9 Telemedicine and Diabetes

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Among the chronic diseases, diabetes is especially amenable to remote monitoring by telemedicine. Further, diabetology is the leading medical specialty in terms of volume of publications regarding telemedicine in Medline [1]. While the value of telemedicine has already been demonstrated in screening for diabetic retinopathy and/or follow-up of diabetic foot lesions, most of the studies in telemedicine with regard to diabetology continue to focus on remote blood glucose measurement via telemonitoring. In this case, patients transmit the data necessary for their follow-up, either automatically or manually, to a healthcare professional, who then interprets them remotely and sends back comments to the patients by text message, email or teleconsultation (Fig. 9.1a). The prominence of telemonitoring is partly due to the data transmission capacity of technologies, which facilitates the monitoring of clinical and laboratory parameters and the transmission of appropriate alerts. However, such systems have their limitations: they can be extremely time-consuming for healthcare providers who must analyse the data, and the time lag means that the comments are generally of little practical value to patients. A more elaborate form of telemedicine however is currently being developed with the aim not only of transmitting data but also of processing this data and enabling the caregiver to provide targeted assistance (Fig. 9.1b) [2]. This form of telemedicine is now moving out of the experimental stage and towards large-scale development and integration in patient care.

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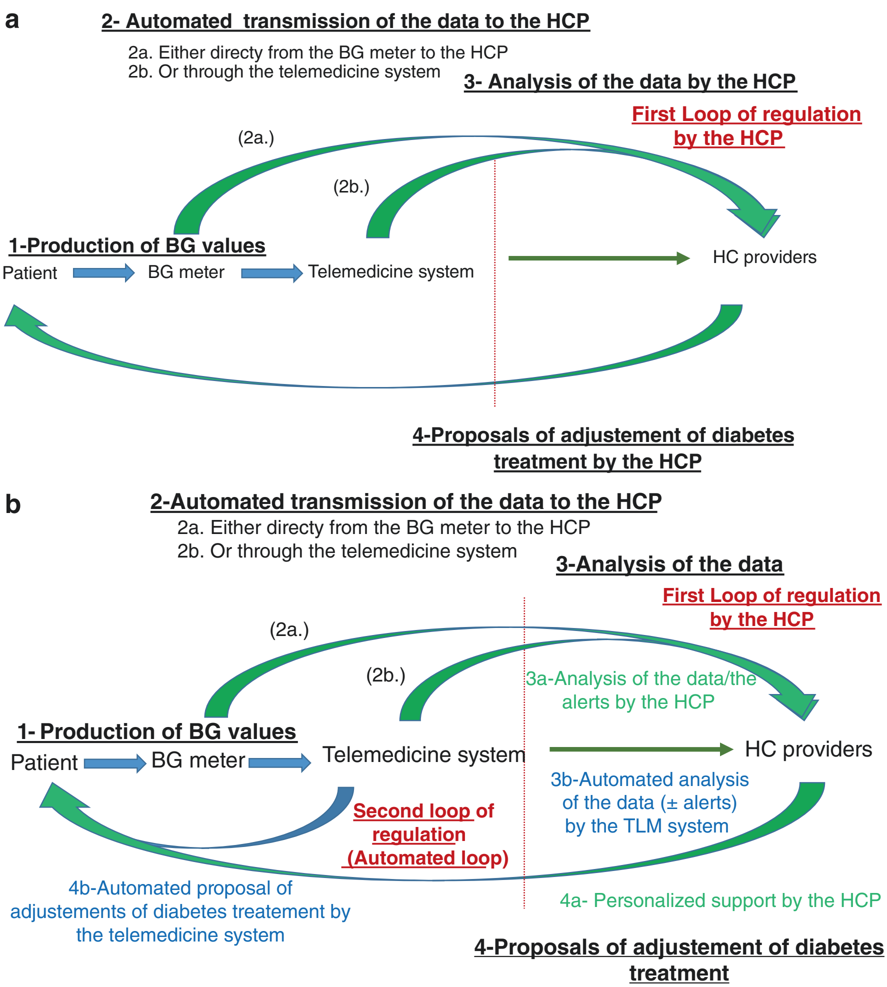

Fig. 9.1 Steps in a telemedicine system, from Klonoff et al. [2]. (**a**) A standard telemedicine system focused on remote telemonitoring. (**b**) An advanced telemedicine system with two loops of regulation

9.1 Results of Evaluations of Telemedicine in Diabetes Care

The results of the initial meta-analyses have proved somewhat disappointing for telemedicine in comparison with standard care (Table 9.1). Like all meta-analyses, these include studies and devices of heterogeneous quality. The latest publications appear to show slightly better results.

