dietary patterns should be recommended in people with T1D?

Recommendations

1. No recommendation can be issued for or against low-carbohydrate or moderate-carbohydrate diets in people with T1D.
2. No recommendation can be issued for or against low-carbohydrate, low-fibre diets in people with T1D.

WEAK RECOMMENDATION, IN FAVOUR

3. In people with T1D and diabetic nephropathy or intermittent or persistent proteinuria, a protein intake of 0.6–0.8 g/kg body weight/day is suggested.
4. In people with T1D, a high-fibre diet is suggested.

Implementation Considerations:

In clinical practice, dietary planning should be individualised by considering factors that influence glycaemic regulation and energy requirements, such as physical activity levels and exercise intensity (including vigorous exercise), age, and physiological stages (e.g. adolescence, menstruation, or menopause).

Nutritional planning should incorporate structured therapeutic education and practical training in instrumental activities of daily living (IADLs) related to food, such as meal preparation and healthy grocery shopping. These strategies improve self-care autonomy and long-term dietary adherence in people with T1D. In addition, the need for assistive devices or supportive tools should be evaluated to compensate for functional or cognitive impairments that may hinder dietary management.

Rationale

The GDG was unable to formulate a recommendation for or against low-carbohydrate, moderate-carbohydrate, or low-carbohydrate/low-fibre diets in people with T1D. This decision stems from a lack

of conclusive evidence regarding expected desirable and undesirable clinical effects, beyond a non-significant impact on HbA1c levels, quality of life, or hypoglycaemia rates. The certainty of evidence was rated as low. Furthermore, the GDG noted significant uncertainty regarding potential adverse effects these restrictive diets might exert across various life stages, such as growth restriction in children and adolescents, increased risk of ketoacidosis, and poor dietary acceptability.

The recommendation suggesting a protein intake of 0.6–0.8 g/kg body weight/day in people with T1D and co-existing diabetic kidney disease or proteinuria is grounded in evidence demonstrating that dietary protein restriction slows renal disease progression without compromising overall metabolic control. Additionally, the GDG aligned this threshold with the National Kidney Foundation's Kidney Disease Outcomes Quality Initiative (KDOQI) clinical practice guidelines on nutrition in chronic kidney disease (CKD), which considers 0.6–0.8 g/kg/day reasonable for adults with CKD stages 3–5 and diabetes (399).

Finally, the GDG suggested recommending a high-fibre diet in both children and adults with T1D based on well-documented systemic health benefits and chronic disease prevention. Although T1D-specific evidence regarding high-fibre intake on short-term glycaemic control is limited and demonstrates no significant immediate reduction in HbA1c, robust population studies consistently link higher dietary fibre intake with lower risks of cardiovascular disease, coronary heart disease, cancer, and all-cause mortality, as well as reduced incidence of respiratory and infectious diseases. Given that individuals with T1D face elevated baseline cardiovascular risk, promoting a fibre-rich dietary pattern supports long-term health outcomes.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-7

References

- Holt RIG, DeVries JH, Hess-Fischl A, Hirsch IB, Kirkman MS, Klupa T, et al. The management of type 1 diabetes in adults. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetologia. diciembre de 2021;64(12):2609-52. DOI: 10.1007/s00125-021-05568-3
- ElSayed NA, Aleppo G, Aroda VR, Bannuru RR, Brown FM, Bruemmer D, et al. Summary of Revisions: Standards of Care in Diabetes—2023. Diabetes Care. 1 de enero de 2023;46(Supplement_1):S5-9. DOI: 10.2337/dc23-Srev
- Schmidt S, Meldgaard M, Serifovski N, Storm C, Christensen TM, Gade-Rasmussen B, et al. Use of an automated bolus calculator in MDI-treated type 1 diabetes: the BolusCal Study, a randomized controlled pilot study. Diabetes Care. mayo de 2012;35(5):984-90. DOI: 10.2337/DC11-2044
- National Institute for Health and Care Excellence. Type 1 diabetes in adults: Quality standard [Internet]. 2023 p. 1-37. Report No.: QS208. Disponible en: www.nice.org.uk/guidance/qs208 ©
- Evert AB, Dennison M, Gardner CD, Timothy Garvey W, Karen Lau KH, MacLeod J, et al. Nutrition therapy for adults with diabetes or prediabetes: A consensus report. Diabetes Care. 2019;42(5):731-54. DOI: 10.2337/dci19-0014

- Diabetes and Nutrition Study Group (DNSG) of the European Association for the Study of Diabetes (EASD). Evidence-based European recommendations for the dietary management of diabetes. Diabetologia. 2023;66(6):965-85. DOI: 10.1007/s00125-023-05894-8
- Ikizler TA, Burrowes JD, Byham-Gray LD, et al. KDOQI Clinical Practice Guideline for Nutrition in CKD: 2020 Update. Am J Kidney Dis. 76(3):S1-107.
- Anderson J, Zeigler J, Deakins D, Floore T, Dillon D, Wood C, et al. Metabolic effects of high-carbohydrate, high-fiber diets for insulin-dependent diabetic individuals. Am J Clin Nutr. noviembre de 1991;54(5):936-43. DOI: 10.1093/ajcn/54.5.936
- Krebs JD, Parry Strong A, Cresswell P, Reynolds AN, Hanna A, Haeusler S. A randomised trial of the feasibility of a low carbohydrate diet vs standard carbohydrate counting in adults with type 1 diabetes taking body weight into account. Asia Pac J Clin Nutr. 2016;25(1):78-84. DOI: 10.6133/apjcn.2016.25.1.11
- Marquard J, Stahl A, Lerch C, Wolters M, Grotzke-Leweling M, Mayatepek E, et al. A prospective clinical pilot-trial comparing the effect of an optimized mixed diet versus a flexible low-glycemic index diet on nutrient intake and HbA1c levels in children with type 1 diabetes. J Pediatr Endocrinol Metab. 2011;24(7-8):441-7. DOI: 10.1515/jpem.2011.176
- Duffus SH, Slaughter JC, Cooley W, Sharif N, Rainer K, Coate KC, et al. A pragmatic low carbohydrate diet intervention changes neither carbohydrate consumption nor glycemia in adolescents and young adults with type 1 diabetes in a randomized trial. Pediatr Diabetes. 2022;23(7):1088-100. DOI: 10.1111/pedi.13407
- Neuman V, Plachy L, Drnkova L, Pruhova S, Kolouskova S, Obermannova B, et al. Low-carbohydrate diet in children and young people with type 1 diabetes: A randomized controlled trial with cross-over design. Diabetes Res Clin Pract. noviembre de 2024;217:111844. DOI: 10.1016/j.diabres.2024.111844
- Ranjan A, Schmidt S, Damm-Frydenberg C, Holst JJ, Madsbad S, Nørgaard K. Short-term effects of a low carbohydrate diet on glycaemic variables and cardiovascular risk markers in patients with type 1 diabetes: A randomized open-label crossover trial. Diabetes Obes Metab. octubre de 2017;19(10):1479-84. DOI: 10.1111/dom.12953
- Schmidt S, Christensen MB, Serifovski N, Damm-Frydenberg C, Jensen JB, Fløyel T, et al. Low versus high carbohydrate diet in type 1 diabetes: A 12-week randomized open-label crossover study. Diabetes Obes Metab. julio de 2019;21(7):1680-8. DOI: 10.1111/dom.13725
- Sterner Isaksson S, Ólafsdóttir AF, Ivarsson S, Imberg H, Toft E, Hallström S, et al. The effect of carbohydrate intake on glycaemic control in individuals with type 1 diabetes: a randomised, open-label, crossover trial. Lancet Reg Health – Eur. febrero de 2024;37:100799. DOI: 10.1016/j.lanepe.2023.100799
- Hansen HP, Tauber-Lassen E, Jensen BR, Parving HH. Effect of dietary protein restriction on prognosis in patients with diabetic nephropathy. Kidney Int. julio de 2002;62(1):220-8. DOI: 10.1046/j.1523-1755.2002.00421.x
- Hansen HP, Christensen PK, Tauber-Lassen E, Klausen A, Jensen BR, Parving HH. Low-protein diet and kidney function in insulin-dependent diabetic patients with diabetic nephropathy. Kidney Int. febrero de 1999;55(2):621-8. DOI: 10.1046/j.1523-1755.1999.00274.x
- Ciavarella A, Di Mizio G, Stefoni S, Borgnino LC, Vannini P. Reduced Albuminuria After Dietary Protein Restriction in Insulin-Dependent Diabetic Patients With Clinical Nephropathy. Diabetes Care. 1 de julio de 1987;10(4):407-13. DOI: 10.2337/diacare.10.4.407

