

Barriers to the Use of Diabetes Technologies – A Portuguese Perspective from the User and Health Care Professional

Barreiras ao Uso de Tecnologias em Diabetes – Uma Perspetiva Portuguesa do Utente e do Profissional de Saúde

D. Salazar^{1,2,3}, C. Esteves⁴, Grupo de Estudos de Tecnologias Avançadas de Diabetes da Sociedade Portuguesa de Diabetologia

1 – Department of Endocrinology, Diabetes and Metabolism of Centro Hospitalar Universitário de São João, Portugal.

2 – Faculty of Medicine of the University of Porto, Portugal.

3 – Instituto de Investigação e Inovação em Saúde, University of Porto, Portugal.

4 – Grupo Luz Saúde, Portugal.

Abstract

Introduction: The use of advanced technologies contributes to improving the control of diabetes and increasing patient's quality of life. The objective of this study was to determine barriers that prevent patients and health professionals from using technologies in the treatment of diabetes. **Methods:** Prospective study, performed from december 2018 to july 2019, based on electronic surveys to patients with diabetes and healthcare professionals involved in their treatment.

Results: Among 161 patients (92.5% type 1 diabetes), 87.1% used continuous glucose monitor (CGM), and 30.6% continuous subcutaneous insulin infusion (CSII). The main barriers identified by patients were: cost (59.6% for CGM, 64.0% for CSII); device alarms (54.7% for CGM, 41.0% for CSII); desire to spend minimal time treating diabetes (45.3% for CGM, 42.2% for CSII), and fear of device malfunction (36.6% for CGM, 43.5% for CSII). From 95 professionals surveyed, 76.8% were physicians. 92.6% recommend the use of diabetes technologies (mostly CGM [90.9%] and CSII [68.2%]). The major barrier to using CGM (69.5%) and CSII (72.6%) was the cost for users/coverage by the National Health Service (NHS) or insurer, while 49.5% admitted not understanding information/features of CSII, and 48.4% reported difficulty handling the devices. Patients and professionals consider that better NHS/insurer coverage, easier access to devices, more therapeutic education, and improved technology, could ameliorate the use of technologies in diabetes treatment. Professionals consider it is important to increase consultation time and education on the use of devices.

Conclusion: Accessibility and coverage of the NHS to diabetes management and treatment devices remains an obstacle in glycemic control. Education of patients/their families and health professionals looks essential to override barriers in using diabetes technologies, an ally for evolution of diabetes treatment.

Keywords: diabetes; advanced technology; barriers

Resumo

Introdução: O uso das tecnologias avançadas contribui para a melhoria do controlo da diabetes e para o aumento da qualidade de vida dos doentes. O objetivo deste estudo foi determinar as barreiras que impedem doentes e profissionais de saúde de usar novas tecnologias no tratamento da diabetes.

Métodos: Estudo prospetivo, realizado entre dezembro de 2018 e julho de 2019, baseado em inquéritos *online* a pessoas com diabetes e profissionais de saúde envolvidos no seu tratamento.

CORRESPONDÊNCIA/CORRESPONDENCE

Cristina Daniela Alves Salazar
Alameda Prof. Hernâni Monteiro
4200-319 Porto
Portugal
Móvel/Mobile: +351 916 774 730
E-mail: cdasalazar@gmail.com

