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Use of Insulin Pumps in Adults and Older Adults Living With Type 1 or Type 2 Diabetes

April 2022

Summary of Abstracts

CADTH

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Cite As: *Use of Insulin Pumps in Adults and Older Adults Living With Type 1 or Type 2 Diabetes*. (CADTH reference list: summary of abstracts). Ottawa: CADTH; 2022 Apr.

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Funding: CADTH receives funding from Canada's federal, provincial, and territorial governments, with the exception of Quebec.

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Key Messages

- Three randomized controlled trials were identified about the clinical effectiveness of insulin pump use in adults and older adults living with type 1 or type 2 diabetes.
- One economic evaluation was identified about the cost-effectiveness of insulin pump use in adults and older adults living with type 1 or type 2 diabetes.
- No evidence-based guidelines were identified about the use of insulin pumps in adults and older adults living with type 1 or type 2 diabetes.

Research Questions

1. What is the clinical effectiveness of insulin pump use in adults and older adults living with type 1 or type 2 diabetes?
2. What is the cost-effectiveness of insulin pump use in adults and older adults living with type 1 or type 2 diabetes?
3. What are the evidence-based guidelines for the use of insulin pumps in adults and older adults living with type 1 or type 2 diabetes?

Methods

Literature Search Methods

A limited literature search was conducted by an information specialist on key resources including MEDLINE, the Cochrane Library, the University of York Centre for Reviews and Dissemination (CRD) databases, the websites of Canadian and major international health technology agencies, as well as a focused internet search. The search strategy comprised both controlled vocabulary, such as the National Library of Medicine's MeSH (Medical Subject Headings), and keywords. The main search concepts were insulin pumps and diabetes. Search filters were applied to limit retrieval to health technology assessments, systematic reviews, meta-analyses or network meta-analyses, randomized controlled trials or controlled clinical trials, economic studies, and guidelines. Search filters were also applied to limit retrieval to adult populations. Comments, newspaper articles, editorials, and letters were excluded. If possible, retrieval was limited to the human population. The search was also limited to English-language documents published between January 1, 2018, and April 2, 2022.

Selection Criteria and Summary Methods

One reviewer screened literature search results (titles and abstracts) and selected publications according to the inclusion criteria presented in Table 1. Full texts of study publications were not reviewed. The information presented in the Overall Summary of Findings section was based on information available in the abstracts of selected publications. Open-access, full-text versions of evidence-based guidelines were reviewed when available, and relevant recommendations were summarized.

Table 1: Selection Criteria

Criteria	Description
Population	Adults (aged 25 years and older) and older adults (aged ≥ 65 years) living with diabetes (either type 1 or type 2)
Intervention	Insulin administered via insulin pump
Comparator	Q1 and Q2: Insulin administered via manual subcutaneous injections Q3: Not applicable
Outcomes	Q1: Clinical effectiveness (e.g., optimal hemoglobin A1C levels, general or diabetes-specific quality of life, patient satisfaction, adverse events, and safety [severe hypoglycemia, diabetic ketoacidosis, emergency department visits, hospitalizations, mortality]) Q2: Cost-effectiveness (e.g., quality-adjusted life-years gained, cost per adverse event avoided) Q3: Recommendations about best practices for the use of insulin pumps in adult and older adult populations (e.g., appropriate patient populations or settings, recommended treatment strategies including dosage and type of insulin delivered, strategies to mitigate harms and adverse events)
Study designs	Health technology assessments, systematic reviews, randomized controlled trials, economic evaluations, evidence-based guidelines

Q = question.

Results

Four relevant references were identified for this report.[1-4] Three randomized controlled trials were identified about the clinical effectiveness of insulin pumps for the treatment of adults and older adults living with diabetes.[1-3] No relevant health technology assessments or systematic reviews were identified. One economic evaluation was identified regarding the cost-effectiveness of insulin pumps for the treatment of adults and older adults living with diabetes.[4] No evidence-based guidelines were identified about the use of insulin pumps in the treatment of adults and older adults living with diabetes.

Additional references of potential interest that did not meet the inclusion criteria are listed in Appendix 1.