- Brouhard BH, Lagrone L. Effect of dietary protein restriction on functional renal reserve in diabetic nephropathy. Am J Med. octubre de 1990;89(4):427-31. DOI: 10.1016/0002-9343(90)90370-S
- Raal F, Kalk W, Lawson M, Esser J, Buys R, Fourie L, et al. Effect of moderate dietary protein restriction on the progression of overt diabetic nephropathy: a 6-mo prospective study. Am J Clin Nutr. octubre de 1994;60(4):579-85. DOI: 10.1093/ajcn/60.4.579
- Yan B, Su X, Xu B, Qiao X, Wang L. Effect of diet protein restriction on progression of chronic kidney disease: A systematic review and meta-analysis. Cheungpasitporn W, editor. PLOS ONE. 7 de noviembre de 2018;13(11):e0206134. DOI: 10.1371/journal.pone.0206134
- Venhaus A, Chantelau E. Self-selected unrefined and refined carbohydrate diets do not affect metabolic control in pump-treated diabetic patients. Diabetologia. marzo de 1988;31(3):153-7. DOI: 10.1007/BF00276848
- Giacco R, Parillo M, Rivellese AA, Lasorella G, Giacco A, D'Episcopo L, et al. Long-term dietary treatment with increased amounts of fiber-rich low-glycemic index natural foods improves blood glucose control and reduces the number of hypoglycemic events in type 1 diabetic patients. Diabetes Care. octubre de 2000;23(10):1461-6. DOI: 10.2337/diacare.23.10.1461
- Reynolds A, Mann J, Cummings J, Winter N, Mete E, Te Morenga L. Carbohydrate quality and human health: a series of systematic reviews and meta-analyses. The Lancet. febrero de 2019;393(10170):434-45. DOI: 10.1016/S0140-6736(18)31809-9
- Aune D, Keum N, Giovannucci E, Fadnes LT, Boffetta P, Greenwood DC, et al. Whole grain consumption and risk of cardiovascular disease, cancer, and all cause and cause specific mortality: systematic review and dose-response meta-analysis of prospective studies. BMJ. 14 de junio de 2016;i2716. DOI: 10.1136/bmj.i2716
- Aune D, Giovannucci E, Boffetta P, Fadnes LT, Keum N, Norat T, et al. Fruit and vegetable intake and the risk of cardiovascular disease, total cancer and all-cause mortality—a systematic review and dose-response meta-analysis of prospective studies. Int J Epidemiol. 1 de junio de 2017;46(3):1029-56. DOI: 10.1093/ije/dyw319
- Kawashima S, Sogi C, Kamimura M, Kikuchi A, Kanno J. Severe growth retardation during carbohydrate restriction in type 1 diabetes mellitus: A case report. Clin Pediatr Endocrinol. 2024;33(3):181-6. DOI: 10.1297/cpe.2024-0003

5.2. Carbohydrate Counting

Sub-question

- How should carbohydrate counting be done in people with T1D?

Recommendations

WEAK RECOMMENDATION, IN FAVOUR

1. In adults with T1D, the application of a carbohydrate counting method is suggested.
2. In people with T1D, using a bolus calculator to assist with carbohydrate counting is suggested over manual calculations.

STRONG RECOMMENDATION, IN FAVOUR

3. In children with T1D, the application of a carbohydrate counting method is recommended.

Rationale

Considering the desirable effects, the GDG formulated recommendations in favour of carbohydrate counting as a nutritional management strategy in people with T1D, issued as a weak recommendation for adults and a strong recommendation for children. This recommendation is based on the potential utility of carbohydrate counting in improving postprandial glycaemia and reducing non-severe hypoglycaemia in children, without adverse effects regarding severe hypoglycaemia. The certainty of evidence was rated as low for children and very low for adults.

Regarding automated bolus calculators, their use is suggested—as a weak recommendation—recognising their potential utility as an adjunctive management tool. The certainty of evidence was rated as low.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-7

References

- Insel RA, Dunne JL, Atkinson MA, Chiang JL, Dabelea D, Gottlieb PA, et al. Staging Presymptomatic Type 1 Diabetes: A Scientific Statement of JDRF, the Endocrine Society, and the American Diabetes Association. Diabetes Care. 1 de octubre de 2015;38(10):1964-74. DOI: 10.2337/dc15-1419
- Holt RIG, DeVries JH, Hess-Fischl A, Hirsch IB, Kirkman MS, Klupa T, et al. The management of type 1 diabetes in adults. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetologia. diciembre de 2021;64(12):2609-52. DOI: 10.1007/s00125-021-05568-3
- Schmidt S, Meldgaard M, Serifovski N, Storm C, Christensen TM, Gade-Rasmussen B, et al. Use of an automated bolus calculator in MDI-treated type 1 diabetes: the BolusCal Study, a randomized controlled pilot study. Diabetes Care. mayo de 2012;35(5):984-90. DOI: 10.2337/DC11-2044
- Trento M, Trinetta A, Kucich C, Grassi G, Passera P, Gennari S, et al. Carbohydrate counting improves coping ability and metabolic control in patients with Type 1 diabetes managed by Group Care. J Endocrinol Invest. febrero de 2011;34(2):101-5. DOI: 10.1007/BF03347038
- DAFNE Study Group. Training in flexible, intensive insulin management to enable dietary freedom in people with type 1 diabetes: dose adjustment for normal eating (DAFNE) randomised controlled trial. BMJ. 5 de octubre de 2002;325(7367):746. DOI: 10.1136/bmj.325.7367.746
- Builes-Montaño CE, Ortiz-Cano NA, Ramirez-Rincón A, Rojas-Henao NA. Efficacy and safety of carbohydrate counting versus other forms of dietary advice in patients with type 1 diabetes mellitus: a systematic review and meta-analysis of randomised clinical trials. J Hum Nutr Diet. diciembre de 2022;35(6):1030-42. DOI: 10.1111/jhn.13017

- Scavone G, Manto A, Pitocco D, Gagliardi L, Caputo S, Mancini L, et al. Effect of carbohydrate counting and medical nutritional therapy on glycaemic control in Type 1 diabetic subjects: a pilot study. Diabet Med. 2010;27(4):477-9. DOI: 10.1111/j.1464-5491.2010.02963.x
- Laurenzi A, Bolla AM, Panigoni G, Doria V, Uccellatore A, Peretti E, et al. Effects of carbohydrate counting on glucose control and quality of life over 24 weeks in adult patients with type 1 diabetes on continuous subcutaneous insulin infusion: a randomized, prospective clinical trial (GIOCAR). Diabetes Care. 2011;34(4):823-7. DOI: 10.2337/dc10-1490
- Gökşen D, Atik Altınok Y, Özen S, Demir G, Darcan Ş. Effects of Carbohydrate Counting Method on Metabolic Control in Children with Type 1 Diabetes Mellitus. J Clin Res Pediatr Endocrinol. 5 de junio de 2014;6(2):74-8. DOI: 10.4274/jcrpe.1191
- Donzeau A, Bonnemaison E, Vautier V, Menut V, Houdon L, Bendelac N, et al. Effects of advanced carbohydrate counting on glucose control and quality of life in children with type 1 diabetes. Pediatr Diabetes. noviembre de 2020;21(7):1240-8. DOI: 10.1111/pedi.13076
- Enander R, Gundevall C, Strömgren A, Chaplin J, Hanas R. Carbohydrate counting with a bolus calculator improves post-prandial blood glucose levels in children and adolescents with type 1 diabetes using insulin pumps: Carbohydrate counting in children. Pediatr Diabetes. noviembre de 2012;13(7):545-51. DOI: 10.1111/j.1399-5448.2012.00883.x
- Alfonsi JE, Choi EEY, Arshad T, Sammott SAS, Pais V, Nguyen C, et al. Carbohydrate Counting App Using Image Recognition for Youth With Type 1 Diabetes: Pilot Randomized Control Trial. JMIR mHealth and uHealth. 28 de octubre de 2020;8(10):e22074. DOI: 10.2196/22074
- Hommel E, Schmidt S, Vistisen D, Neergaard K, Gribhild M, Almdal T, et al. Effects of advanced carbohydrate counting guided by an automated bolus calculator in Type 1 diabetes mellitus (StenoABC): a 12-month, randomized clinical trial. Diabet Med. mayo de 2017;34(5):708-15. DOI: 10.1111/DME.13275

6. T1D Management in Special Situations

6.1. The Inpatient

Question

- What should the insulin regimens be during hospitalisation for people with T1D: surgical, critically ill, and clinically stable patients?

Recommendations

GOOD CLINICAL PRACTICE

1. In people with T1D, adding a clinical alert in the electronic health record specifying the diagnosis of T1D and the essential need for insulin therapy is suggested to prevent inadvertent insulin omission during hospital admission.

2. In people with T1D admitted to hospital for surgery or acute illness, establishing a local clinical protocol to monitor and manage blood glucose levels is suggested.

3. Aiming for a target plasma glucose level between 90 and 180 mg/dL (5.0–10.0 mmol/L) is suggested in hospitalised people with T1D.

4. Aiming for a post-operative target plasma glucose level between 140 and 180 mg/dL (7.8–10.0 mmol/L) is suggested in people with T1D hospitalised for surgery to reduce the risk of hypoglycaemia.

5. In hospitalised people with T1D, thorough medicines reconciliation must be performed upon admission through patient or family interview to ensure accurate insulin prescribing.

6. Continuous intravenous insulin infusion regimens are suggested over subcutaneous insulin in hospitalised people with T1D if:

    - They are unable to eat or are expected to miss more than one meal;
    - An acute illness/condition is expected to cause unpredictable blood glucose levels (e.g. major surgery, high-dose steroid therapy, inotropic therapy, or sepsis); or
    - Insulin absorption is expected to be unpredictable, for example, due to circulatory compromise.

7. Continuing their pre-admission basal insulin regimen (including basal rates if on insulin pump therapy) alongside protocol-driven insulin administration to manage blood glucose levels is suggested in people with T1D admitted for surgery or acute illness.

8. Subcutaneous insulin regimens including pre-prandial rapid-acting insulin administration are suggested in people with T1D hospitalised for an acute illness who are able to eat.

9. Allowing hospitalised adults with T1D to self-administer subcutaneous insulin is suggested, provided they have the capacity and desire to do so and it is deemed clinically safe. Similarly,

permitting this practice in hospitalised children and young people with T1D is suggested; if the child cannot self-administer, involving their parents or main carers in insulin administration is suggested, provided they possess the required knowledge and child safety is ensured. This practice supports continuity of diabetes self-management, reduces distress for the young person and family, and facilitates a smooth transition home at discharge.

10. Continuing sensor use during hospital admission is suggested in people with T1D using continuous interstitial glucose monitoring (both real-time and Flash/IsCGM), provided it is feasible and does not interfere with medical care.