Resultados: Entre 161 pacientes (92,5% diabetes tipo 1), 87,1% usavam monitor contínuo de glicose intersticial (MCG) e 30,6% perfusão subcutânea contínua de insulina (PSCI). As principais barreiras identificadas pelos doentes foram: custo (59,6% para MCG, 64,0% para PSCI); alarmes do dispositivo (54,7% para MCG, 41,0% para PSCI); desejo de dedicar menos tempo ao tratamento da diabetes (45,3% para MCG, 42,2% para PSCI), e medo do mau funcionamento do dispositivo (36,6% para MCG, 43,5% para PSCI). Dos 95 profissionais inquiridos, 76,8% eram médicos. 92,6% recomendam o uso de tecnologias para diabetes (maioritariamente MCG [90,9%] e PSCI [68,2%]). A principal barreira ao uso de MCG (69,5%) e PSCI (72,6%) foi o custo para usuários/ausência de cobertura pelo Serviço Nacional de Saúde (SNS) ou seguradora, enquanto 49,5% admitiram não compreender informações/características da bomba infusora de insulina, e 48,4% relataram dificuldade no manuseio dos dispositivos. Doentes e profissionais consideram que uma melhor cobertura do SNS/seguradora, acesso mais fácil a dispositivos, mais educação terapêutica e tecnologia aprimorada podem melhorar o uso de tecnologias no tratamento da diabetes. Os profissionais consideram importante aumentar o tempo de consulta e a educação sobre o uso dos dispositivos.

Conclusão: A acessibilidade e cobertura do SNS a dispositivos de monitorização e tratamento de diabetes mantém-se um obstáculo no controlo glicémico. A educação dos doentes/suas famílias e profissionais de saúde parece essencial para superar as barreiras no uso de tecnologias para o tratamento da diabetes, um aliado para a evolução do tratamento do diabetes.

Palavras-chave: diabetes; tecnologias avançadas; barreiras

> INTRODUCTION

The treatment of diabetes has evolved, and medical devices are critical components of the management of type 1 diabetes (T1D). ⁽¹⁾ Diabetes technology is defined as the “hardware, devices, and software that people with diabetes use to help manage their condition, from lifestyle to blood glucose levels”. ⁽²⁾ It can involve various combinations of diabetes devices and tools, ranging from multiple daily injections (MDI) in association with a blood glucose meter (BGM), CSII and CGM, or systems that partially integrate these devices as in sensor-augmented pump (SAP) therapies, to mobile applications, smart pens, and telemedicine. ^(3, 4) Research is now sufficient to conclude that diabetes technologies provide benefits to many patients in glycemic control (glycated hemoglobin [HbA1c] and time in range [TIR]), reductions in hypoglycemia, and increased quality of life and treatment satisfaction. ^(1, 4, 5) Evidence also shows that there may be an additional burden of wearing and using these technologies. ⁽⁶⁾

The United States has the greatest prevalence of pump usage (up to 60% of T1D), while in Europe rates range between 5 to 15%, and increasing. ⁽⁷⁻⁹⁾ Implementation of these devices still has room for improvement, as better glucose control depends on consistent CGM use, accessibility is still an issue in several countries, and some patients decline devices, have difficulties in handling them, use them inconsistently or discontinue use for various reasons. ⁽³⁾ Furthermore, diabetes and its treatment can impact the lives of people living with T1D in both positive and negative ways, ⁽⁶⁾ and alarm fatigue, technical failure, and accuracy problems limit ongoing engagement. ⁽¹⁰⁾ Despite a high overall proportion of insulin pump use, discontinuation rates of CGM are high, particularly among children. ⁽¹¹⁾

Professionals involved in the treatment of diabetes ha-

ve an important role in promoting adherence to diabetes technology. However, there are nonmodifiable barriers to adherence that include cost, socioeconomic factors, health insurance, access to health care, and other demographic variables. Some of these, however, may still be addressed at the policy level. Modifiable factors, including human factors, patient perceptions, beliefs, attitudes, and preferences, are addressed at the person or family level, and are prime targets for clinical intervention. ⁽¹²⁻¹⁴⁾

Some barriers to adherence can be modifiable through psychological intervention, but little is known about which barriers and in which patients to intervene. Documenting barriers to device use can help in the design of interventions to increase uptake. Our aim was to determine barriers to advanced technology devices uptake in the treatment of diabetes, understanding what measures are considered more important by patients and healthcare professionals, in order to get the best out of diabetes technologies.