Overall Summary of Findings

Three randomized controlled trials[1-3] were identified about the clinical effectiveness of insulin pumps for the treatment of adults and older adults living with type 1 or type 2 diabetes. All studies compared insulin pump therapy in the form of continuous subcutaneous insulin infusion (CSII) with multiple daily injection (MDI).[1-3] Two studies showed that CSII was associated with greater satisfaction compared with MDI.[1,3] One study showed that after 6 months, there was a greater reduction in hemoglobin A1C levels and total daily dose (TDD) of insulin in the CSII group compared with the MDI group.[2] After 12 months, participants in the MDI group switched to CSII therapy, which continued to be associated with reduced hemoglobin A1C levels and TDD.[2] Another study also showed that CSII therapy was associated with reduced hemoglobin A1C levels after both 6 months and 12 months, and that CSII therapy was associated with reduced TDD.[3] The authors of the same study performed a subgroup analysis on participants aged 65 or older and found that the results were similar to the rest of the study population regarding treatment satisfaction, hemoglobin A1C levels, and TDD.[3] A detailed summary, including specific populations, additional outcomes, and authors' conclusions from the identified studies can be found in Table 2.

One economic evaluation was identified about the cost-effectiveness of insulin pumps for the treatment of adults and older adults living with diabetes.[4] A cost-effectiveness analysis compared CSII with MDI in adults with type 1 diabetes and found that CSII can be considered cost-effective when considering a threshold of 3 gross domestic products per capita with 43.9% probability of being cost-effective.[4] A detailed summary of the identified study can be found in Table 3.

No relevant evidence-based guidelines were identified about the use of insulin pumps in the treatment of adults and older adults living with diabetes; therefore, no summary can be provided.

Table 2: Summary of Included Clinical Effectiveness Studies

Study citation	Study design, population	Mean age of population	Intervention and comparator(s)	Relevant outcome(s)	Author's conclusions
Randomized controlled trials					
Speight et al. (2019)[1]	**Study design**: RCT **Population**: Adults living with type 1 diabetes and problematic hypoglycemia N = 96	49 ± 12 years	**Intervention:** CSII **Comparator:** MDI	Device delivery satisfaction, hypoglycemia control satisfaction. Outcomes were assessed at 6 months and 2 years.	Noninferiority of MDI vs. CSII was demonstrated for biomedical outcomes; however, participants' satisfaction with delivery device was greater in those allocated to the CSII group than the MDI group.
Chlup et al. (2018)[2]	**Study design**: Single-centre RCT **Population**: Adults who are insulin-resistant and CSII therapy–naive living with type 2 diabetes and using MDI therapy and metformin N = 23	57.2 ± 8.03 years	**Intervention:** CSII **Comparator:** MDI Initial MDI group crossed over to CSII after 6 months	Hemoglobin A1C levels, weight loss, TDD of insulin, diabetic ketoacidosis, severe hypoglycemia. Outcomes were assessed at 6 months and 12 months.	CSII therapy safely and significantly improved metabolic control with less insulin usage and with no sustainable reduction of body mass, blood pressure, and lipid profile. Treatment adherence and satisfaction was excellent.
Vigersky et al. (2018)[3]	**Study design**: RCT **Population**: Adults living with type 2 diabetes N = 331 (168 in initial CSII group, 163 in initial MDI group)	**Initial CSII group**: 56.4 ± 9.5 years **Initial MDI group:** 56.4 ± 9.5 years	**Intervention:** CSII **Comparator:** MDI Initial MDI group crossed over to CSII after 6 months	Hemoglobin A1C levels, weight, TDD of insulin, treatment satisfaction. Outcomes were assessed at 6 months and 12 months.	Hemoglobin A1C, TDD, and treatment satisfaction improved for individuals using CSII vs. MDI therapy, regardless of baseline C-peptide level. A subgroup of patients aged 65 years and older displayed a similar trend.

CSII = continuous subcutaneous insulin infusion; MDI = multiple daily injection; RCT = randomized controlled trial ; TDD = total daily dose; vs. = versus.

Table 3: Summary of Included Economic Evaluation

Study citation	Type of analysis, population	Mean age of population	Intervention and comparator(s)	Relevant outcome(s)	Authors' conclusions
Doubova et al. (2019)[4]	**Analysis**: Cost-effectiveness **Population**: Adults in Mexico living with type 1 diabetes for an average duration of 19 years	32 years	**Intervention:** CSII **Comparator:** MDI	Quality-adjusted life-years, incremental cost-effectiveness ratio	Insulin pump therapy can be considered cost-effective when considering a threshold of 3 gross domestic products per capita with 43.9% probability. Results improve substantially when individuals have a hemoglobin A1C level greater than 9%.

CSII = continuous subcutaneous insulin infusion; MDI = multiple daily injection.

References

Health Technology Assessments

No literature identified.

Systematic Reviews

No literature identified.