11. Continuing pump therapy during hospitalisation is suggested in people with T1D using a continuous subcutaneous insulin infusion (CSII) pump, provided clinical status allows and the individual or a trained carer can manage the device. The healthcare team must oversee pump function and make adjustments according to patient needs.

12. Consulting a specialist multidisciplinary diabetes team is suggested if the attending clinical team lacks expertise in T1D management to optimise inpatient care.

13. During hospitalisation, respecting and valuing the patient's expertise in managing their own diabetes is suggested, integrating them into routine blood glucose monitoring and insulin administration on the ward.

14. During hospitalisation, supporting people with T1D to choose their own meals based on personal knowledge of their nutritional needs is suggested, except when acute illness or surgical/medical procedures significantly alter dietary requirements.

15. In all adults with T1D at risk of stroke, optimal insulin therapy—achieved via intravenous insulin and glucose infusion—is suggested. Emergency and acute care departments should have established clinical protocols for this pathway.

Rationale

The GDG formulated GCP points as no direct scientific trial evidence was identified to address the research question. These recommendations, based on GDG clinical consensus and aligned with NICE guidelines (428), aim to promote safe and effective clinical care during hospital admission for people with T1D.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-8

References

- Holt RIG, DeVries JH, Hess-Fischl A, Hirsch IB, Kirkman MS, Klupa T, et al. The management of type 1 diabetes in adults. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetologia. diciembre de 2021;64(12):2609-52. DOI: 10.1007/s00125-021-05568-3

- National Institute for Health and Care Excellence (NICE). Type 1 diabetes in adults: diagnosis and management (NG17) [Internet]. 2018 p. 1-87. Report No.: August 2015. Disponible en: www.nice.org.uk/guidance/ng17
- Mendez CE, Umpierrez GE. Management of Type 1 Diabetes in the Hospital Setting. Curr Diab Rep. octubre de 2017;17(10):98. DOI: 10.1007/s11892-017-0919-7
- Barajas-Galindo DE, Pintor-de La Maza B, Cano-Rodríguez I, Ballesteros-Pomar MD. Valoración de hospitalizaciones en pacientes con diabetes con herramientas de sistemas de información clínica. Endocrinol Diabetes Nutr. junio de 2021;68(6):444-6. DOI: 10.1016/j.endinu.2020.03.009

6.2. Sick-Day Management

People with T1D whose metabolic control is within recommended target ranges do not face a higher overall risk of acute intercurrent infectious illnesses than healthy individuals. However, among the most frequent acute infectious conditions are upper/lower respiratory tract infections, urinary tract infections, and bacterial skin or mucosal infections (431,432).

The onset of an intercurrent illness can lead to acute hyperglycaemic decompensation (blood glucose ≥ 250–300 mg/dL [13.9–16.7 mmol/L]) and precipitate diabetic ketoacidosis (DKA) (433).

Clinical management depends on the degree of hyperglycaemia, the individual's routine insulin regimen, and the presence and severity of ketonaemia. Nevertheless, intensive capillary blood glucose monitoring and routine ketone testing are generally required in all cases (2).

When acute intercurrent illnesses occur, healthcare professionals involved in T1D care must provide clear guidance on "sick-day rules" and diabetes management during illness. These guidelines must be reinforced periodically to prevent acute complications such as ketosis, diabetic ketoacidosis, dehydration, severe hyperglycaemia, and hypoglycaemia (434).

Question

- What are the recommended preventive and therapeutic measures in people with T1D during acute intercurrent illnesses in outpatient settings?

This question was divided into four specific sub-questions based on the interventions identified in the scientific literature according to the predefined selection criteria:

- *Should direct telephone contact be used to prevent metabolic decompensation during acute intercurrent illness in people with T1D?*
- *Should people with T1D receive an educational intervention to prevent or improve the management of metabolic decompensation during outpatient acute intercurrent illness?*
- *Should blood 3-hydroxybutyrate testing be used instead of urine ketone testing for monitoring ketonaemia to prevent diabetic ketoacidosis in people with T1D experiencing an outpatient acute intercurrent illness?*
- *Should other preventive and therapeutic measures for metabolic decompensation be used in people with T1D experiencing an outpatient acute intercurrent illness?*

6.2.1. Direct Telephone Access

Sub-question

- Should direct telephone contact be used in people with T1D to prevent metabolic decompensation during acute intercurrent illness?

Recommendations

GOOD CLINICAL PRACTICE

1. In people with T1D experiencing an outpatient acute intercurrent illness, the use of a direct telephone or digital communication channel with their diabetes specialist team during extended hours is suggested to prevent metabolic decompensation.

Rationale

A GCP point in favour of using a direct communication line to prevent metabolic decompensation during acute intercurrent illness in people with T1D was formulated. The GDG considered the expected magnitude of desirable and undesirable effects to be uncertain. The overall certainty of evidence was rated as very low. The GDG decided to formulate this GCP recommendation based on the available scientific evidence to promote the prevention of metabolic decompensation during acute illness in people with T1D.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-9

References

- American Diabetes Association. Standards of Care in Diabetes-2025. Diabetes Care [Internet]. 2025;48(Supplement_1). Disponible en: https://diabetesjournals.org/care/issue/48/Supplement_1
- Giwa AM, Ahmed R, Omidian Z, Majety N, Karakus KE, Omer SM, et al. Current understandings of the pathogenesis of type 1 diabetes: Genetics to environment. World J Diabetes. 15 de enero de 2020;11(1):13-25. DOI: 10.4239/wjd.v11.i1.13
- Piccolo G, De Rose EL, Bassi M, Napoli F, Minuto N, Maghnie M, et al. Infectious diseases associated with pediatric type 1 diabetes mellitus: A narrative review. Front Endocrinol. 24 de agosto de 2022;13:966344. DOI: 10.3389/fendo.2022.966344
- Codina Marcet M, Minas Ribas. Complicaciones agudas de la diabetes mellitus:cetoacidosis diabética y estado hiperglucémico hiperosmolar en pacientes diabéticos adultos. Manual de Endocrinología y Nutrición. SEEN; 2018.
- Lázaro Martínez JL, Almaraz MC, Álvarez Hermida Á, Blanes Mompó I, Escudero Rodríguez JR, García Morales EA, et al. Consensus document on actions to prevent and to improve the management of the diabetic foot in Spain. Endocrinol Diabetes Nutr. 2021;68(7):509-13. DOI: 10.1016/J.ENDINU.2020.08.001

- Farrell K, Holmes-Walker DJ. Mobile phone support is associated with reduced ketoacidosis in young adults. Diabet Med. agosto de 2011;28(8):1001-4. DOI: 10.1111/j.1464-5491.2011.03302.x
- Silverstein J, Klingensmith G, Copeland K, Plotnick L, Kaufman F, Laffel L, et al. Care of Children and Adolescents With Type 1 Diabetes: A statement of the American Diabetes Association. Diabetes Care. 1 de enero de 2005;28(1):186-212. DOI: 10.2337/diacare.28.1.186
- Grupo de trabajo de la Guia Clínica sobre Diabetes mellitus tipo 1. Guía de Práctica Clínica sobre Diabetes mellitus Tipo 1 [Internet]. Agencia de Evaluacion de Tecnologias Sanitarias del País Vasco. Vitoria-Gasteiz: Ministerio De Sanidad, Servicios Sociales E Igualdad. Servicio Central de Publicaciones del Gobierno Vasco.; 2012. 345 p. Disponible en: http://www.guiasalud.es/GPC/GPC_513_Diabetes_1_Osteba_compl.pdf
- Phelan H, Hanas R, Hofer SE, James S, Landry A, Lee W, et al. Sick day management in children and adolescents with diabetes. Pediatr Diabetes. noviembre de 2022;23(7):912-25. DOI: 10.1111/pedi.13415

6.2.2. Educational Intervention

Sub-question

Should people with T1D receive an educational intervention to prevent or improve the management of metabolic decompensation during outpatient acute intercurrent illness?

Recommendations

WEAK RECOMMENDATION, IN FAVOUR

1. It is suggested that all people with T1D, as well as their families or carers, receive therapeutic education focused on the identification, prevention, and management of acute complications during intercurrent illness—including ketosis, diabetic ketoacidosis, and other potential causes of metabolic decompensation—to prevent hospital admissions.

2. In people with T1D experiencing an outpatient acute intercurrent illness, implementing educational interventions is suggested to prevent hospital admissions due to metabolic decompensations such as diabetic ketoacidosis.