> MATERIAL AND METHODS

Study Design and Participants

Electronic surveys were applied during the first half of 2019 to patients with diabetes and healthcare professionals involved in their treatment. Two different surveys were electronically distributed (1 for patients and 1 for clinicians) through portuguese diabetes groups on social networks, and by electronic mail to providers treating diabetes in Portugal. Patients with any type of diabetes were considered for the study. Professionals should be adult and/or pediatric providers, including doctors, nurses, psychologists, and nutritionists from private and public sector. Clinicians recruited included anyone involved in diabetes care – from Endocrinolo-

gists, to Internal Medicine or General and Family Medicine – including PSCI and pregnancy treatment centers. The Ethics Committee of Centro Hospitalar Universitário de São João approved the study procedures, and all participants provided electronic informed consent before responding.

Data Collection and Analysis

Information collected from patients included sex, age, diabetes type and duration, last HbA1c, scholarship, and employment status, and data from health professionals included sex, age, role, and sector of activity (private or public).

Uptake of advanced technology devices was recorded – CGM, CSII, bolus calculator integrated into a glucometer or smartphone app, diabetes management aid apps, online diabetes aid management platforms and social networks.

Possible barriers to device use, and solutions to overcome them, were identified based on literature review and results from previous surveys, ranging from questions related to operation and use of devices, cost, insurance, socioeconomic and psychosocial factors.^(1, 15) Each item was rated on a 3-point scale according to the attributed importance as a barrier to device use or a solution to improve adherence.

Descriptive statistics were used to document demographic characteristics, rates of diabetes device uptake and relevance of each barrier for patients and providers (presented with percentages).

> RESULTS

Characteristics of the population included in the study are resumed in Tables I and II, and Figure 1. Among 161 patients with diabetes who answered the questionnaire, 92.5% had T1D (n=149). 66.5% of the patients were women, with mean age of 37.3 ± 13.66 years, and diabetes duration 16.3 ± 12.23 years. Mean reported HbA1c was 7.0 ± 1.86 %. About 60% of patients had a superior degree and 77.0% had a current job. Ninety five health care professionals were inquired: 74.7% (n=95) were women, with mean age of 43.3 ± 13.09 years, and more than 60% mainly working in the public sector. The majority of providers were Physicians (76.8%, n=73) – 49.5% Endocrinologists and 16.8% Internists – 16.9% were Nurses and 4.2% were Nutritionists.

Most patients (89.4%) reported using some type of advanced diabetes technology, while 92.6% of providers recommend the use to their patients. CGM was the de-

Table I - Characteristics of the population – patients with diabetes *mel-litus* (n=161).

Women, %	66.5
Age ± SD, years	37.3 ± 13.66
Type 1 diabetes, %	92.5
Years from diagnosis ± SD	16.3 ± 12.23
Recent HbA1c ± SD, %	7.0 ± 1.86
Graduated, %	59.6
Professionally active, %	77.0

Table II - Characteristics of population – health professionals (n=95)

Women, %	74.7%
Age ± SD, years	43.3 ± 13.09
Public sector, %	62.7%

vice used by the majority of patients (87.1%), followed by social networks and other sites (56.5%), and only 30.6% of patients were CSII users. Practitioners largely recommended CGM (90.9%), but also insulin pumps (68.2%) and bolus calculators integrated into a glucose meter (61.4%) (Figure 2). Diabetes decision support system apps were the least recommended devices, used by 15.6% of patients.

Barriers to adherence considered of importance by patients with diabetes and health professionals involved in their treatment are represented in Figure 3a-h. Cost for users (or lack of coverage by the NHS or insurer) was the main barrier identified by patients – 59.6% for CGM and 64% for CSII – and providers – 69.5% for CGM and 72.6% for CSII. 54.7% and 41% of patients considered that alarms from CGM and CSII, respectively, were an important barrier to their use. For patients, desire to spend minimal time treating diabetes (45.3% of patients for CGM, and 42.2% for CSII), and fear of device malfunction (36.6% for CGM, 43.5% for CSII) were also major difficulties in fully embracing diabetes technology. Health care professionals, on the other hand, admitted that not understanding information/features of the devices (45.3% for CGM and 49.5% for CSII) and difficulty handling them (44.2% for CMG and 48.4% for CSII), were the second and third most important barriers for implementation, after cost.