In all cases, the firm evaluation criterion remains HbA1c. However, particular attention should be paid to the following: (1) initial HbA1c level, with greater benefits being seen with higher initial levels, and (2) intervention time, with the shortest

Table 9.1 Key meta-analyses in the field of diabetes

Authors	Mean difference in HbA1c	Types of study	No. of patients (*n*)	Populations
Farmer et al. [3]	−0.1% 95% CI [−0.4 to 0.04]	9 RCTs	636	Mainly T1D
Verhoever et al. [4]	−0.03% 95% CI [−0.31 to 0.24]	6 RCTs	435	T1D or T2D or both
Polisena et al. [5]	−0.22% 95% CI [−0.35 to −0.08]	26 studies (12 RCTs)	5069	T1D or T2D or both
Marcolino et al. [6]	−0.44% 95% CI [−0.61 to −0.26] $p < 0.001$	13 RCTs	4207	T1D or T2D or both
Liang et al. [7]	−0.5% 95% CI [−0.3 to −0.7]	22 studies (11 RCTs)	1657	T1D or T2D or both
Su et al. [8]	Hedges' $g = -0.48$, $p < 0.001$	55 RCTs	9258	T1D and T2D or both

RCT randomised clinical trial

study duration generally being associated with the clearest benefits [8]. Because of the trend of decreasing intervention impact over time [6], it appears that contact through telemedicine and positive motivation should be intensified overtime. Regarding the study populations, while certain studies have shown more favourable results for telemedicine in T2D [7, 8] others have reported greater efficacy in T1D [6]. This could be associated with the type of intervention concerned: interventions that include changes in patient prescription through telemedicine are associated with better HbA1c reduction than those that do not [6].

The difference between T2D and T1D in terms of how telemedicine can facilitate disease management is determined by the therapeutic goals. For T1D patients, the focus is on determining the proper insulin dose. T2D patients, especially in the early stages of the disease, can be more reactive to lifestyle changes revolving around physical exercise and diet, which can be taught or reinforced through telemedicine. In both types of diabetes, if we leave aside the educational programmes provided online, the experiments performed in telemedicine range from telephone consultations, the simplest type of study, to DSS (decision support systems) the goal of which is automatic treatment adjustment.

9.2 Telemedicine in T2D

9.2.1 Telephone Consultations and Similar

Older short studies have shown that remote follow-up of diabetic patients involving phone calls by a nurse improved glycaemic control. Although teleconsultations are still widely used, they are now generally associated with telemonitoring. In the study by Oh in 2003 [9], over 12 weeks, patients transmitted details on BG, diet and exercise via a diary, which was further analysed by a dietitian, and subjects were subsequently instructed about the results by a nurse via phone counselling or email. The results militated clearly in favour of phone counselling (HbA1c: −1.8%).

However, large-scale studies have not proven as clear-cut. Within the European RENEWING Health project, a study in Norway to assess use over 1 year of the few touch application (FTA) self-management system combining a mobile telephone and a blood glucose meter with automatic data transfer via Bluetooth, with or without phone counselling by a nurse specialised in diabetes, showed increased capacity for self-management, but the decrease in HbA1c recorded after 1 year did not differ from that seen in the control group [10]. However, the intervention of the specialised nurse was of low intensity (five 20-min phone calls (one/month), during the 4 first months of the study), and rather general, stressing the importance of the quality of the relationship. The meta-analysis by Wu et al. [11] specifically examining the effects of telephone follow-up interventions on glycaemic control in patients with T2D showed weighted mean differences of −0.44 (95% CI −0.93 to 0.06) in favour of telephone follow-up intervention. Subgroup analysis of more intensive interventions showed a greater benefit (−0.84%, 95% CI [−1.67 to 0.0]), indicating, as expected, that more intensive modes of follow-up may have better effects on glycaemic control, with the frequency of contact between patients and doctors being a key factor for success, although the cost of such interventions and caregiver availability are clearly limiting factors. The extension of telephone follow-up interventions to large populations without increasing costs has resulted in attempts to rationalise caregiver time.