Rationale

Two weak recommendations in favour were made. The first suggests that all people with T1D, along with their families or carers, receive therapeutic education to prevent, identify, and manage acute complications during intercurrent illness; the second suggests that individuals with T1D receive educational interventions during an acute intercurrent illness to prevent and/or manage metabolic decompensation. The GDG considered the expected desirable effects to be large, demonstrating a reduction in hospital admissions for diabetic ketoacidosis, although the certainty of evidence was rated as low.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-9

References

- American Diabetes Association. Standards of Care in Diabetes-2025. Diabetes Care [Internet]. 2025;48(Supplement_1). Disponible en: https://diabetesjournals.org/care/issue/48/Supplement_1
- National Institute for Health and Care Excellence (NICE). Type 1 diabetes in adults: diagnosis and management (NG17) [Internet]. 2018 p. 1-87. Report No.: August 2015. Disponible en: www.nice.org.uk/guidance/ng17
- Giwa AM, Ahmed R, Omidian Z, Majety N, Karakus KE, Omer SM, et al. Current understandings of the pathogenesis of type 1 diabetes: Genetics to environment. World J Diabetes. 15 de enero de 2020;11(1):13-25. DOI: 10.4239/wjd.v11.i1.13
- Piccolo G, De Rose EL, Bassi M, Napoli F, Minuto N, Maghnie M, et al. Infectious diseases associated with pediatric type 1 diabetes mellitus: A narrative review. Front Endocrinol. 24 de agosto de 2022;13:966344. DOI: 10.3389/fendo.2022.966344
- Codina Marcet M, Minas Ribas. Complicaciones agudas de la diabetes mellitus.cetoacidosis diabética y estado hiperglucémico hiperosmolar en pacientes diabéticos adultos. Manual de Endocrinología y Nutrición. SEEN; 2018.
- Lázaro Martínez JL, Almaraz MC, Álvarez Hermida Á, Blanes Mompó I, Escudero Rodríguez JR, García Morales EA, et al. Consensus document on actions to prevent and to improve the management of the diabetic foot in Spain. Endocrinol Diabetes Nutr. 2021;68(7):509-13. DOI: 10.1016/J.ENDINU.2020.08.001
- Silverstein J, Klingensmith G, Copeland K, Plotnick L, Kaufman F, Laffel L, et al. Care of Children and Adolescents With Type 1 Diabetes: A statement of the American Diabetes Association. Diabetes Care. 1 de enero de 2005;28(1):186-212. DOI: 10.2337/diacare.28.1.186
- Grupo de trabajo de la Guia Clínica sobre Diabetes mellitus tipo 1. Guía de Práctica Clínica sobre Diabetes mellitus Tipo 1 [Internet]. Agencia de Evaluacion de Tecnologias Sanitarias del País Vasco. Vitoria-Gasteiz: Ministerio De Sanidad, Servicios Sociales E Igualdad. Servicio Central de Publicaciones del Gobierno Vasco.; 2012. 345 p. Disponible en: http://www.guiasalud.es/GPC/GPC_513_Diabetes_1_Osteba_compl.pdf
- Phelan H, Hanas R, Hofer SE, James S, Landry A, Lee W, et al. Sick day management in children and adolescents with diabetes. Pediatr Diabetes. noviembre de 2022;23(7):912-25. DOI: 10.1111/pedi.13415
- Vitale RJ, Card CE, Lichtman JH, Weyman K, Michaud C, Sikes K, et al. An Effective Diabetic Ketoacidosis Prevention Intervention in Children With Type 1 Diabetes. SAGE Open Nurs. 2018;4:2377960818804742. DOI: 10.1177/2377960818804742
- Deeb A, Yousef H, Abdelrahman L, Tomy M, Suliman S, Attia S, et al. Implementation of a Diabetes Educator Care Model to Reduce Paediatric Admission for Diabetic Ketoacidosis. J Diabetes Res. 2016;2016:3917806. DOI: 10.1155/2016/3917806

6.2.3. Laboratory Investigations

Sub-question

- Should blood 3-hydroxybutyrate testing be used in people with T1D experiencing an outpatient acute intercurrent illness instead of urine ketone testing for monitoring ketonaemia to prevent diabetic ketoacidosis?

Recommendations

WEAK RECOMMENDATION, IN FAVOUR

1. In people with T1D experiencing an outpatient acute intercurrent illness, capillary blood 3-hydroxybutyrate testing is suggested over urine ketone testing for monitoring ketosis and preventing diabetic ketoacidosis.

Implementation Considerations:

The availability and accessibility of capillary blood 3-hydroxybutyrate test meters and strips needs to be ensured across all healthcare settings—particularly in areas where access may be constrained—to guarantee appropriate monitoring for people with T1D during intercurrent illness episodes.

Furthermore, strengthening health education for people with T1D and their carers regarding when and how to measure ketones is recommended, as well as instructing them on result interpretation and immediate clinical action steps for elevated readings. Emerging technologies, such as continuous ketone monitoring (CKM), may offer additional clinical benefits in the future, but require robust evaluation prior to routine implementation.

Rationale

A weak recommendation was made in favour of capillary blood 3-hydroxybutyrate testing to monitor ketonaemia end prevent diabetic ketoacidosis. The GDG considered the magnitude of expected desirable effects to be large, owing to a reduction in visits and hospitalisations for diabetic ketoacidosis. The overall certainty of evidence was rated as low.

The GDG agrees on the importance of reinforcing education regarding ketone monitoring, given the limited awareness and utilisation among people living with T1D. Emerging technologies—such as continuous ketone monitoring or multi-analyte biosensors combining glucose and β-hydroxybutyrate—show promising potential for early detection of ketonaemia and DKA risk reduction. However, current evidence is primarily derived from technical validation studies and expert consensus, lacking conclusive data on clinical hard outcomes or cost-effectiveness. Consequently, the GDG considers it premature to recommend their routine use in clinical practice, while acknowledging their relevance for future updates of this CPG.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-9

References

- American Diabetes Association. Standards of Care in Diabetes-2025. Diabetes Care [Internet]. 2025;48(Supplement_1). Disponible en: https://diabetesjournals.org/care/issue/48/Supplement_1
- Giwa AM, Ahmed R, Omidian Z, Majety N, Karakus KE, Omer SM, et al. Current understandings of the pathogenesis of type 1 diabetes: Genetics to environment. World J Diabetes. 15 de enero de 2020;11(1):13-25. DOI: 10.4239/wjd.v11.i1.13

- Piccolo G, De Rose EL, Bassi M, Napoli F, Minuto N, Maghnie M, et al. Infectious diseases associated with pediatric type 1 diabetes mellitus: A narrative review. Front Endocrinol. 24 de agosto de 2022;13:966344. DOI: 10.3389/fendo.2022.966344
- Codina Marcet M, Minas Ribas. Complicaciones agudas de la diabetes mellitus.cetoacidosis diabética y estado hiperglucémico hiperosmolar en pacientes diabéticos adultos. Manual de Endocrinología y Nutrición. SEEN; 2018.
- Lázaro Martínez JL, Almaraz MC, Álvarez Hermida Á, Blanes Mompó I, Escudero Rodríguez JR, García Morales EA, et al. Consensus document on actions to prevent and to improve the management of the diabetic foot in Spain. Endocrinol Diabetes Nutr. 2021;68(7):509-13. DOI: 10.1016/J.ENDINU.2020.08.001
- Grupo de trabajo de la Guia Clínica sobre Diabetes mellitus tipo 1. Guía de Práctica Clínica sobre Diabetes mellitus Tipo 1 [Internet]. Agencia de Evaluacion de Tecnologias Sanitarias del País Vasco. Vitoria-Gasteiz: Ministerio De Sanidad, Servicios Sociales E Igualdad. Servicio Central de Publicaciones del Gobierno Vasco.; 2012. 345 p. Disponible en: http://www.guiasalud.es/GPC/GPC_513_Diabetes_1_Osteba_compl.pdf
- Phelan H, Hanas R, Hofer SE, James S, Landry A, Lee W, et al. Sick day management in children and adolescents with diabetes. Pediatr Diabetes. noviembre de 2022;23(7):912-25. DOI: 10.1111/pedi.13415
- Brink SJ. Paediatric and adolescent diabetic ketoacidosis. Pract Diabetes. 2014;31(8):342-347a. DOI: 10.1002/pdi.1899
- Laffel L. Ketone bodies: a review of physiology, pathophysiology and application of monitoring to diabetes. Diabetes Metab Res Rev. 1999;15(6):412-26. DOI: 10.1002/(sici)1520-7560(199911/12)15:6<412::aid-dmrr72>3.0.co;2-8
- Laffel LMB, Wentzell K, Loughlin C, Tovar A, Moltz K, Brink S. Sick day management using blood 3-hydroxybutyrate (3-OHB) compared with urine ketone monitoring reduces hospital visits in young people with T1DM: a randomized clinical trial. Diabet Med J Br Diabet Assoc. marzo de 2006;23(3):278-84. DOI: 10.1111/j.1464-5491.2005.01771.x

6.2.4. Other Measures

Sub-question

- Should other preventive and therapeutic measures for metabolic decompensation be used in people with T1D experiencing an outpatient acute intercurrent illness?

Recommendations

GOOD CLINICAL PRACTICE

1. In people with T1D experiencing an outpatient acute intercurrent illness, frequent glucose assessment via continuous interstitial glucose monitoring or, failing that, capillary blood glucose testing every 3–4 hours (including overnight) and occasionally every 1–2 hours is suggested to prevent acute complications. In addition, adjusting insulin doses and ensuring adequate food and fluid intake is suggested.

2. In people with T1D experiencing an outpatient acute intercurrent illness, increasing or decreasing insulin doses may be required to adapt to changes in glucose metabolism during

illness; however, insulin therapy must NEVER be stopped. Even with reduced oral intake or complete fasting, basal insulin requirements must always be maintained. These dose adjustments are closely linked to the frequency of glucose and ketone monitoring.

3. In people with T1D experiencing an outpatient acute intercurrent illness, maintaining adequate fluid intake—incorporating not only water but also electrolyte solutions, particularly in the presence of vomiting or diarrhoea—is suggested. In the paediatric population, considering the use of oral rehydration solutions (ORS) is recommended.

4. In people with T1D experiencing an outpatient acute intercurrent illness, checking for potential sensor interference with certain medications prescribed during acute illness (e.g. paracetamol/acetaminophen) is suggested. In such cases, continuous glucose monitoring should be supplemented with capillary blood glucose testing.

5. In people with T1D experiencing an outpatient acute intercurrent illness who use hybrid closed-loop systems, it's suggested to evaluate the need for manual insulin boluses or temporary profile increases, depending on the specific system algorithm.