Both patients and providers considered equally important to improve access to devices (Figure 4a). For patients, better coverage by NHS/insurance companies, technology improvement and more therapeutic education, were the most important actions to implement –

92.5% considered that CGM technology needed greater accuracy, more than 80% pointed to the need of reducing the risk of skin reactions with both CGM and CSII, and 92.5% emphasized the need for better coverage for CSII (Figure 4b, d, f and g). Practitioners agreed on the need for more therapeutic education (94.7% for CGM and 96.8% for CSII) and better coverage for CSII, but also acknowledge the need for more training in the use of devices (88.4% for CMG and 90.5% for CSII), and more consultation time (75.8% in the case of CGM use and 85.3% with CSII) in order to provide better care to patients using diabetes technologies (Figure 4b-e). Technology improvement was not considered by the majority of health professionals as crucial for implementation of devices (Figure 4f-g).

> DISCUSSION

Our survey seems to point that, despite there is a significant percentage of users of diabetes technology and great interest from both patients and providers in its use, available technologies and implementation strategies in Portugal are scarce and do not give a complete answer to the needs of people with diabetes, their families, and professionals involved in their care. It is important to notice that most patients are using diabetes technology in their treatment. However, this is mostly represented by CGM, and in a much smaller percentage, CSII. The greater CGM uptake from patients in comparison to CSII is probably related to accessibility and cost. Flash CGM (Freestyle Libre) is reimbursed by portuguese NHS, while CSII was of limited access in the adult population, until a new law was approved in 2020, making all patients eligible for CSII. Lack of human resources in now limits it's broad implementation. In accordance, both patients and providers identified the importance of better access to devices in order to improve their global use. One study of a Norwegian

cohort of patients with diabetes found that technologies are adopted and diffused through a population unequally, favoring those with higher income and educational levels. (16) Notably, this occurred in a health system with universal healthcare, like ours, and may contribute to worsening of disparities in health care. Social networks gained relevance in the last years in the treatment of diabetes, as supporting groups became an important place for patients and their families to share experiences, knowledge and doubts. (17) 45.4% of providers recommended their use by patients, but more en-

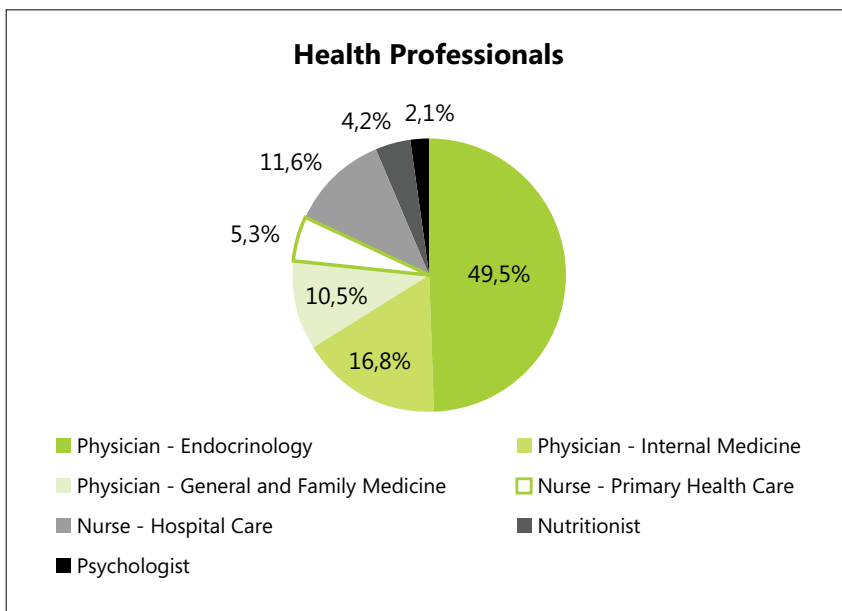


Figure 1 - Distribution of health care professionals inquired.