9.2.1.1 Recourse to Non-treating HCP Supervised by a Specialised Diabetes Nurse

In the study by Walker et al. [12] in 526 T2D patients with baseline HbA1c of 8.6%, a telephone intervention from a health educator supervised by a certified diabetes educator nurse was tested vs. the mailing of print self-management materials (no calls). This study showed modest results favouring telephone intervention, with a 0.40% (95% CI [−0.10 to −0.70], $p = 0.009$) difference in HbA1c between the two groups at 1 year. However, such interventions are only effective where diabetes is not too uncontrolled. In the study conducted in Salford, UK, involving a call centre with telecarers, the latter being managed by a specialist diabetes nurse [13], subgroup analysis showed that only in fairly controlled diabetes (HbA1c 7–9%) was a modest improvement in HbA1c recorded (−0.49%).

9.2.1.2 Focus of the Nurse on Patients Identified as the Most Distressed

The problem here is to identify this patient subpopulation. In a randomised study conducted in the USA, involving 248 veterans with diabetes, the intervention group received a series of automated telephone assessments to identify the most distressed patients likely to benefit most from targeted intervention by a nurse (telephone monitoring) [14]. However, such intervention in this population showed no significant benefits regarding metabolism. This disappointing result may be due again to the general nature of the intervention or the brief patient contact (6 min/month/patient) but also to failure of the method to identify the most distressed patients.

9.2.2 Systems Focused on Data Transmission and Telemonitoring

Numerous systems have been developed to provide a variety of data to the care provider for the management of diabetes and potential associated risk factors. The main goal of these devices is to facilitate interaction with the care provider, who can then contact the patient. However, these systems have not been wholeheartedly embraced by all patients (e.g. the T-IDDM project, [15]) and/or caregivers, being considered too complex. The IDEATel system provides a perfect illustration of such systems based upon data transmission and telemonitoring. It was used in a large ($n = 1665$) randomised trial comparing TM case management with standard care in older (71 years), ethnically diverse, medically underserved, Medicare beneficiaries with diabetes (HbA1c = 7.4%) residing in medically underserved areas of New York State. Patients included in the TM group received a home TM unit to allow video conferencing with a diabetes educator every 4–6 weeks mainly for self-management education and for review of blood glucose and blood pressure measurements. However, the metabolic results were rather disappointing with a difference after 5 years of follow-up that although statistically significant was not clinically relevant (−0.29% (0.12–0.46) [16]). However, the major limiting factor for the spread of such systems is cost ($3425/unit in 2006) [17].

Dedicated websites have also been developed focusing on data transmission. Using the MyCareTeam diabetes care management application, patients could upload their blood glucose data from their glucometer and manually enter other data (blood pressure, vital signs, weight, calorie intake and exercise) to a secure central database integrated with the clinic's electronic health record. The website had an internal messaging system for patients to communicate with the care manager. Based on their data reviewed, providers could contact patients and make adjustments in their treatment plan [18]. A RCT demonstrated lower HbA1c over 12 months (−1.6 ± 1.4% vs −1.2 ± 1.4%, $p < 0.05$) compared to education and conventional care. Interestingly, greater numbers of website data uploads were associated with larger declines in HbA1c (highest tertile, −2.1%; lowest tertile, −1.0%, $p < 0.02$). Thus, provided a quick interaction between patient and HCP, web-based care management can be a useful adjunct in the care of patients with poorly controlled diabetes mellitus [19].

In all of these instances of data transmission, it is in fact the caregivers who adjust the treatment, which again raises the issue of their availability and of treatment costs.

9.2.3 Automated Clinical Decision Support Systems (CDSS)

These systems are designed to adjust treatment on the basis of a predetermined algorithm and without the direct intervention of the caregiver, have therefore been developed in T2D but with rather disappointing results at the moment as most often, no improvement over the control group could be demonstrated [20].