Rationale

A series of GCP points in favour of other preventive and therapeutic measures for metabolic decompensation in people with T1D were formulated. The GDG considered the expected magnitude of desirable effects to be large. No studies reporting on these specific primary outcomes were identified. The overall certainty of evidence was rated as very low.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-9

References

- American Diabetes Association. Standards of Care in Diabetes-2025. Diabetes Care [Internet]. 2025;48(Supplement_1). Disponible en: https://diabetesjournals.org/care/issue/48/Supplement_1
- Libman I, Haynes A, Lyons S, Pradeep P, Rwagasor E, Tung JY, et al. Clinical Practice Consensus Guidelines 2022: Definition, epidemiology, and classification of diabetes in children and adolescents. Pediatr Diabetes. diciembre de 2022;23(8):1160-74. DOI: 10.1111/pedi.13454
- National Institute for Health and Care Excellence. 2022 exceptional surveillance of diabetes (type 1 and type 2) in children and young people: diagnosis and management (NICE guideline NG18) [Internet]. London: National Institute for Health and Care Excellence (NICE); 2022 [citado 27 de noviembre de 2023]. Disponible en: http://www.ncbi.nlm.nih.gov/books/NBK584374/ DOI: 978-1-4731-4409-5
- Holt RIG, DeVries JH, Hess-Fischl A, Hirsch IB, Kirkman MS, Klupa T, et al. The management of type 1 diabetes in adults. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetologia. diciembre de 2021;64(12):2609-52. DOI: 10.1007/s00125-021-05568-3

- Grupo de trabajo de la Guia Clínica sobre Diabetes mellitus tipo 1. Guía de Práctica Clínica sobre Diabetes mellitus Tipo 1. Plan de Calidad para el Sistema Nacional de Salud del Ministerio de Sanidad y Política Social. Agencia Evaluacion Tecnol Sanit País Vasco. 2012;345.
- Fröhlich-Reiterer E, Elbarbary NS, Simmons K, Buckingham B, Humayun KN, Johannsen J, et al. ISPAD Clinical Practice Consensus Guidelines 2022: Other complications and associated conditions in children and adolescents with type 1 diabetes. Pediatr Diabetes. diciembre de 2022;23(8):1451-67. DOI: 10.1111/pedi.13445
- National Institute for Health and Care Excellence (NICE). Type 1 diabetes in adults: diagnosis and management (NG17) [Internet]. 2018 p. 1-87. Report No.: August 2015. Disponible en: www.nice.org.uk/guidance/ng17
- Giwa AM, Ahmed R, Omidian Z, Majety N, Karakus KE, Omer SM, et al. Current understandings of the pathogenesis of type 1 diabetes: Genetics to environment. World J Diabetes. 15 de enero de 2020;11(1):13-25. DOI: 10.4239/wjd.v11.i1.13
- Piccolo G, De Rose EL, Bassi M, Napoli F, Minuto N, Maghnie M, et al. Infectious diseases associated with pediatric type 1 diabetes mellitus: A narrative review. Front Endocrinol. 24 de agosto de 2022;13:966344. DOI: 10.3389/fendo.2022.966344
- Codina Marcet M, Minas Ribas. Complicaciones agudas de la diabetes mellitus: cetoacidosis diabética y estado hiperglucémico hiperosmolar en pacientes diabéticos adultos. Manual de Endocrinología y Nutrición. SEEN; 2018.
- Lázaro Martínez JL, Almaraz MC, Álvarez Hermida Á, Blanes Mompó I, Escudero Rodríguez JR, García Morales EA, et al. Consensus document on actions to prevent and to improve the management of the diabetic foot in Spain. Endocrinol Diabetes Nutr. 2021;68(7):509-13. DOI: 10.1016/J.ENDINU.2020.08.001
- Phelan H, Hanas R, Hofer SE, James S, Landry A, Lee W, et al. Sick day management in children and adolescents with diabetes. Pediatr Diabetes. noviembre de 2022;23(7):912-25. DOI: 10.1111/pedi.13415
- Castellanos L, Tuffaha M, Koren D, Levitsky LL. Management of Diabetic Ketoacidosis in Children and Adolescents with Type 1 Diabetes Mellitus. Pediatr Drugs. 1 de agosto de 2020;22(4):357-67. DOI: 10.1007/s40272-020-00397-0

6.3. Transition from Paediatric to Adult Care Services

T1D is one of the most common chronic conditions in the paediatric population (30). With the onset of adolescence, young patients previously managed within paediatric services begin their transfer to adult endocrinology and diabetes services. This transition takes place during a critical life stage characterised by distinct physiological and psychological changes. Moreover, adolescence is associated with an increased risk of developing and progressive chronic microvascular/macrovascular complications, as well as a higher incidence of diabetes-related hospital admissions (445–447).

During childhood, treatment management rests primarily with the family; however, as individuals progress towards adulthood, responsibility is gradually transferred to the patient. The primary objective during the transition period is to build adequate self-management skills, facilitating the shift from the dependency characteristic of childhood and adolescence towards the self-autonomy required in adult life. This transfer of responsibility can represent an abrupt shift for both young people and their carers.

Studies have documented loss to follow-up during transfer to adult care units if the transition process is not managed effectively (448,449), alongside deterioration in glycaemic control (450,451). A recent qualitative study reported that young people with T1D felt unprepared for differences in care delivery and were predominantly less satisfied with the follow-up care provided in adult services (452).

This section evaluates the scientific evidence and provides clinical recommendations regarding specific interventions for managing T1D during the transition from paediatric to adult care services.

Question

- *What should the specific interventions be for managing T1D during the transition period from paediatric to adult care services?*

This question was divided into two specific sub-questions based on the interventions identified in the scientific literature according to the predefined selection criteria:

- *Should a structured therapeutic education programme be implemented during this process in people with T1D transitioning from paediatric to adult care?*
- *Should an appointment management programme be used in people with T1D transitioning from paediatric to adult care?*

6.3.1. Structured Therapeutic Education Programme in Transition

Sub-questioi

- Should a structured therapeutic education programme in transition be used in people with T1D transitioning from paediatric to adult care?

Recommendations

WEAK RECOMMENDATION, IN FAVOUR

1. In young people with T1D during early adolescence, the implementation of a dedicated transition plan in the paediatric service itself is suggested, encouraging greater patient autonomy and preparing young people and their families for the transfer of care.
2. In adolescents with T1D during the final year prior to transfer to adult services, a joint transfer plan between the referring (paediatric) and receiving (adult) care teams—involving both medical and specialist nursing staff—is suggested.

Rationale

Considering the expected desirable clinical effects, the GDG formulated weak recommendations in favour of implementing transition plans, both during early adolescence in paediatric services and during the final year prior to transfer to adult services. These plans aim to foster greater patient self-autonomy and prepare adolescents and their families for the transition process. The overall certainty of evidence was rated as very low.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-10

References

- Atkinson MA, Eisenbarth GS, Michels AW. Type 1 diabetes. The Lancet. enero de 2014;383(9911):69-82. DOI: 10.1016/S0140-6736(13)60591-7
- Holt RIG, DeVries JH, Hess-Fischl A, Hirsch IB, Kirkman MS, Klupa T, et al. The management of type 1 diabetes in adults. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetologia. diciembre de 2021;64(12):2609-52. DOI: 10.1007/s00125-021-05568-3
- Petitti DB, Klingensmith GJ, Bell RA, Andrews JS, Dabelea D, Imperatore G, et al. Glycemic Control in Youth with Diabetes: The SEARCH for Diabetes in Youth Study. J Pediatr. noviembre de 2009;155(5):668-672.e3. DOI: 10.1016/j.jpeds.2009.05.025
- Modern-Day Clinical Course of Type 1 Diabetes Mellitus After 30 Years' Duration: The Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications and Pittsburgh Epidemiology of Diabetes Complications Experience (1983-2005). Arch Intern Med. 27 de julio de 2009;169(14):1307. DOI: 10.1001/archinternmed.2009.193
- Bryden KS, Dunger DB, Mayou RA, Peveler RC, Neil HAW. Poor Prognosis of Young Adults With Type 1 Diabetes: a longitudinal study. Diabetes Care. 1 de abril de 2003;26(4):1052-7. DOI: 10.2337/diacare.26.4.1052
- Daneman D, Nakhlay M. Moving on: transition of teens with type 1 diabetes to adult care. Diabetes Spectr. 2011;24:14-8. DOI: 10.2337/diaspect.24.1.14
- Peters A, Laffel L, the American Diabetes Association Transitions Working Group. Diabetes Care for Emerging Adults: Recommendations for Transition From Pediatric to Adult Diabetes Care Systems. Diabetes Care. 1 de noviembre de 2011;34(11):2477-85. DOI: 10.2337/dc11-1723
- Martín-Frías M, Álvarez MA, Yelmo R, Alonso M, Barrio R. Evaluación de la transición desde la Unidad de Diabetes Pediátrica a la de Adultos en adolescentes con diabetes mellitus tipo 1. An Pediatría. diciembre de 2014;81(6):389-92. DOI: 10.1016/j.anpedi.2013.10.048
- Cadario F, Prodam F, Bellone S, Trada M, Binotti M, Trada M, et al. Transition process of patients with type 1 diabetes (T1DM) from paediatric to the adult health care service: a hospital-based approach. Clin Endocrinol (Oxf). septiembre de 2009;71(3):346-50. DOI: 10.1111/j.1365-2265.2008.03467.x
- Iversen E, Kolltveit BCH, Hernar I, Mårtensson J, Haugstvedt A. Transition from paediatric to adult care: a qualitative study of the experiences of young adults with type 1 diabetes. Scand J Caring Sci. septiembre de 2019;33(3):723-30. DOI: 10.1111/scs.12668
- Spaic T, Robinson T, Goldbloom E, Gallego P, Hramiak I, Lawson ML, et al. Closing the Gap: Results of the Multicenter Canadian Randomized Controlled Trial of Structured Transition in Young Adults With Type 1 Diabetes. Diabetes Care. junio de 2019;42(6):1018-26. DOI: 10.2337/dc18-2187
- Steinbeck KS, Shrewsbury VA, Harvey V, Mikler K, Donaghue KC, Craig ME, et al. A pilot randomized controlled trial of a post-discharge program to support emerging adults with type 1 diabetes mellitus transition from pediatric to adult care. Pediatr Diabetes. diciembre de 2015;16(8):634-9. DOI: 10.1111/pedi.12229