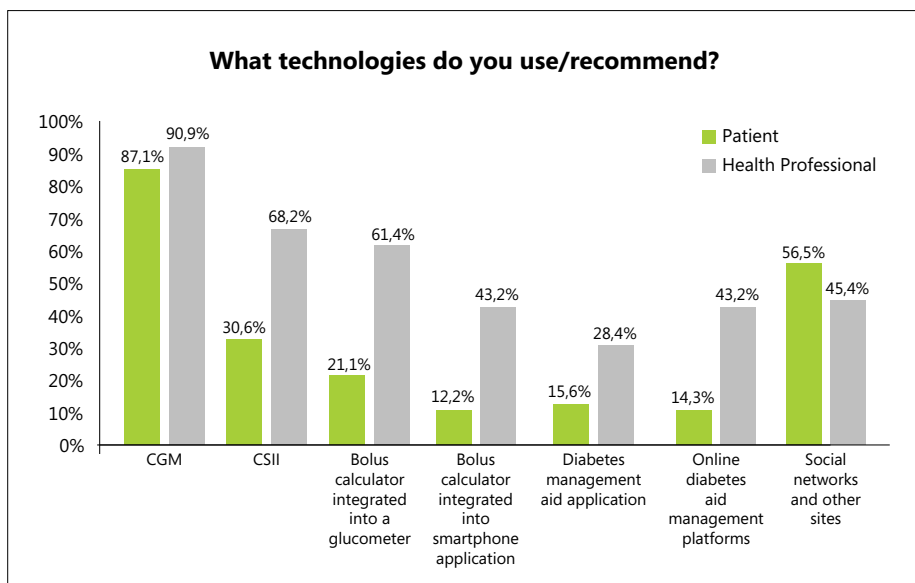


Figure 2 - Diabetes technology used by patients and recommend by health care professionals