Smartphones. Although web ink systems have yielded interesting results, the future of telemedicine is clearly in smartphones and associated apps. Cellular phones are widely used across socioeconomic groups, and their technical capabilities (including text messaging, internet access, applications and the ability to connect to sensing devices) are continually being enhanced, making smartphones a promising means for healthcare delivery. Many applications have been developed for diabetes management. As previously, most of the systems consist in a single-loop system (Fig. 9.1a). Although the cost of these apps is lower than that of a dedicated telemedicine system, the amount of caregiver time involved remains a limiting factor. Some teams have sought to *develop a further automatic feedback to the patient (second loop, automatic)*. Such is the case of the WellDoc Diabetes Manager "Bluestar" system, the only "app" to have received FDA clearance for the management of adult T2D patients and which is now marketed in the USA. It consists of software integrated in the patient's smartphone and linked to a web portal. Glucose values are uploaded from the monitor via Bluetooth, and all of the data taken together allows the identification of different profiles and situations, which then generate an automatic message in real time from among a base of 1000 preset automatic messages that are either educational, behavioural or motivational in nature. If the system does not propose any therapeutic adjustment, all of the data may be transmitted to a secure website accessible to the caregiving team, who can then propose the necessary adjustments. In patients followed by a general practitioner and with chronic imbalance (HbA1c = 9.4%), this system demonstrated significant improvement of 0.9% at 1 year versus the control group [21].

Towards integrated management. Management of T2D patients depends upon changes in lifestyle (increased physical activity, dietary changes) that may be taught or reinforced through telemedicine.

While systems like AiperMotion500, which records physical activity levels and information about food consumption and provides motivational feedback based on energy balance, could meet this requirement, the results are still not satisfactory. Thus, a 12-week study in 27 overweight or obese T2D patients has so far not provided any conclusive data regarding the metabolic benefits [22], which means that such therapeutic systems still have to be improved. Finally, a version of the Diabeo system has been customised specifically for T2DM patients. This system, geared towards patients inadequately controlled by OADs and in whom the introduction of a basal insulin injection at bedtime is warranted, was adapted to provide automated proposals for insulin dose based on an algorithm preset by the physician. However, its chief value remains educational coaching to provide patients with advice on diet and physical activity by way of automatic messages for blood glucose values falling outside the target range. This system, evaluated in the multicentre Telediab-2 study, demonstrated a 0.5% improvement in HbA1C at 4 months compared to the control group and, significantly, twice as many patients under 7% at 13 months [23].

9.3 Towards High-Technology Solutions in T1D

9.3.1 Phones Consultations

The Diabetes Control and Complications Trial (DCCT) had already shown that increased follow-up combining monthly consultations and regular telephone calls improved blood glucose control, although it was not possible to assess the specific contribution of telephone calls to such improvement [24]. More recently, regular telephone follow-up of 46 patients treated with insulin and having diabetes poorly controlled over a 6-month period demonstrated significant improvement in HbA1c (−1.3%) [25], although this requires considerable caregiver time, equivalent to a part-time job.

9.3.2 Web-Based TM Systems Focused on Data Transmission

Web-based TM systems focused on data transmission led to rather disappointing results. With the DIABTel system, patients can load blood glucose values directly from their glucometer to a palmtop device, then from that device to their physician's computer, with feedback provided by text messages. However, no significant improvement could be demonstrated. Using the GlucoNet software developed in Grenoble and offered to T1D patients on pump therapy, the result was again unconvincing. Data teletransmission was carried out for both groups (treatment and control). Weekly feedback in the treatment group to enable insulin dose optimisation by the diabetologist via text message did not result in any significant improvement in HbA1c at 6 months in relation to the control group; however, an improvement was seen in the quality-of-life indices [26]. Certain studies evaluated not the impact of the equipment but rather that of caregiver feedback. In the Mayo Clinic study, all patients use the same data transmission via modem and telephone from their monitor (in this case Accu-Chek Complete) to the caregivers' computer, but it was only in the treatment group that nurses provided feedback to patients within 24 h [27]. The 0.4% improvement in HbA1c at 6 months was significant compared with the control group ($p = 0.03$), but nursing time was considerable: 3.4 h per patient (of which 2.4 h for data review, including 10 min with the clinical endocrinologist and 1 h for telephone feedback to patients), compared with 30 min for the unaccompanied control group. Given the high amount of caregiver time involved, large-scale introduction of this device, combining data transmission and telephone consultations, is not feasible.

Overall, coupling the transmission of blood glucose values with such retrospective feedback has been disappointing, regardless of the technological improvements introduced. One meta-analysis comprising seven randomised trials of T1DM adults using such systems showed statistically significant, but limited (0.4%), improvement [27]. These systems generally upload patient data, sending a mass of blood glucose values, but do not incorporate truly effective feedback from caregivers other than increased weekly telephone contact, which is neither feasible nor acceptable in routine practice in the long term.