- Sequeira PA, Pyatak EA, Weigensberg MJ, Vigen CP, Wood JR, Ruelas V, et al. Let's Empower and Prepare (LEAP): Evaluation of a Structured Transition Program for Young Adults With Type 1 Diabetes. Diabetes Care. agosto de 2015;38(8):1412-9. DOI: 10.2337/dc14-2577
- Schmidt S, Herrmann-Garitz C, Bomba F, Thyen U. A multicenter prospective quasi-experimental study on the impact of a transition-oriented generic patient education program on health service participation and quality of life in adolescents and young adults. Patient Educ Couns. marzo de 2016;99(3):421-8. DOI: 10.1016/j.pec.2015.10.024
- Vidal Flor M, Jansà I Morató M, Roca Espino D, Viñals Domenech C, Quirós López C, Mesa Pineda Á, et al. Resultados de un programa específico y estructurado en la transición de pacientes jóvenes con diabetes tipo 1 desde pediatría a un hospital de adultos. La experiencia de una década. Endocrinol Diabetes Nutr. febrero de 2021;68(2):82-91. DOI: 10.1016/j.endinu.2020.06.001
- Walsh Ó, Wynne M, O' Donnell M, O'Hara MC, Geoghegan R. The Perceptions of Patients, their Parents and Healthcare Providers on the Transition of Young Adults with Type 1 Diabetes to Adult Services in the West of Ireland. Ir Med J. agosto de 2018;111(7):787.
- Hanna KM, Woodward J. The transition from pediatric to adult diabetes care services. Clin Nurse Spec. 2013;27(3):132-45. DOI: 10.1097/NUR.0b013e31828c8372
- Williams S, Shulman R, Allwood Newhook LA, Power H, Guttmann A, Smith S, et al. A province wide review of transition practices for young adult patients with type 1 diabetes. J Eval Clin Pract. febrero de 2021;27(1):111-8. DOI: 10.1111/jep.13399
- Perry L, Lowe JM, Steinbeck KS, Dunbabin JS. Services doing the best they can: service experiences of young adults with type 1 diabetes mellitus in rural Australia. J Clin Nurs. julio de 2012;21(13-14):1955-63. DOI: 10.1111/j.1365-2702.2011.04012.x
- Garvey KC, Beste MG, Luff D, Atakov-Castillo A, Wolpert HA, Ritholz MD. Experiences of health care transition voiced by young adults with type 1 diabetes: a qualitative study. Adolesc Health Med Ther. 2014;5:191-8. DOI: 10.2147/AHMT.S67943
- Butalia S, McGuire KA, Dyjur D, Mercer J, Pacaud D. Youth with diabetes and their parents' perspectives on transition care from pediatric to adult diabetes care services: A qualitative study. Health Sci Rep. septiembre de 2020;3(3):e181. DOI: 10.1002/hsr2.181
- Pierce JS, Aroian K, Schifano E, Milkes A, Schwindt T, Gannon A, et al. Health Care Transition for Young Adults With Type 1 Diabetes: Stakeholder Engagement for Defining Optimal Outcomes. J Pediatr Psychol. octubre de 2017;42(9):970-82. DOI: 10.1093/jpepsy/jsx076
- Hilliard ME, Perlus JG, Clark LM, Haynie DL, Plotnick LP, Guttmann-Bauman I, et al. Perspectives from before and after the pediatric to adult care transition: a mixed-methods study in type 1 diabetes. Diabetes Care. febrero de 2014;37(2):346-54. DOI: 10.2337/dc13-1346
- Leung JMWS, Tang TS, Lim CE, Laffel LM, Amed S. The four I's of adolescent transition in type 1 diabetes care: A qualitative study. Diabet Med. julio de 2021;38(7):e14443. DOI: 10.1111/dme.14443
- Lundin CS, Danielson E, Ohrn I. Handling the transition of adolescents with diabetes: participant observations and interviews with care providers in paediatric and adult diabetes outpatient clinics. Int J Integr Care. febrero de 2007;7:e05. DOI: 10.5334/ijic.178
- Nakhla M, Bell LE, Wafa S, Dasgupta K. Improving the transition from pediatric to adult diabetes care: the pediatric care provider's perspective in Quebec, Canada. BMJ Open Diabetes Res Care. 2017;5(1):e000390. DOI: 10.1136/bmjdrc-2017-000390

- Tremblay ES, Ruiz J, Buccigrosso T, Dean T, Garvey K. Health Care Transition in Youth With Type 1 Diabetes and an A1C >9%: Qualitative Analysis of Pre-Transition Perspectives. Diabetes Spectr. noviembre de 2020;33(4):331-8. DOI: 10.2337/ds20-0011
- Price CS, Corbett S, Lewis-Barned N, Morgan J, Oliver LE, Dovey-Pearce G. Implementing a transition pathway in diabetes: a qualitative study of the experiences and suggestions of young people with diabetes. Child Care Health Dev. noviembre de 2011;37(6):852-60. DOI: 10.1111/j.1365-2214.2011.01241.x
- Harris M, James S, Perry L, Lowe J, Dunbabin J, Steinbeck K. Health care professionals talking: Are services for young adults with type 1 diabetes fit for purpose? J Eval Clin Pract. febrero de 2020;26(1):335-42. DOI: 10.1111/jep.13210
- Rasmussen B, Ward G, Jenkins A, King SJ, Dunning T. Young adults' management of Type 1 diabetes during life transitions. J Clin Nurs. julio de 2011;20(13-14):1981-92. DOI: 10.1111/j.1365-2702.2010.03657.x
- Ng AH, Crowe TC, Ball K, Rasmussen B. Transitional Needs of Australian Young Adults With Type 1 Diabetes: Mixed Methods Study. J Med Internet Res Diabetes. noviembre de 2017;2(2):e29. DOI: 10.2196/diabetes.8315
- Holtz BE, Mitchell KM, Holmstrom AJ, Cotten SR, Hershey DD, Dunneback JK, et al. Teen and Parental Perspectives Regarding Transition of Care in Type 1 Diabetes. Child Youth Serv Rev [Internet]. 2020;110(104800). Disponible en: https://www.sciencedirect.com/science/article/abs/pii/S0190740919309314 DOI: https://doi.org/10.1016/j.childyouth.2020.104800
- Pyatak EA, Sequeira PA, Whittemore R, Vigen CP, Peters AL, Weigensberg MJ. Challenges contributing to disrupted transition from paediatric to adult diabetes care in young adults with type 1 diabetes. Diabet Med. diciembre de 2014;31(12):1615-24. DOI: 10.1111/dme.12485

6.3.2. Appointment Management Programme

Sub-question

- Should an appointment management programme be used in people with T1D transitioning from paediatric to adult care?

Recommendations

WEAK RECOMMENDATION, IN FAVOUR

1. Considering the implementation of an appointment management programme precisely at the point of transfer from paediatric to adult care services is suggested in people with T1D.

Rationale

The GDG formulated a weak recommendation in favour of implementing an appointment management programme at the point of transfer from paediatric to adult care services, taking into account the desirable clinical effects and the trivial magnitude of undesirable effects associated with the intervention according to available evidence. Although the overall certainty of evidence is very low, considering this intervention is suggested based on the following clinical rationales:

1. **Potential benefits:** An appointment management programme can facilitate a smoother, more coordinated transition, reducing the risk of care disruption during this critical period.
2. **Mitigation of clinical risks:** The transition from paediatric to adult services represents a high-risk period for young people with T1D, with potential negative consequences for metabolic control and ongoing medical follow-up.
3. **Trivial undesirable effects:** Implementing an appointment management programme carries no significant risks for the patient and poses a minimal administrative burden on the healthcare system.
4. **Individualisation of the transition process:** It enables the timing of transfer to be tailored to the somatic and emotional maturity of each individual, which is crucial to the success of the process.
5. **Enhanced continuity of care:** It can help maintain engagement between the individual with T1D and the multidisciplinary healthcare team, facilitating long-term follow-up and treatment adherence.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-10

References

- Atkinson MA, Eisenbarth GS, Michels AW. Type 1 diabetes. The Lancet. enero de 2014;383(9911):69-82. DOI: 10.1016/S0140-6736(13)60591-7
- Petitti DB, Klingensmith GJ, Bell RA, Andrews JS, Dabelea D, Imperatore G, et al. Glycemic Control in Youth with Diabetes: The SEARCH for Diabetes in Youth Study. J Pediatr. noviembre de 2009;155(5):668-672.e3. DOI: 10.1016/j.jpeds.2009.05.025
- Modern-Day Clinical Course of Type 1 Diabetes Mellitus After 30 Years' Duration: The Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications and Pittsburgh Epidemiology of Diabetes Complications Experience (1983-2005). Arch Intern Med. 27 de julio de 2009;169(14):1307. DOI: 10.1001/archinternmed.2009.193
- Bryden KS, Dunger DB, Mayou RA, Peveler RC, Neil HAW. Poor Prognosis of Young Adults With Type 1 Diabetes. Diabetes Care. 1 de abril de 2003;26(4):1052-7. DOI: 10.2337/diacare.26.4.1052
- Daneman D, Nakhlay M. Moving on: transition of teens with type 1 diabetes to adult care. Diabetes Spectr. 2011;24:14-8. DOI: 10.2337/diaspect.24.1.14
- Peters A, Laffel L, the American Diabetes Association Transitions Working Group. Diabetes Care for Emerging Adults: Recommendations for Transition From Pediatric to Adult Diabetes Care Systems. Diabetes Care. 1 de noviembre de 2011;34(11):2477-85. DOI: 10.2337/dc11-1723
- Martín-Frías M, Álvarez MA, Yelmo R, Alonso M, Barrio R. Evaluación de la transición desde la Unidad de Diabetes Pediátrica a la de Adultos en adolescentes con diabetes mellitus tipo 1. An Pediatría. diciembre de 2014;81(6):389-92. DOI: 10.1016/j.anpedi.2013.10.048
- Cadario F, Prodam F, Bellone S, Trada M, Binotti M, Trada M, et al. Transition process of patients with type 1 diabetes (T1DM) from paediatric to the adult health care service: a hospital-based

approach. Clin Endocrinol (Oxf). septiembre de 2009;71(3):346-50. DOI: 10.1111/j.1365-2265.2008.03467.x