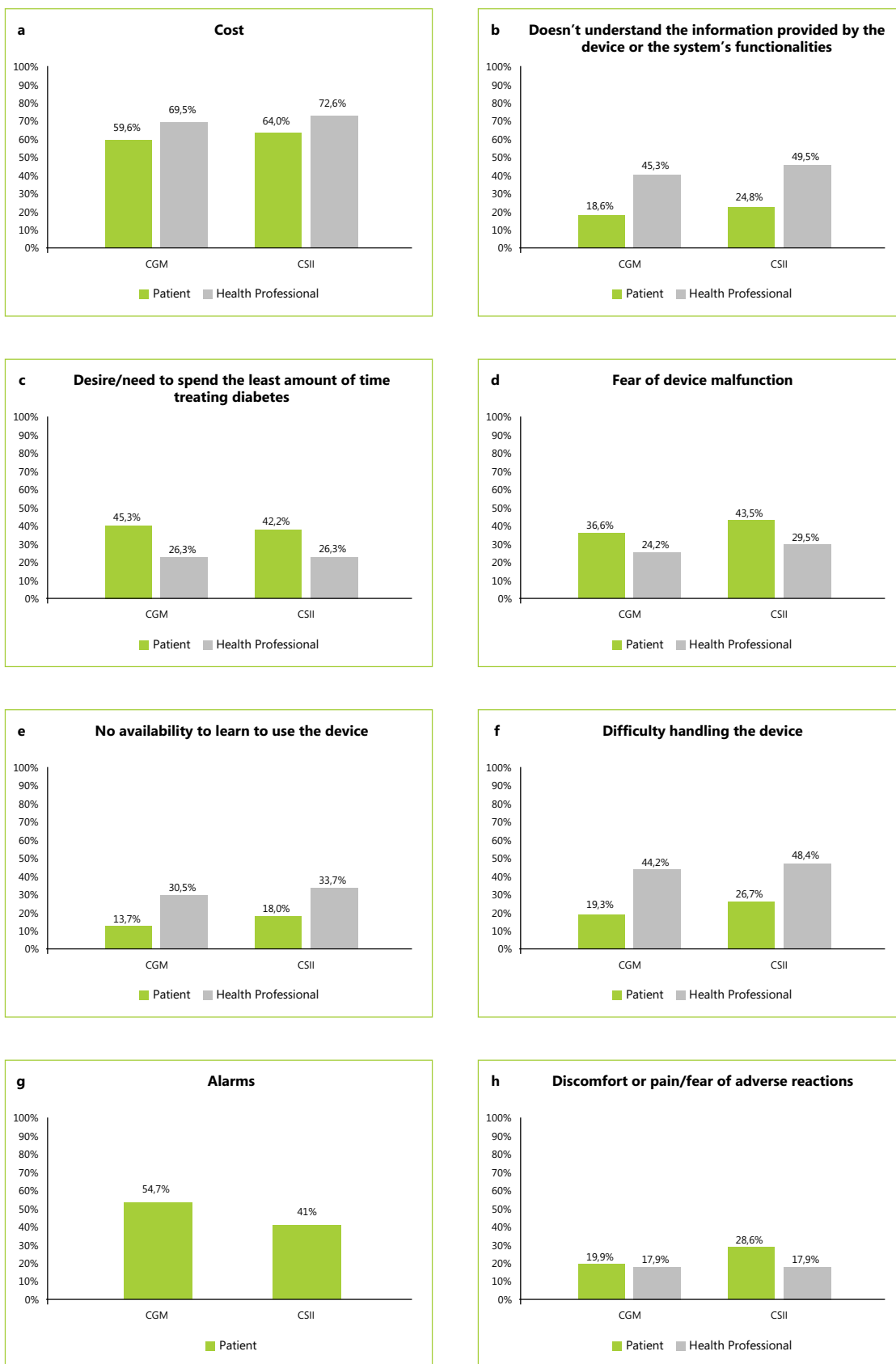


Figure 3 - Personal barriers to adherence to diabetes technology identified by patients with diabetes and health care professionals involved in their treatment.