9.3.3 Systems with Automated Feedback

The Diabetes Insulin Guidance System (DIGS) (Hygieia, Inc.) software, which automatically advises patients on adjustment of insulin dosage, was tested in a feasibility study conducted in insulin-treated patients [28]. During the 12-week intervention period, DIGS processed patients' glucose readings and provided insulin dosage adjustments on a weekly basis. If approved by the study team (99% of cases), the adjusted insulin dosage was communicated to the patients. This resulted in HbA1c reduction from 8.4% to 7.9% ($p < 0.05$) and a 25% reduction in hypoglycaemia. While the findings indicate that automatic advice on insulin dosage adjustment is both feasible and reliable, from a practical standpoint, the stage of systematic approval by the doctor should be skipped, and the advice made immediately available to the patient.

9.3.4 Decision Support Systems

Among smartphones incorporating automated decision-making software, only the Diabeo system has demonstrated real efficacy with regard to HbA1c levels in T1D. This system, designed by CERITD with a programme development by Voluntis, incorporates three distinct programmes:

– A first programme uploaded via a secure website in the patient's smartphone calculates basal and prandial insulin doses according to target fasting and post-prandial blood glucose levels and to the recommendations previously set by the doctor. The data collected in the electronic diary are transmitted to the HCP's computer towards a secure website.
– A second programme automatically analyses the data generated by the patient's electronic logbook and transmits alert messages to the patient and to designated caregivers. Certain of these are coaching messages encouraging the patient to use the system more while others are generated by results outside the target range, and others still are intended for the doctor, who may choose to modify the patient's algorithms; the final category concerns the use of the system by the patient (repeated declining of the proposed dose or underuse of the system).
– A third programme developed to help and define tasks for nurses to whom work has been entrusted by the doctor, within the context of a personalised training plan. This programme has already undergone preliminary assessment.

The metabolic improvement provided by the first version of the Diabeo system, with only the programme to calculate basal and prandial doses, was assessed in patients with chronic disturbances of glucose control in the multicentre Télédiab 1 study [29]. This study included 180 T1D patients with HbA1c > 8.0% despite basal-bolus insulin therapy, delivered either by multiple injections or insulin pump; baseline HbA1c was 9.07%. Patients were randomised to one of the three groups: a control group (G1) or two groups provided with the software uploaded to their personal smartphone, but with (G3) or without (G2) remote follow-up. Patients in groups G1 and G2 had 3-monthly face-to-face consultations; patients in group G3 were only followed up via short telephone calls every 2 or 3 weeks. After 6 months, patients in group G3 experienced a 0.9% reduction in HbA1c ($p < 0.001$) vs. the control group; HbA1c reduction in group G2, without remote follow-up, was 0.7% ($p < 0.001$). This improvement in HbA1c was achieved without any change in incidence of hypoglycaemia, whether mild or severe. The daily frequency of self-monitoring of blood glucose levels increased very slightly over the course of the study (3.29 at baseline vs. 3.57 at the end), but since it occurred in identical fashion in the three groups ("study effect"), it could not account for the improvement seen in HbA1c. It thus appears that for equal frequency of self-monitoring of blood glucose levels, the Diabeo system allowed patients to use their blood glucose readings more successfully and calculate their insulin requirements more accurately.

9.3.5 Towards Entirely Automatic Systems

A new version of the Diabeo system has been developed with the introduction of an automatic analysis system that allows large-scale scrutiny of data, with caregiver intervention being required only in the event of an alert. A 24/24 telemonitoring platform provides the requisite level of safety for the introduction of such a device. This automatic operation with the development of alerts frees caregivers from the laborious task of analysing data, enabling them to focus instead on assisting patients. Such a system is currently being assessed in the Télésage multicentre study (target: 700 patients within 2 years) and should result in the system being reimbursed by social security in France [30].

9.4 Development of Telemedicine

Adoption of telemedicine now seems certain. How has this change come about?

9.4.1 Great Technological Pressure

II-1-1 Explosion in technological tools [31]: Smartphones and tablet computers have become the most popular and widespread types of mobile device. Close to 55% of British adults claim to own a mobile phone and over a third own a tablet. In the USA, a report by the Pew Research Center found that 64% of all adults now own a mobile phone and 34% own a tablet computer.