- Iversen E, Kolltveit BCH, Hernar I, Mårtensson J, Haugstvedt A. Transition from paediatric to adult care: a qualitative study of the experiences of young adults with type 1 diabetes. Scand J Caring Sci. septiembre de 2019;33(3):723-30. DOI: 10.1111/scs.12668
- Walsh Ó, Wynne M, O' Donnell M, O'Hara MC, Geoghegan R. The Perceptions of Patients, their Parents and Healthcare Providers on the Transition of Young Adults with Type 1 Diabetes to Adult Services in the West of Ireland. Ir Med J. agosto de 2018;111(7):787.
- Hanna KM, Woodward J. The transition from pediatric to adult diabetes care services. Clin Nurse Spec. 2013;27(3):132-45. DOI: 10.1097/NUR.0b013e31828c8372
- Williams S, Shulman R, Allwood Newhook LA, Power H, Guttmann A, Smith S, et al. A province wide review of transition practices for young adult patients with type 1 diabetes. J Eval Clin Pract. febrero de 2021;27(1):111-8. DOI: 10.1111/jep.13399
- Perry L, Lowe JM, Steinbeck KS, Dunbabin JS. Services doing the best they can: service experiences of young adults with type 1 diabetes mellitus in rural Australia. J Clin Nurs. julio de 2012;21(13-14):1955-63. DOI: 10.1111/j.1365-2702.2011.04012.x
- Garvey KC, Beste MG, Luff D, Atakov-Castillo A, Wolpert HA, Ritholz MD. Experiences of health care transition voiced by young adults with type 1 diabetes: a qualitative study. Adolesc Health Med Ther. 2014;5:191-8. DOI: 10.2147/AHMT.S67943
- Butalia S, McGuire KA, Dyjur D, Mercer J, Pacaud D. Youth with diabetes and their parents' perspectives on transition care from pediatric to adult diabetes care services: A qualitative study. Health Sci Rep. septiembre de 2020;3(3):e181. DOI: 10.1002/hsr2.181
- Pierce JS, Aroian K, Schifano E, Milkes A, Schwindt T, Gannon A, et al. Health Care Transition for Young Adults With Type 1 Diabetes: Stakeholder Engagement for Defining Optimal Outcomes. J Pediatr Psychol. octubre de 2017;42(9):970-82. DOI: 10.1093/jpepsy/jsx076
- Hilliard ME, Perlus JG, Clark LM, Haynie DL, Plotnick LP, Guttmann-Bauman I, et al. Perspectives from before and after the pediatric to adult care transition: a mixed-methods study in type 1 diabetes. Diabetes Care. febrero de 2014;37(2):346-54. DOI: 10.2337/dc13-1346
- Leung JMWS, Tang TS, Lim CE, Laffel LM, Amed S. The four I's of adolescent transition in type 1 diabetes care: A qualitative study. Diabet Med. julio de 2021;38(7):e14443. DOI: 10.1111/dme.14443
- Lundin CS, Danielson E, Ohrn I. Handling the transition of adolescents with diabetes: participant observations and interviews with care providers in paediatric and adult diabetes outpatient clinics. Int J Integr Care. febrero de 2007;7:e05. DOI: 10.5334/ijic.178
- Nakhla M, Bell LE, Wafa S, Dasgupta K. Improving the transition from pediatric to adult diabetes care: the pediatric care provider's perspective in Quebec, Canada. BMJ Open Diabetes Res Care. 2017;5(1):e000390. DOI: 10.1136/bmjdrc-2017-000390
- Tremblay ES, Ruiz J, Buccigrosso T, Dean T, Garvey K. Health Care Transition in Youth With Type 1 Diabetes and an A1C >9%: Qualitative Analysis of Pre-Transition Perspectives. Diabetes Spectr. noviembre de 2020;33(4):331-8. DOI: 10.2337/ds20-0011
- Price CS, Corbett S, Lewis-Barned N, Morgan J, Oliver LE, Dovey-Pearce G. Implementing a transition pathway in diabetes: a qualitative study of the experiences and suggestions of young people with diabetes. Child Care Health Dev. noviembre de 2011;37(6):852-60. DOI: 10.1111/j.1365-2214.2011.01241.x

- Harris M, James S, Perry L, Lowe J, Dunbabin J, Steinbeck K. Health care professionals talking: Are services for young adults with type 1 diabetes fit for purpose? J Eval Clin Pract. febrero de 2020;26(1):335-42. DOI: 10.1111/jep.13210
- Rasmussen B, Ward G, Jenkins A, King SJ, Dunning T. Young adults' management of Type 1 diabetes during life transitions. J Clin Nurs. julio de 2011;20(13-14):1981-92. DOI: 10.1111/j.1365-2702.2010.03657.x
- Ng AH, Crowe TC, Ball K, Rasmussen B. Transitional Needs of Australian Young Adults With Type 1 Diabetes: Mixed Methods Study. J Med Internet Res Diabetes. noviembre de 2017;2(2):e29. DOI: 10.2196/diabetes.8315
- Holtz BE, Mitchell KM, Holmstrom AJ, Cotten SR, Hershey DD, Dunneback JK, et al. Teen and Parental Perspectives Regarding Transition of Care in Type 1 Diabetes. Child Youth Serv Rev [Internet]. 2020;110(104800). Disponible en: https://www.sciencedirect.com/science/article/abs/pii/S0190740919309314 DOI: https://doi.org/10.1016/j.childyouth.2020.104800
- Pyatak EA, Sequeira PA, Whittemore R, Vigen CP, Peters AL, Weigensberg MJ. Challenges contributing to disrupted transition from paediatric to adult diabetes care in young adults with type 1 diabetes. Diabet Med. diciembre de 2014;31(12):1615-24. DOI: 10.1111/dme.12485
- White M, O'Connell MA, Cameron FJ. Clinic attendance and disengagement of young adults with type 1 diabetes after transition of care from paediatric to adult services (TrACeD): a randomised, open-label, controlled trial. Lancet Child Adolesc Health. diciembre de 2017;1(4):274-83. DOI: 10.1016/S2352-4642(17)30089-5

6.4. Preconception Care

Question

- Are there specific preconception interventions that can be recommended to improve maternal and neonatal outcomes in women with T1D?

Recommendations

STRONG RECOMMENDATION, IN FAVOUR

1. Implementing structured preconception care is recommended to improve maternal and neonatal outcomes in women of childbearing potential with T1D.

GOOD CLINICAL PRACTICE

2. Raising awareness among both healthcare professionals and women with T1D regarding the critical importance of pregnancy planning and integrating preconception care is suggested.

3. Screening for diabetic retinopathy and nephropathy prior to conception is suggested in women with T1D planning a pregnancy.

4. In women with T1D planning a pregnancy, conducting a comprehensive pharmacotherapeutic review and discontinuing or substituting medications where the risk-benefit profile does not justify continued use during pregnancy (e.g. statins or other lipid-lowering agents, angiotensin-

converting enzyme inhibitors [ACEi], angiotensin receptor blockers [ARBs], and other contraindicated antihypertensives) is suggested.

5. Providing detailed pre-pregnancy counselling to women with T1D and diabetic nephropathy to estimate maternal and fetal clinical risks is suggested.

6. Comprehensive clinical evaluation and clear information regarding significant risks associated with pregnancy are suggested in women with T1D and established cardiovascular disease planning a pregnancy.

Rationale

Considering the substantial magnitude of desirable clinical effects, the GDG formulated a strong recommendation in favour of implementing structured preconception care to improve maternal and neonatal outcomes. Although the overall certainty of evidence was rated as low, available data indicate a clinically meaningful reduction in perinatal mortality rates.

