

Cost Utility Analysis of the Flash Glucose Monitoring System in the Management of People with Type 2 Diabetes Mellitus on Basal Insulin Therapy – an Italian Healthcare System Perspective

Francesco Saverio Mennini PhD¹, Stefano Del Prato MD², Francesco Giorgino MD PhD³, Yeesha Poon PhD⁴, Kirk Szafranski MSc⁵

¹Economic Evaluation and HTA (EEHTA CEIS), Department of Economics and Finance, Faculty of Rome "Tor Vergata", Rome, Italy; ²Interdisciplinary Research Center "Health Science" of the Sant'Anna School of Advanced Studies, Pisa, Italy; ³Department of Precision and Regenerative Medicine and Ionian Area, University of Bari Aldo Moro, Bari, BA, Italy; ⁴Abbott Diabetes Care, Alameda, California, USA; ⁵Eversana, Burlington, Ontario, Canada

Introduction

- Type 2 diabetes mellitus (T2DM) is associated with substantial reductions in patients' health-related quality of life and a high level of healthcare resource use¹
- In Italy, more than 3 million people are living with T2DM, with an annual cost exceeding €20 billion, including direct healthcare costs of more than €8 billion^{2,3}
- Optimal glycaemic control is important to people with T2DM to help reduce disease burden and complications⁴
 - However, capillary-based self-monitoring of blood glucose (SMBG) can be painful, frustrating and cumbersome, and may interfere with patients' daily life^{5,6}
- In addition, SMBG does not provide comprehensive information on daily glucose profiles, which may be particularly useful when patients are using insulin therapy⁷
- Guidelines in the USA and Europe recommend flash glucose monitoring or real-time CGM devices for people living with diabetes on basal insulin^{8,9}
- FreeStyle Libre (FSL) is a factory-calibrated flash glucose monitoring system designed to reduce

Utilities •

- A baseline health utility of 0.785 was used,²⁵ with disutilities applied per event for hypoglycaemic events and DKA, and per year for diabetes-related complications (**Table 2**)
- A utility improvement of 0.03 versus SMBG was applied to patients using FSL, based on the results of a UK time-trade off study²⁶

Sensitivity analyses

- Scenario analyses were performed to test the robustness of the base-case results (**Table 3**)
- Probabilistic sensitivity analysis was conducted varying discount rates, treatment effects, complications, utilities and costs

Results

Base-case results

The base-case incremental cost-effectiveness ratio (ICER) for FSL versus SMBG was €6,641/QALY (Table 4)

Table 4. Base-case cost-effectiveness results

	FSL	SMBG	Incremental
Costs	€62,085	€57,483	€4,602
QALYs	13.71	13.02	0.69
ICER (Cost/QALY)			€6,641

FSL, FreeStyle Libre system; ICER, incremental cost-effectiveness ratio; SMBG, self-monitoring of blood glucose; QALY, quality-adjusted life year

Figure 1. Scenario analysis ICERs



€16,393

the burden of glucose monitoring and provide reliable monitoring of daily glucose fluctuations and responses to insulin¹⁰

- Importantly, in clinical trials and real-world data studies, FSL has been shown to improve glucose control by increasing the time spent in glycaemic range, reducing the number of hypoglycaemic events and lowering glycated haemoglobin (HbA1c) levels^{11–15}
- FSL is currently reimbursed in Italy for people with T2DM using multiple daily injections of insulin
 - For people with T2DM on basal insulin therapy, FSL is reimbursed only in Sicily

Objectives

To assess the cost utility from an Italian healthcare system perspective of FSL, compared with SMBG, in people with T2DM using basal insulin

Materials and methods

Microsimulation model

- DEDUCE (DEtermination of Diabetes Utilities, Costs, and Effects) is a recently developed, validated, patient-level microsimulation model¹⁶
- The DEDUCE model assigns costs and utilities according to the complications and acute diabetic events (ADEs; severe hypoglycaemic events [SHE], non-severe hypoglycaemic events [NSHE] and diabetic ketoacidosis [DKA]) experienced by each simulated patient, with the incidence and history of complications updated each 1-year cycle
- Diabetes-related complications are modelled using the RECODe risk engine, which was developed using data from the Action to Control Cardiovascular Risk in Diabetes (ACCORD) study¹⁷