II-1-2 Development of applications but also of connected objects: The development of apps is progressing in similar fashion. The number of mHealth apps available to consumers now exceeds 165,000. Some mHealth apps focus specifically on disease management through implementation of treatment protocols, such as medication reminders (35%). Among disease-specific apps (9%), diabetes accounts for 15% [32]. Another estimate of diabetes apps has shown that in 01/2013, there were 600 apps in the Apple Store and 480 in the Android Marketplace; in 07/2014, there were 969 results in the Apple Store, demonstrating how quickly the number of available apps is increasing [33].

9.4.2 Incorporation of Telemedicine in the Health System in Certain Cases

Certain public insurance systems such as Medicare (the US health insurance system, designed to assist patients aged over 65 years or in specific situations) have carried out large-scale studies of telemedicine but with unconvincing results at the moment in terms of improvement in glycaemic control.

9.4.3 Use of Telemedicine in Specific Populations

9.4.3.1 Pregnant Women

In a recent meta-analysis [34], telemedicine showed real benefits in glycaemic control: HbA1c −0.18% [−0.50, 0.14], and caesarean section rates were similar between the telemedicine and usual care groups. Its advantage may lie in the convenience of reducing face-to-face and unscheduled consultations. However, studies are limited, and more trials that include cost evaluation are required.

9.4.3.2 Transition Period in Adolescents

Telemedicine represents a unique opportunity for transition age youth with T1D to engage in diabetes management using the tools with which they are familiar and comfortable. Tools such as Skype have already been used, but if the experience was found to be a viable option for addressing nonadherence and suboptimal glycaemic control in adolescents with T1D and poor glycaemic control in a randomised controlled trial conducted over a 12-week period, in terms of improvement of HbA1c, the results were disappointing [35]. The reason might be due to the fact that in this case, Skype was used, not for spontaneous communication, but to deliver the behavioural family systems therapy diabetes programme by video conferencing. Other recent studies involving social media (Skype and Facebook) in T1D patients on pump therapy yielded far better results than conventional monitoring [36]. A meta-analysis reviewed a number of telemedicine interventions in adolescents with T1D including text messaging, phone and video consultation, remote blood glucose and disease monitoring, mobile phone applications and computer software [37]. The authors noted statistically significant improvement in HbA1c values in three studies, although a trend towards improvement was observed in 10 of the 15 studies reviewed. Interventions combining technology with clinician and parental involvement were found to be the most successful.

9.4.3.3 Experiences of Telemedicine in Correctional Facilities

A number of studies have been conducted in correctional facilities. In the study by Kassar et al. [38] in 106 diabetic subjects (44% T1D), mean HbA1c was 9.3% with an average decrease of 0.5% from the initial to the final visit (mean: 3.6 televisits). Patients with initial HbA1c > 9% (n = 28) had an average drop of 1.3%. Given the high costs of transporting prisoners to healthcare facilities, telemedicine should help improve diabetes care for this vulnerable population.

9.5 The Question of User Profile

Although technology appears advantageous for some patients and HC providers, there may be some challenges with adoption and use of telemedicine systems by patient and caregivers [18]. Poor usability is one factor that may have had a negative effect on acceptance of telemedicine technologies. The area of human factor has become a key discipline in recent years. It focuses on system usability, designing system interfaces to optimise users' ability to accomplish their task error-free within a reasonable time and thus to accept the system as a useful tool.

9.5.1 Patient Profile

The question of patient profiling is generally considered more in terms of patient obstacles to the use of telemedicine. In this regard, very few actual obstacles have been identified other than unease about using technology [39]. The study of the effect of age on the use of telemedicine systems has yielded controversial results (the effect is generally neutral or even favourable in some studies).

We carried out patient profiling in the additional analysis for the telediab-1 study using the Diabeo system [40]. In its initial version (see paragraph 9.3.4), this tool had two programmes: the technological tool for dose determination and telemonitoring. We attempted to determine the profile of high-use patients, and HbA1c improved in comparable fashion in this population, whether the patients used the technological tool alone or were also followed up by a caregiver (−0.5% reduction in HbA1c in both cases); in other words, the help of a caregiver was not crucial. Conversely, in low-use patients, the patients benefiting most from the system were those also assisted by a caregiver (twofold greater reduction in HbA1c: −0.9% vs. −0.45%). The Diabeo system thus proved useful not only for fairly compliant patients with moderate glucose imbalance who used the dose calculation feature and carried out their injections accordingly but also for patients with poor blood glucose control, with major compliance problems and who appeared to benefit more from the motivational support provided regularly through frequent telephone consultations made possible by a smartphone linked to the website.