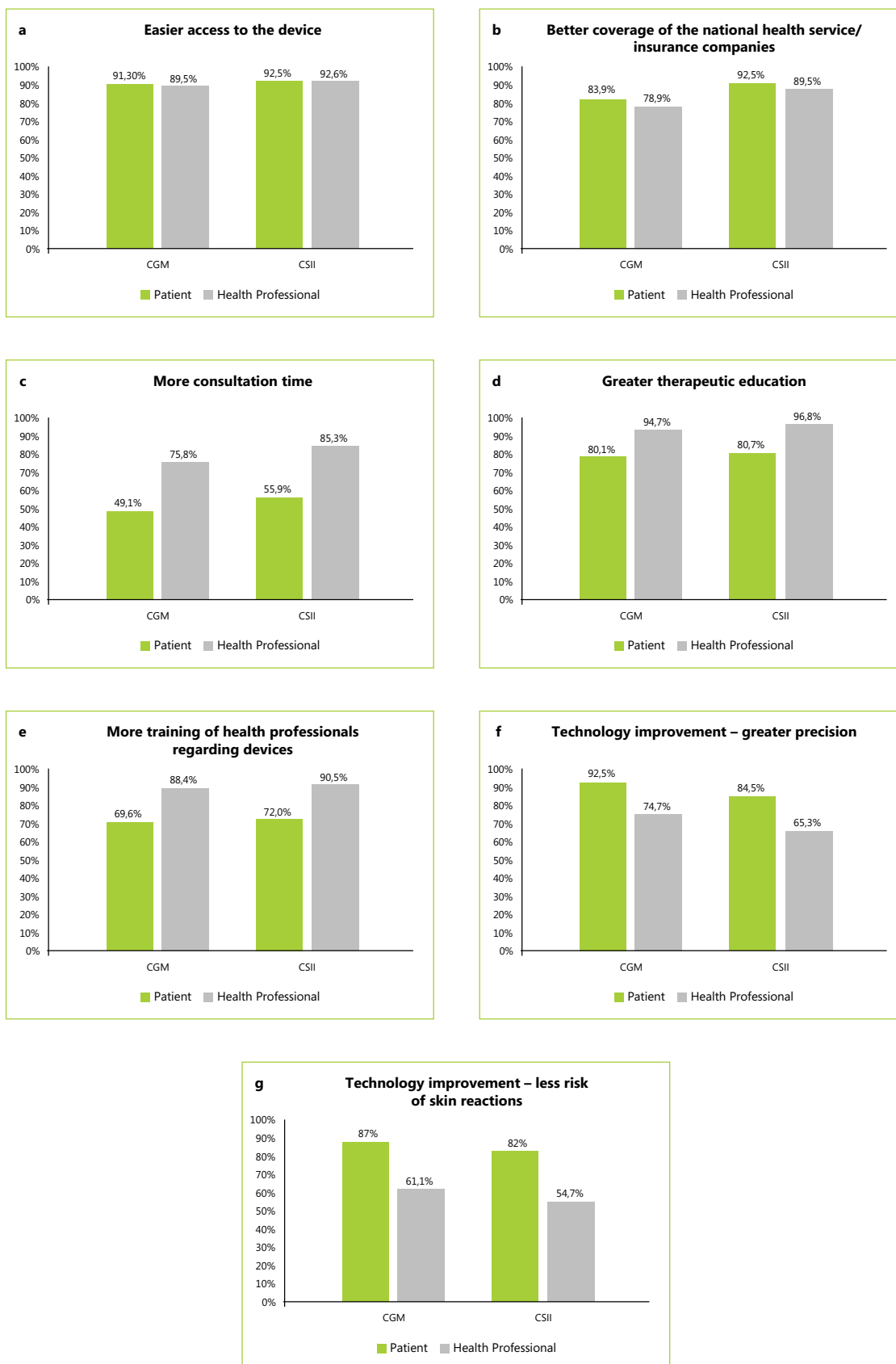


Figure 4 - Solutions to improve access/use of diabetes technology - identified by patients with diabetes and health care professionals involved in their treatment.

gagement from the diabetes multidisciplinary team in social networking will be paramount to bring professionals closer to patients and to provide more accurate information through them. Despite 61.4% of practitioners suggesting the use of bolus calculators integrated into a glucometer, only around 20% of patients used them. Discrepancy between providers reported recommendations and patients actual use of these devices may be explained by the lack of trained diabetes experts in some regions of the country, as compared to others. Additionally, alternative bolus calculation tools, such as smartphone apps, may be a relevant recommendation in some hospital centers.

Moreover, useful tools such as bolus calculators integrated into smartphone applications and other diabetes aid applications, were either little used by patients or recommended by healthcare professionals. The incorporation of some of these apps in the daily diabetes treatment routine would be useful, as they may help in weight management, reduce error in carbohydrate counting or insulin doses, allow for remote monitoring, and are of easier access.⁽¹⁸⁻²⁰⁾ However, there is yet insufficient evidence of their effectiveness.⁽¹⁸⁾

Given the value of insulin pumps and CGMs for improving glycemic control,^(9,11,21) it is essential to identify important barriers to their use and, eventually, discontinuation. Some of those barriers are modifiable and could be addressed through clinical intervention and/or changes in hospital policies.

The availability of lower cost or better coverage by the NHS or insurer are not directly modifiable by clinicians, but they still have a role in changing local policies. In Portugal, from 2017 to 2019, CSII were acquired for all eligible patients under 18 years (according to dispatch 13277/2016). However, more recently, all eligible patients with diabetes started to be considered for CSII use. Most barriers identified by health care professionals relate to lack of knowledge about devices' features and their use, particularly in the case of CSII, and they themselves recognize the importance of more therapeutic education, and training in the use of these devices. Diabetes technology training programs are scarce, and their availability should be revised, with mentorship schemes being proposed.⁽²²⁾ Also, consultation time is not enough for the provider to address all the information provided by devices, educate the patient on how to use that data, adjust therapeutic regimen, and evaluate diabetes complications, at once.