Analysis overview

- The DEDUCE model was run using Microsoft Excel for 10 000 patients over a lifetime horizon (50 years)
- Outcomes were assessed as quality-adjusted life years (QALYs), with costs (in 2023 €) and utilities discounted at 3% and 0%, respectively
- Disutilities were applied annually for complications and per event for ADEs

- Total costs were €4,602 higher with FSL than with SMBG (€62,085 vs €57,483)
- FSL was associated with an additional 0.69 QALYs versus SMBG (13.71 vs 13.02)

Sensitivity analysis results

- Scenario analysis ICERs ranged from €2,433/QALY to €17,227/QALY (Figure 1)
 - The highest ICERs were seen when the model time horizon was reduced to 5 years and when lower reductions in HbA1c were applied
- In the probabilistic analysis, FSL was 86% likely to be cost effective at a willingness-to-pay threshold of €10,000/QALY, and 100% likely at thresholds > €15,000/QALY (Figure 2)

Table 2. Key inputs in the base-case analysis

	FSL	SMBG	Source
HbA1c benefit			
One-time absolute reduction in HbA1c	1.1%	0.3%	Carlson 2022; ¹⁵ Malanda 2012 ²¹
Hypoglycaemic events			
SHE (annual rate)	0.41%	0.73%	Guerci 2023 ²²
NHSE (events per year)	16.50	23.31	Bergenstal 2021; ²³ Edridge 2015 ²⁷
DKA events			
DKA (annual rate)	0.34%	1.37%	Guerci 2023 ²²
Mortality DKA (probability per event)	4.7%		Sagy 2021 ²⁸
Glucose monitoring costs			
Annual cost	€910.00	€124.19	Calculated ^a
ADE costs			
SHE, per event	€840 €2,637		Haldrup 2020 ²⁴
DKA, per event			
Costs for complications, year 1 (subse	equent years)		
Myocardial infarction	€17,809 (€3,093) €1,964 (€1,964) €6,497 (€6,497) €36,317 (€3,455)		Haldrup 2020 ²⁴
Congestive heart failure			
Blindness			
Renal failure			
Stroke	€21,567 (€1,536)		
General utilities			
Baseline health utility	0.785		Takahara 2019 ²⁵
Fingerstick disutility	0.03		Matza 2017 ²⁶
ADE disutilities			
SHE, per event	0.0183		- Bilir 2018 ²⁹
NHSE, per event	0.00163		
DKA, per event	0.0091		Jorissen 2022 ³⁰
Disutilities for complications, year 1 (subsequent yea	rs)	
Myocardial infarction	0.0409 (0.012)		- CADTH 2017 ³¹
Congestive heart failure	0.0635 (0.018)		
Blindness	0.0498 (0.0498)		
Renal failure	0.263 (0.263)		
Stroke	0.0524 (0.04)		Shao 2019 ³²



ADE, acute diabetic event; FSL, FreeStyle Libre system; HbA1c, glycated haemoglobin; ICER, incremental cost-effectiveness ratio; QALY, quality-adjusted life year; SMBG, self-monitoring of blood glucose

Figure 2. Cost-effectiveness acceptability curve

Model inputs and assumptions

- Target population
 - Patient characteristics (Table 1) were based on Italian population data, randomized controlled trials (RCTs) and a real-world database^{17–20}
- Treatment effects and complications
- The effect of FSL on HbA1c was modelled as a persistent 0.8% reduction relative to SMBG (Table 2)
 - As no Italy-specific studies were available, data for FSL were taken from a recent analysis of 191 medical records from 14 centres in the USA and Canada¹⁵
 - Data for SMBG were taken from a meta-analysis of 12 RCTs²¹
- Compared with SMBG, use of FSL was associated with a 44% reduction in SHEs and a 29% reduction in NSHEs, based on French and US real-world data, respectively^{22,23}
 - In addition, DKA, which is rare in T2DM but can be life-threatening, was reduced by 75%²²
- Costs
 - The costs of glucose monitoring were calculated based on the use of 26 FSL sensors per year or 1.6 SMBG test strips and lancets per day (Table 2)
 - Costs associated with diabetes-related complications and ADEs were taken from Italian data reported in a previous cost-effectiveness study²⁴
 - NSHEs were assumed to have no associated costs