Randomized Controlled Trials

1. Speight J, Holmes-Truscott E, Little SA, et al. Satisfaction with the Use of Different Technologies for Insulin Delivery and Glucose Monitoring Among Adults with Long-Standing Type 1 Diabetes and Problematic Hypoglycemia: 2-Year Follow-Up in the HypoCOMPaSS Randomized Clinical Trial. *Diabetes Technol Ther* 11 2019; 21(11): 619-626. PubMed
2. Chlup R, Runzis S, Castaneda J, Lee SW, Nguyen X, Cohen O. Complex Assessment of Metabolic Effectiveness of Insulin Pump Therapy in Patients with Type 2 Diabetes Beyond HbA1c Reduction. *Diabetes Technol Ther* 02 2018; 20(2): 153-159. PubMed
3. Vigersky RA, Huang S, Cordero TL, et al. Improved Hba1c, Total Daily Insulin Dose, and Treatment Satisfaction with Insulin Pump Therapy Compared to Multiple Daily Insulin Injections in Patients with Type 2 Diabetes Irrespective of Baseline C-Peptide Levels. *Endocr Pract* May 2018; 24(5): 446-452. PubMed

Economic Evaluations

4. Doubova SV, Roze S, Ferreira-Hermosillo A, et al. Cost-effectiveness of the use of the continuous subcutaneous insulin infusion pump versus daily multiple injections in type 1 diabetes adult patients at the Mexican Institute of Social Security. *Cost Eff Resour Alloc* 2019; 17(): 19. PubMed

Guidelines and Recommendations

No literature identified.

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Appendix 1: References of Potential Interest

Note this reference has not been copy-edited.

Previous CADTH Reports

5. CADTH. Hybrid closed-loop insulin delivery systems for people with Type 1 diabetes; 2021. https://cadth.ca/sites/default/files/ou-tr/op0548-hcl-consolidated-report-appendices-7.0.pdf. Accessed 2022 Apr 8

6. CADTH. Insulin Pumps for the Management of Type 2 Diabetes: A Review of Clinical Effectiveness, Cost-Effectiveness and Guidelines; 2018. https://cadth.ca/sites/default/files/pdf/htis/2019/RC1033%20Insulin%20Pumps%20Final.pdf. Accessed 2022 Apr 8

Systematic Reviews

Mixed Population – Adults Older than 18 Years

7. Pease A, Lo C, Earnest A, Kiriakova V, Liew D, Zoungas S. The Efficacy of Technology in Type 1 Diabetes: A Systematic Review, Network Meta-analysis, and Narrative Synthesis. *Diabetes Technol Ther* 05 2020; 22(5): 411-421. PubMed

Population Age Not Specified

8. William J, McCluskey J, Gleeson N. RT-CGM in conjunction with CSII vs MDI in optimizing glycaemic control in T1DM: Systemic review and meta-analysis. *Endocrinol* Mar 2022; 5(2): e00324. PubMed

9. Thomas MG, Avari P, Godsland IF, Lett AM, Reddy M, Oliver N. Optimizing type 1 diabetes after multiple daily injections and capillary blood monitoring: Pump or sensor first? A meta-analysis using pooled differences in outcome measures. *Diabetes Obes Metab* 11 2021; 23(11): 2521-2528. PubMed

10. Gad H, Al-Muhannadi H, Mussleman P, Malik RA. Continuous subcutaneous insulin infusion versus multiple daily insulin injections in patients with Type 1 diabetes mellitus who fast during Ramadan: A systematic review and meta-analysis. *Diabetes Res Clin Pract* May 2019; 151(): 265-274. PubMed

11. Rys PM, Ludwig-Slomczynska AH, Cyganek K, Malecki MT. Continuous subcutaneous insulin infusion vs multiple daily injections in pregnant women with type 1 diabetes mellitus: a systematic review and meta-analysis of randomised controlled trials and observational studies. *Eur J Health Econ Outcomes Res*. May 2018; 178(5): 545-563. PubMed

Randomized Controlled Trials

Mixed Population – Adults 18 or Older

12. Grunberger G, Bhargava A, Ly T, et al. Human regular U-500 insulin via continuous subcutaneous insulin infusion versus multiple daily injections in adults with type 2 diabetes: The VIVID study. *Diabetes Obes Metab* 03 2020; 22(3): 434-441. PubMed

Population Age Not Specified

13. Feig DS, Corcoy R, Donovan LE, et al. Pumps or Multiple Daily Injections in Pregnancy Involving Type 1 Diabetes: A Prespecified Analysis of the CONCEPTT Randomized Trial. *Diabetes Care* 12 2018; 41(12): 2471-2479. PubMed

14. Levitt DL, Spanakis EK, Ryan KA, Silver KD. Insulin Pump and Continuous Glucose Monitor Initiation in Hospitalized Patients with Type 2 Diabetes Mellitus. *Diabetes Technol Ther* 01 2018; 20(1): 32-38. PubMed