In addition, the GDG decided to formulate GCP points to support safe clinical decision-making and optimal management for women with T1D who are planning to conceive.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-11

References

- Balsells M, García-Patterson A, Gich I, Corcoy R. Maternal and fetal outcome in women with type 2 versus type 1 diabetes mellitus: a systematic review and metaanalysis. J Clin Endocrinol Metab. noviembre de 2009;94(11):4284-91. DOI: 10.1210/jc.2009-1231
- Semertzidou A, Grout-Smith H, Kalliala I, Garg A, Terzidou V, Marchesi J, et al. Diabetes and anti-diabetic interventions and the risk of gynaecological and obstetric morbidity: an umbrella review of the literature. BMC Med. 18 de abril de 2023;21(1):152. DOI: 10.1186/s12916-023-02758-1
- Widyaputri F, Rogers SL, Kandasamy R, Shub A, Symons RCA, Lim LL. Global Estimates of Diabetic Retinopathy Prevalence and Progression in Pregnant Women With Preexisting Diabetes: A Systematic Review and Meta-analysis. JAMA Ophthalmol. 1 de mayo de 2022;140(5):486-94. DOI: 10.1001/jamaophthalmol.2022.0050
- Rasmussen B, Hendrieckx C, Clarke B, Botti M, Dunning T, Jenkins A, et al. Psychosocial issues of women with type 1 diabetes transitioning to motherhood: a structured literature review. BMC Pregnancy Childbirth. diciembre de 2013;13(1):218. DOI: 10.1186/1471-2393-13-218
- Wahabi HA, Fayed A, Esmaeil S, Elmorshedy H, Titi MA, Amer YS, et al. Systematic review and meta-analysis of the effectiveness of pre-pregnancy care for women with diabetes for improving maternal and perinatal outcomes. PLOS ONE. 2020;15(8):e0237571. DOI: 10.1371/journal.pone.0237571
- Nakshine VS, Jogdand SD. A Comprehensive Review of Gestational Diabetes Mellitus: Impacts on Maternal Health, Fetal Development, Childhood Outcomes, and Long-Term Treatment Strategies. Cureus [Internet]. 23 de octubre de 2023 [citado 23 de enero de 2025]; Disponible en: https://www.cureus.com/articles/176328-a-comprehensive-review-of-gestational-diabetes-

mellitus-impacts-on-maternal-health-fetal-development-childhood-outcomes-and-long-term-treatment-strategies DOI: 10.7759/cureus.47500

- The Diabetes Control Complications Trial Research Group. Pregnancy outcomes in the Diabetes Control and Complications Trial. Am J Obstet Gynecol. abril de 1996;174(4):1343-53. DOI: 10.1016/S0002-9378(96)70683-X
- Earle S, Tariq A, Komaromy C, Lloyd CE, Karamat MA, Webb J, et al. Preconception care for women with type 1 or type 2 diabetes mellitus: a mixed-methods study exploring uptake of preconception care. Health Technol Assess. marzo de 2017;21(14):1-130. DOI: 10.3310/hta21140
- Griffiths F, Lowe P, Boardman F, Ayre C, Gadsby R. Becoming pregnant: exploring the perspectives of women living with diabetes. Br J Gen Pract. marzo de 2008;58(548):184-90. DOI: 10.3399/bjgp08X277294
- Berg M, Sparud-Lundin C. Experiences of professional support during pregnancy and childbirth – a qualitative study of women with type 1 diabetes. BMC Pregnancy Childbirth. julio de 2009;9:27. DOI: 10.1186/1471-2393-9-27
- Adolfsson A, Jansson M. Prototype for Internet support of pregnant women and mothers with type 1 diabetes: focus group testing. Psychol Res Behav Manag. 2012;5:97-103. DOI: 10.2147/PRBM.S32799
- King R, Wellard S. Juggling type 1 diabetes and pregnancy in rural Australia. Midwifery. abril de 2009;25(2):126-33. DOI: 10.1016/j.midw.2007.01.016
- McGrath M, Chrisler JC. A lot of hard work, but doable: Pregnancy experiences of women with type-1 diabetes. Health Care Women Int. junio de 2017;38(6):571-92. DOI: 10.1080/07399332.2016.1267183
- McCorry NK, Hughes C, Spence D, Holmes VA, Harper R. Pregnancy planning and diabetes: a qualitative exploration of women's attitudes toward preconception care. J Midwifery Womens Health. 2012;57(4):396-402. DOI: 10.1111/j.1542-2011.2011.00143.x

6.5. Management of Complications in Pregnancy

Question

- What should the management of T1D complications be before, during, and after pregnancy?

Recommendations

GOOD CLINICAL PRACTICE

1. Providing detailed counselling to the woman and her partner regarding maternal and neonatal clinical risks prior to making a fully informed decision regarding pregnancy is suggested in women of childbearing potential with T1D who have complications of the disease.

2. Delivering care before and during pregnancy through a multidisciplinary team—including an endocrinologist/diabetologist, an obstetrician, a dietitian-nutritionist, a diabetes specialist nurse (DSN), and a midwife with expertise in diabetes—is suggested to minimise maternal and fetal risks in women with T1D.

3. Frequent blood glucose monitoring and precise insulin dose adjustments to manage and prevent hypoglycaemia are suggested in pregnant women with T1D.

4. Suboptimal glycaemic control, or greater HbA1c reductions during pregnancy, closer retinal surveillance during gestation and in the first year postpartum is suggested in women with T1D and more severe pre-existing retinopathy.

5. Monitoring both the impact of pregnancy on renal function and the effect of kidney disease on pregnancy outcomes is suggested in pregnant women with T1D and diabetic nephropathy. This includes monitoring blood pressure, proteinuria, and renal function.

6. In women with T1D and diabetic nephropathy previously treated with low-dose aspirin, continuing this treatment during pregnancy to prevent pre-eclampsia is suggested. A dosage of 150 mg daily is suggested.

7. Initiating low-dose aspirin therapy after organogenesis to prevent pre-eclampsia is suggested in pregnant women with T1D and diabetic nephropathy. If first-trimester pre-eclampsia risk screening is performed, initiating treatment based on screening results may be considered.

8. Providing detailed information on the benefits and risks of continuing treatment during pregnancy is suggested in women with T1D who have complications of the disease and become pregnant.

Rationale

The GDG decided to formulate GCP points, as insufficient scientific evidence was identified to answer the research question directly. These recommendations aim to support appropriate clinical management before, during, and after pregnancy for women with T1D who have or are at risk of developing chronic complications.

The recommendations are grounded in general principles of good clinical practice, international expert consensus (491), and established evidence on the impact and management of chronic T1D complications during pregnancy—including retinopathy, nephropathy, hypoglycaemia, and cardiovascular disease—alongside associated risk factors and prevention and treatment strategies. The GDG considers the expected desirable effects of these recommended clinical actions to be substantial.

Complete clinical question

For further information on this question, please consult the full guidelines (in Spanish): https://portal.guiasalud.es/guia-en-capas/diabetes_mellitus_tipo_1/#question-12

References

- American Diabetes Association. 15. Management of Diabetes in Pregnancy: Standards of Care in Diabetes—2024. Diabetes Care. enero de 2024;47(Supplement_1):S282-94. DOI: 10.2337/dc24-S015
- Chew EY, Mills JL, Metzger BE, Remaley NA, Jovanovic-Peterson L, Knopp RH, et al. Metabolic Control and Progression of Retinopathy: The Diabetes in Early Pregnancy Study. Diabetes Care. 1 de mayo de 1995;18(5):631-7. DOI: 10.2337/diacare.18.5.631

- Sunness JS, Schechet SA. Diabetic Retinopathy in Pregnancy. JAMA Ophthalmol. 1 de mayo de 2022;140(5):495. DOI: 10.1001/jamaophthalmol.2022.0051
- Diabetes Control and Complications Trial Research Group. Effect of pregnancy on microvascular complications in the diabetes control and complications trial. The Diabetes Control and Complications Trial Research Group. Diabetes Care. 1 de agosto de 2000;23(8):1084-91. DOI: 10.2337/diacare.23.8.1084
- Cundy T, Slee F, Gamble G, Neale L. Hypertensive disorders of pregnancy in women with Type 1 and Type 2 diabetes. Diabet Med. junio de 2002;19(6):482-9. DOI: 10.1046/j.1464-5491.2002.00729.x
- Lövestam-Adrian M, Agardh CD, Åberg A, Agardh E. Pre-eclampsia is a potent risk factor for deterioration of retinopathy during pregnancy in type 1 diabetic patients. Diabet Med. diciembre de 1997;14(12):1059-65. DOI: 10.1002/(SICI)1096-9136(199712)14:12<1059::AID-DIA505>3.0.CO;2-8
- Tulek F, Kahraman A, Taskin S, Ozkavukcu E, Soylemez F. The effects of isolated single umbilical artery on first and second trimester aneuploidy screening test parameters. J Matern Fetal Neonatal Med. 13 de abril de 2015;28(6):690-4. DOI: 10.3109/14767058.2014.928856
- Mathiesen ER, Ringholm L, Feldt-Rasmussen B, Clausen P, Damm P. Obstetric Nephrology: Pregnancy in Women with Diabetic Nephropathy—The Role of Antihypertensive Treatment. Clin J Am Soc Nephrol. diciembre de 2012;7(12):2081-8. DOI: 10.2215/CJN.00920112
- Seaquist ER, Anderson J, Childs B, Cryer P, Dagogo-Jack S, Fish L, et al. Hypoglycemia and Diabetes: A Report of a Workgroup of the American Diabetes Association and The Endocrine Society. Diabetes Care. 1 de mayo de 2013;36(5):1384-95. DOI: 10.2337/dc12-2480
- Mills JL, Knopp RH, Simpson JL, Jovanovic-Peterson L, Metzger BE, Holmes LB, et al. Lack of Relation of Increased Malformation Rates in Infants of Diabetic Mothers to Glycemic Control during Organogenesis. N Engl J Med. 17 de marzo de 1988;318(11):671-6. DOI: 10.1056/NEJM198803173181104
- Rosenn BM, Miodovnik M, Khoury JC, Siddiqi TA. Deficient Counterregulation: A Possible Risk Factor for Excessive Fetal Growth in IDDM Pregnancies. Diabetes Care. 1 de mayo de 1997;20(5):872-4. DOI: 10.2337/diacare.20.5.872
- Bagg W, Henley PG, Macpherson P, Cundy TF. Pregnancy in Women With Diabetes and Ischaemic Heart Disease. Aust N Z J Obstet Gynaecol. febrero de 1999;39(1):99-102. DOI: 10.1111/j.1479-828X.1999.tb03454.x