Table 1. Patient characteristics

	Value (SD)	Source	
Demographics			
Age at model entry (years)	68.1 (12.5)	AMD ¹⁸	
Gender (% female)	46.7%	SIMG ²⁰	
Ethnicity			
White	100%		
Black	0%	Assumption	
Hispanic	0%	·	
Baseline risk factors			
HbA1c level	8.7% (1.9%)	AMD ¹⁸	
SBP (mmHg)	136.5 (17.1)	_	
Total cholesterol (mg/dL)	183.20 (41.7)		
HDL cholesterol (mg/dL)	41.8 (11.6)	ACCORD ¹⁷	
Serum creatinine (mg/dL)	0.9 (0.2)	-	
Urine albumin:creatinine ratio	99.2 (359.4)		
% current smokers	14.0%	SIMG ²⁰	
% with CVD	15.9%	AMD ¹⁸	
Medication use			
Blood pressure	69.6%	AMD ¹⁹	
Statins	63.0%		
Oral antidiabetics	83.0%	SIMG ²⁰	
Anticoagulants	13.2%		

^aBased on 26 FSL sensors per year or 1.6 SMBG test strips and lancets per day

ADE, acute diabetic event; CADTH, Canadian Agency for Drugs and Technologies in Health; DKA, diabetic ketoacidosis; FSL, FreeStyle Libre system; HbA1c, glycated haemoglobin; NSHE, non-severe hypoglycaemic event; SHE, severe hypoglycaemic event; SMBG, self-monitoring of blood glucose

Table 3. Scenario analyses

Explore shorter time horizons of 5, 10 and 20 years	
Vary discount rate for costs/utilities from 3%/0% to 0%/0%, 3%/3% and 5%/5%	
Vary test strip and lancet use from 1.6 to 0.5, 1.0 and 1.66 per day	
/ary test strip and lancet cost from €0.34 to €0.10 and €0.72	
/ary FSL sensor price from €35 to €31.50 and €38.50	
ncrease annual probability of DKA with FSL from 0.34% to SMBG rate of 1.37%	
ncrease annual probability of SHE with FSL from 0.41% to SMBG rate of 0.73%	
ncrease NSHE rate with FSL from 16.50 events per year to SMBG rate of 23.31 events per year	
Decrease one-time HbA1c reductions with FSL and SMBG from 1.1% and 0.3%,	
espectively, to 0.46% and 0.17% (from Wada 2020 ¹⁴)	



QALY, quality-adjusted life year; SMBG, self-monitoring of blood glucose

Discussion

- This economic evaluation demonstrated that for people with T2DM using basal insulin glucose monitoring with FSL is a cost-effective option compared with current care standards in Italy
- Probabilistic sensitivity analysis found a 100% likelihood of FSL being cost effective at willingness-to-pay thresholds above €15,000
- In addition, the results were generally consistent across all scenarios tested
- The largest increase in ICER was found when HbA1c reductions were taken from an RCT evaluating the use of FSL by patients with T2DM using non-insulin treatment¹⁴ – although this scenario is conservative, the resultant ICER is still likely to be considered cost effective from an Italian healthcare system perspective
- A limitation of this economic analysis is that use of clinical data from multiple sources was required, as individual studies did not provide information on all relevant outcomes

Data are mean (SD) or percentage of patients

ACCORD, Action to Control Cardiovascular Risk in Diabetes; AMD, Associazione Medici Diabetologi; CVD, cardiovascular disease; HbA1c, glycated haemoglobin; HDL, high-density lipoprotein; SBP, systolic blood pressure; SD, standard deviation; SIMG, Societa Italiana di Medicina Generale e Delle Cure Primarie

Acknowledgements

Medical writing support for this poster was provided by Dr Paul Overton (Beacon Medical Communications Ltd, Brighton, UK) in accordance with Good Publication Practice (GPP 2022) guidelines, and was funded by Abbott Abbott provided funding for the study