Besides the need for therapeutic education pointed out by 80% of patients, they considered, more than providers, that factors related to devices features were of

greater relevance. Alarms, and fear of device malfunction – poor precision and adverse effects as skin reactions – prevent patients from fully adopting diabetes technology. For that matter, besides the need for some actual improvement in devices precision (in the case of CGM) and cutaneous reactions, it is up to the health care team to reassure the patients about the safety, efficacy, and benefits of devices, and to provide them enough knowledge for them to be able to act in any situation. Almost half of the patients referred the desire to spend minimal time treating diabetes – education on diabetes complications and comorbidities, and the importance of investing in greater glycemic control for their future health is of highest priority; besides that, after an initial learning phase, it is expected that diabetes technologies make the day to day of patients easier, and providers should use that as a motivation for patients.

Our conclusions are limited because of the recruitment methods. We had a small sample of patients (n=161), and, as the survey was electronically distributed in social networks, only patients with internet access answered. More than that, it is possible that patients involved in social networks are the ones more prone to adopt diabetes technology in their treatment. That might contribute to the difference in the CGM uptake in our study compared to previous studies from other countries^(1,9) – 87.1% vs. 37% and 16%. Also, our survey was not specific regarding whether the presence or absence of alarms were the barrier for patients. Alarm fatigue is an issue in most countries using CGM devices with alarms, however, in our country, reimbursed CGM devices does not have alarms and patients might have considered its absence, instead of presence, as a barrier.

Despite that, other studies also emphasized cost, alarms, and concerns about accuracy as main barriers for patients, along with physical discomfort associated with the device, as one of the most commonly identified modifiable barrier and the primary reason for insulin pump discontinuation.^(1,11) Studies including pediatric patients found that younger patients reported more barriers to using devices and had the lowest uptake of both CGM and CSII,⁽¹⁾ mostly because of personal and social reasons associated with the challenging period of transition between adolescent and adult medical care.⁽²³⁾ Tanenbaum et al.⁽¹⁾ also found that women had higher rates of CSII use, despite higher levels of distress than men.

Studies have related some baseline patient factors associated with CSII discontinuation,⁽²⁴⁾ and those might be considered when indicating insulin pump therapy, to better manage available resources.

Another limitation is that inquired health care profes-

nals might not totally represent the intended population, as it was also a small group, and the distribution of the survey was made by electronic mail, only to providers who were members of Portuguese societies involved in the treatment of diabetes. Also, we did not quantify participants' experience with the technologies; limited exposure may have influenced perceptions. Despite the pointed weaknesses, it is important to note the inclusion of providers from all groups involved in diabetes treatment (from physicians to psychologists). Other findings are in line with previous larger studies.^(15, 22, 25) Cost and insurance, difficulties understanding what to do with information or features of the devices, and lack of time with each individual to discuss pros and cons of devices, were the major barriers endorsed by providers. Those studies highlighted the need for providers' education to promote technology adoption. It would be interesting to evaluate whether perceived lack of knowledge about devices' features and their use were related to the practitioner's age, as it was previously demonstrated that younger clinicians held more positive attitudes about technology compared with older clinicians.⁽²²⁾

Our findings may also not be generalizable to other countries, as their national health system and insurance coverage might differ. However, our aim was to better understand modifiable barriers to device use in the patient and provider perspective, in order to implement local interventions directed to our patient's care.

Policy and strategy for access to common diabetes-related technologies, especially CSII, requires review. But reinforcement in health care professionals' education regarding diabetes technology seems to be the first step to overcome barriers in the uptake of the devices in day-to-day care of diabetic patients.

It would also be important to put effort in developing standardized methods for assessing patient's readiness for device initiation, with continuous education sessions focusing on specific barriers for each individual patient.

> CONCLUSION

The increase in device uptake and promotion of continued use are important factors for improving glycemic control in the short term, but also for promoting future acceptance of automated insulin technology. Accessibility and cost of devices were identified as the major barriers to their implantation on a larger scale, along with the lack of training of professionals and patients on their use.

Modifiable factors, related to user/family beliefs, preferences,

and education in relation to technologies, should be the main targets of clinical intervention. <

Conflict of Interests/Conflito de Interesses:

The authors declare that they have no conflict of interests/Os autores declaram a inexistência de conflito de interesses.

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