9.5.2 Caregiver Profile

Caregivers overall are usually more reticent than patients about using telemedicine. It must be said that some of these have been subject to massive influx of technology in their healthcare structures and have been forced to adapt to it; thus, involvement in telemedicine studies was simply tacked on to their standard tasks, without any reduction in the quantity of such tasks, and without any organisation of the telemonitoring work inherent to telemedicine. Under such circumstances, addition of telemedicine to carers' workload rather than substitution of certain acts is bound to fail. Moreover, the lack of organisation surrounding such technological tools, gives the impression not of mastering the technology but rather of being subjected to it, which tends to encourage rejection. Use of telemedicine in healthcare requires acceptance by caregivers. At least one study found that patients were more likely to participate in the telemedicine programme if encouraged by their healthcare provider to do so. Thus, telemedicine could perhaps strengthen caregiver-patient relations by enabling remote care for patients.

9.6 Structured Organisation with Grading of Interventions for "Optimised" Caregiving

After the meta-analyses based primarily on TS and demonstrating their relative failure, it appeared that the "missing element" was a decision support system that automatically analyses the data and provides the patient with real-time feedback, with a two-loop regulation system (Fig. 9.1b):

1. Automatic management of problems through feedback to patients via automatic advice regarding behaviour or direct adjustment of treatment (e.g. increased number of tablets or automatic adjustment of insulin dose).
2. For persistent problems, automatic alert messages (AAM) are generated to ensure caregiver intervention. The latter must not be the first-line doctor. Indeed, specialist medical time has become rare and expensive, and doctors will no doubt be unavailable to meet this increased demand. It is therefore essential that specialised nurses intervene with patients through a protocol of task delegation by the diabetologist to either correct treatment or encourage and motivate patients. With such an organisation, the majority of AMM should be taken into account, in most cases with remote intervention by the diabetes nurse. A small minority of alerts ultimately require secondary intervention by the diabetologist, which can be carried out under these circumstances.

Regarding organisation, such systems ensure accessibility to healthcare regardless of the declining numbers of doctors and define a new type of organisation, with the intervention of dedicated personnel, and grading of interventions allowing optimisation of caregiver time: doctors now concentrate on visits with patients experiencing the greatest difficulties. However, this form of telemedicine implies new professions. Practising nurses (PNs) who have been leaders in telemedicine practice are now expected to be competent at integrating and translating telemedicine.

9.7 Demonstrating Medico-Economic Benefits

TM does not necessarily result in savings of caregiver time. Thus, in the Télédiab1 study, over a 6-month period, the total time of face-to-face visits per patient was identical in the groups without remote visits (around 1h10), and those allowed short but repeated telephone contacts (nine calls lasting an average of 7 min). However, this time appears to have been better used since patients' HbA1c readings improved by 0.9%, i.e. the same order as that of DCCT, the benefits of which with regard to the chronic complications of diabetes are well known (−39% concerning progression of retinopathy and −25% concerning onset of microalbuminuria). This reduction in morbidity should have a major bearing on cost reduction. Further, TM resulted in savings in transport costs for medical visits: in France these costs are borne by the National Social Security and in 2007 totalled 314€ annually per patient, giving a total annual diabetes-related expenditure of 6927€ [6]. Finally, the absence of travel to hospitals for these young and professionally active patients resulted in savings for travel and waiting times equivalent to almost 1 working day over the 6-month study period.

9.8 Conclusion

In order to ensure quality monitoring, telemedicine cannot be simply reduced to telemonitoring. It is necessary to have special tools allowing interaction between patients and caregivers at the right time together with assistance functions. Certain apparent obstacles such as age are removed. Indeed, patients, even the elderly, are generally in favour of telemedicine monitoring. Resistance to the use of telemedicine is principally on the part of caregivers. Many of these have been subject to the massive influx of technology in their healthcare structures, and in most cases, they have been forced to adapt to such technology, generally without any assistance. However, it is essential that healthcare providers embrace the technology; it is vital that they be involved to a greater extent in advance of the telemedicine studies and that they be allowed to create telemedicine systems with their patients according to their requirements and how they intend to use the systems. Where telemedicine meets the requirements of the caregivers, there is more chance of it being embraced by caregivers and patients alike, with more likelihood of it being adopted in everyday practice. Involving both caregivers and patients should strengthen caregiver-patient relations.

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