Disclosures

YP is an employee and shareholder of Abbott. **FSM** has participated in advisory boards for Abbott, Amarin, Angelini, AstraZeneca, Bayer, Baxter, Beigene, Biogen, Boheringer, Boston Scientific, Daiichi Sankyo, Eli Lilly, EverPharma, Gilead, GSK, Lundbeck, Menarini, MSD, Novo Nordisk, Novartis, Roche, Sanofi and Servier. **SDP** has received research support from AstraZeneca and Boehringer Ingelheim; has participated in advisory boards for Abbott, Amarin Corporation, Applied Therapeutics, Eli Lilly and Co, EvaPharma, Hengrui Therapeutics Inc, Menarini International, Novo Nordisk, Sandoz and Sun Pharmaceuticals; and has received honoraria for speaking engagements from AstraZeneca, Boehringer Ingelheim, Eli Lilly and Co, Merck & Co., Novo Nordisk and Sanofi. **FG** has served as an advisor for AstraZeneca, Boehringer Ingelheim, Eli Lilly, Merck Sharp & Dohme, Medtronic, Novo Nordisk, Roche Diabetes Care, Sanofi; has served as a research investigator for Eli Lilly, Novo Nordisk, Roche Diabetes Care; and has received grants from Eli Lilly and Roche Diabetes Care. **KS** is an employee of Eversana, which has received project funding from Abbott

 This limitation was tested in scenario analyses, which showed that the ICER was robust to changing assumptions for the clinical benefits of FSL

Conclusion

 From an Italian healthcare system perspective, FSL can be considered to be cost effective compared with SMBG for people with T2DM using basal insulin therapy

References

1. Cannon A et al. J Manag Care Spec Pharm 2018;24:S5–S13. **2.** Mannucci E et al. Acta Diabetol 2022;59:579–622. **3.** Marcellusi A et al. BMJ *Open Diabetes Res Care* 2016;4:e000197. **4.** ElSayed NA *et al. Diabetes Care* 2022;46:S97–S110. **5.** Ong WM *et al. Patient Prefer Adherence* 2014;8:237–46. 6. Ward JE et al. J Diabetes Metab Disord 2015;14:43. 7. Bergenstal RM et al. J Diabetes Sci Technol 2013;7:562–78. 8. Davies MJ et al. Diabetes Care 2022;45:2753–2786. 9. ElSayed NA et al. Diabetes Care 2022;46:S111–S127. 10. Rodbard D. Diabetes Technol Ther 2016;18 Suppl 2:S3–S13. **11.** Deshmukh H *et al. Diabetes Care* 2020;43:2153–2160. **12.** Haak T *et al. Diabetes Ther* 2017;8:55–73. **13.** Evans M et al. Diabetes Ther 2020;11:83–95. 14. Wada E et al. BMJ Open Diabetes Res Care 2020;8:e001115. 15. Carlson AL et al. BMJ Open Diabetes Res Care 2022;10:e002590. 16. Coaquira Castro J et al. Value in Health 2022;25:S11. 17. Basu S et al. Lancet Diabetes Endocrinol 2017;5:788–798. 18. Associazione Medici Diabetologi. T2DM report. 2020. 19. Associazione Medici Diabetologi. T2DM report. 2022. 20. Societa Italiana di Medicina Generale e Delle Cure Primarie. T2DM report. 2020. **21.** Malanda UL *et al. Cochrane Database Syst Rev* 2012;1:CD005060. **22.** Guerci B et al. Diabetes Technol Ther 2023;25:20–30. **23.** Bergenstal RM et al. J Endocr Soc 2021;5:bvab013. **24.** Haldrup S et al. J Med *Econ* 2020;23:271–279. **25.** Takahara M *et al. Acta Diabetol* 2019;56:309–319. **26.** Matza LS *et al. Value Health* 2017;20:507–511. **27.** Edridge CL et al. PLoS One 2015;10:e0126427. 28. Sagy I et al. Intern Med J 2021;51:948–954. 29. Bilir SP et al. Eur Endocrinol 2018;14:73–79. **30.** Jorissen W *et al. Acta Clin Belg* 2022;77:945–954. **31.** CADTH. New Drugs for Type 2 Diabetes. 2017. **32.** Shao H *et al. Pharmacoeconomics* 2019;37:921–929

Presented at the International Society for Pharmacoeconomics and Outcomes Research European Congress, 12–15 November 2023, Copenhagen, Denmark