15. Li FF, Zhang WL, Liu BL, et al. Management of glycemic variation in diabetic patients receiving parenteral nutrition by continuous subcutaneous insulin infusion (CSII) therapy. *Sci Rep*. 04 12 2018; 8(1): 5888. PubMed

Mixed Comparator – Multiple Daily Injections and Insulin Pump

16. McAuley SA, Lee MH, Paldus B, et al. Six Months of Hybrid Closed-Loop Versus Manual Insulin Delivery With Fingerprick Blood Glucose Monitoring in Adults With Type 1 Diabetes: A Randomized, Controlled Trial. *Diabetes Care* 12 2020; 43(12): 3024-3033. PubMed

Economic Evaluations

Population Age Not Specified

17. Pease A, Zomer E, Liew D, et al. Cost-Effectiveness Analysis of a Hybrid Closed-Loop System Versus Multiple Daily Injections and Capillary Glucose Testing for Adults with Type 1 Diabetes. *Diabetes Technol Ther* 11 2020; 22(11): 812-821. PubMed

18. Roze S, Smith-Palmer J, Delbaere A, et al. Cost-Effectiveness of Continuous Subcutaneous Insulin Infusion Versus Multiple Daily Injections in Patients with Poorly Controlled Type 2 Diabetes in Finland. *Diabetes Ther* Apr 2019; 10(2): 563-574. PubMed

19. Pollard DJ, Brennan A, Dixon S, et al. Cost-effectiveness of insulin pumps compared with multiple daily injections both provided with structured education for adults with type 1 diabetes: a health economic analysis of the Relative Effectiveness of Pumps over Structured Education (REPOSE) randomised controlled trial. *BMJ Open* 04 07 2018; 8(4): e016766. PubMed

20. Wahlqvist P, Warner J, Morlock R. Cost-effectiveness of Simple Insulin Infusion Devices Compared to Multiple Daily Injections in Uncontrolled Type 2 Diabetics in the United States Based on a Simulation Model. *J Health Econ Outcomes Res*. 2018; 6(1): 84-95. PubMed

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Population Age Not Specified; Mixed Comparator – Multiple Daily Injections and Insulin Pump

22. Serne EH, Roze S, Buompensiere MI, Valentine WJ, De Portu S, de Valk HW. Cost-Effectiveness of Hybrid Closed Loop Insulin Pumps Versus Multiple Daily Injections Plus Intermittently Scanned Glucose Monitoring in People With Type 1 Diabetes in The Netherlands. *Adv Ther*. Feb 28 2022; 28: 28. PubMed

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24. Lambadiari V, Ozdemir Saltik AZ, de Portu S, et al. Cost-effectiveness analysis of an Advanced Hybrid Closed Loop insulin delivery system in people with type 1 diabetes in Greece. *Diabetes Technol Ther.* Dec 28 2021; 28: 28. PubMed

Guidelines and Recommendations

Population Age Not Specified

25. Hur KY, Moon MK, Park JS, et al. 2021 Clinical Practice Guidelines for Diabetes Mellitus of the Korean Diabetes Association. *Diabetes Metab J* 07 2021; 45(4): 461-481. PubMed

26. McGibbon, A., Adams, L., Ingersoll, K., Kader, T., & Tugwell, B. Glycemic management in adults with type 1 diabetes. *Canadian Journal of Diabetes*, 2018;42:S80-S87. 10.1016/j.jcjd.2017.10.012. Accessed 2022 Apr 8 PubMed
See: Continuous Subcutaneous Insulin Infusion Therapy, p. S82-S83; Recommendations 1, 2, 5c, 6, 7a, 7b, 8, 9, 10., p.S84

Mixed Population – Adults and Children

27. Grunberger G, Sherr J, Allende M, et al. American Association of Clinical Endocrinology Clinical Practice Guideline: The Use of Advanced Technology in the Management of Persons With Diabetes Mellitus. *Endocr Pract.* 06 2021; 27(6): 505-537. PubMed

Mixed Population – Adults and Children; Methodology Not Specified

28. American Diabetes Association. Diabetes Technology: Standards of Medical Care in Diabetes—2021; *Diabetes Care* 2021;44(Supplement_1):S85–S99. 10.2337/dc21-S007. Accessed 2022 Apr 8 PubMed
See: Insulin Pumps, p. S91-S92; Insulin Pumps in Patients With Type 2 and Other Types of Diabetes, p. S92; Combined Insulin Pump and Sensor Systems, p.S92-S93; Recommendations: 7.20, 7.21, 7.22, 7.23, 7.24, 7.25, p. S91-S92