The BETACONNECT™ system: MS therapy goes digital

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Adherence to long-term treatment in chronic diseases such as multiple sclerosis is challenging. Many disease-modifying drugs (DMDs) for MS need to be injected. Injection devices may improve satisfaction with the injection procedure and boost adherence. Meeting patients' needs in handling and design of autoinjectors and other supporting elements may be key to successful therapy. The BETACONNECT™ system is a platform-based approach in DMD therapy. It combines autoinjector technology with digital tools to support patient self-management and facilitate communication between patients and healthcare providers. Here, we describe the components of the BETACONNECT system and review data on patients' satisfaction with the BETACONNECT autoinjector and how it compares to other devices. Additionally, we present first data on patients' satisfaction with the myBETAapp™.

Lay abstract: So far, there is no cure for multiple sclerosis, although available therapies can modify the disease course. Sticking to these therapies over time is challenging. Autoinjectors help to improve satisfaction with injectable therapies and facilitate drug administration on a regular basis over years. Current and future systems should combine an electronic autoinjector with an app that supports patients to manage their therapy. These systems enable patients to share injection data with their physician or nurse, allowing timely feedback if needed. Recent surveys clearly demonstrate that the majority of patients are very satisfied with this concept.

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Background

Multiple sclerosis (MS) is a chronic autoimmune degenerative disorder primarily diagnosed in young adults between the ages of 20 and 40 years [1]. Long-term and constant treatment with disease-modifying drugs (DMD) is important to achieve optimum effect on disease course [2–5]. Patients' treatment adherence may be challenging to accomplish, requiring, among others, knowledge about the disease and additional treatment options, motivation and social support [6]. Furthermore, given that many DMDs need to be self-injected, additional supportive elements, including nurse services and autoinjectors, have been developed over the last decades to support patients with their treatment.

Digital tools and communication devices have developed rapidly and have become an integral part of the everyday life, especially among young people. Medicine and medical devices in particular are not excluded from this trend and medical digital gadgets are becoming increasingly available. Compared with classical intermittent face-to-face patient–healthcare provider (HCP) interactions, they function independently of practice visits, may provide a more complete picture and offer greater flexibility. A platform-based approach for a complex treatment regimen, allowing for monitoring of the disease and treatment course as well as interaction between the patient and HCP, may offer an opportunity for both patients and physicians/nurses to improve their understanding of the patients' individual situation and ultimately to foster adherence.

Figure 1. Components of the BETACONNECT™ system.

The BETACONNECT™ system is a platform concept developed by Bayer to meet this need in the field of MS treatment and will be presented in more detail in the following section.

Components of the BETACONNECT system

The system consists of three components. First, the BETACONNECT, an electronic autoinjector, second, the myBETAapp™ for patients and third, the BETACONNECT Navigator, a dashboard monitoring application for the attending physicians and/or specialized MS nurses. The components of the system are connective and allow data sharing between patient and physician/nurse, which can simplify and enhance communication (Figure 1, modified according to Hunter *et al.* 2014 [7]).

The BETACONNECT is an electronic autoinjector for IFN- β -1b (Betaseron® in the USA; Betaferon® in Europe). It was designed to meet the special needs of MS patients. It has an intuitive user interface and its ergonomic design allows easy handling and one-handed operation. A low force safety release ensures correct position at the time of injection. Injection speed and depth are adjustable to allow individualized injection settings. Both needle insertion and retraction are automatic, and the needle is hidden throughout the injection process. Visual and audible signals indicate that the injection has finished. To help patients stick to their therapy, the device features a reminder function. Visual and audible signals indicate when the device's battery is low. Finally, the device allows transfer of the injection data to the myBETAapp, either wireless to a mobile device or via USB to a computer [8].

The myBETAapp facilitates individual management of IFN- β -1b therapy. It features injection planning and recording as well as an injection site rotation scheme. Patients may choose to be reminded by email or push message when the next injection is due. Injection details such as date, time, injection speed and depth can be imported from the BETACONNECT and stored. An injection calendar and the injection history help patients maintain an overview over their therapy. Using the wellness tracker function, patients can record their well-being and selected

Table 1. Market research studies evaluating patients' satisfaction with the BETACONNECT™ and the myBETAapp™.

Study (year) country	Population	Objectives	Results	Ref.
BETACONNECT™				
Hunter <i>et al.</i> (2014) USA	32 patients on IFN β -1b (no experience with BETACONNECT) 30 caregivers (no experience with BETACONNECT)	Patient and caregiver satisfaction (prelaunch usability testing)	–The BETACONNECT was judged to be easy to use – Most features of the BETACONNECT were rated to be highly positive	[7]
Weller <i>et al.</i> (2015) Germany	1365 patients using BETACONNECT and participating in the patient support program BETAPLUS®	Evaluation of patient satisfaction with BETACONNECT in daily routine and the importance of its features	–92% rated the BETACONNECT as very helpful/helpful – 88% feel the autoinjector is very good/good – Most important rated features: – Adjustable injection depth and speed – Optical and acoustic signal – Rechargeable battery	[11]
Ziemssen <i>et al.</i> (2015) Germany	118 patients using BETACONNECT for at least 2 weeks	Validation of the satisfaction levels and of the impact on injection experience (including comparison to previous injection method)	–92% are very confident/confident using BETACONNECT® – 89% believe it is very easy/easy to use – 90% prefer BETACONNECT to their previous injection method – Patients largely perceive injections as more comfortable	[12]
Barone <i>et al.</i> (2016) USA	90 patients using autoinjectors as available for sc. injectable DMTs in the USA (no experience with BETACONNECT)	Comparison of BETACONNECT with mechanical autoinjectors (Rebijiect®, Rebijiect 2®, Autoject®, Autoject 2®, Extaviject®)	–83% prefer the BETACONNECT over their current autoinjector – Features of BETACONNECT were highly rated compared with an ideal autoinjector	[13]
Limmroth <i>et al.</i> (2017) Germany	85 patients: 39 BETACONNECT users, 36 RebiSmart® users and 10 ExtaviPro® users (all typical autoinjectors used in Germany for sc. injectable DMTs)	Comparison of BETACONNECT with an electronic (RebiSmart) and a mechanical (ExtaviPro) device	–BETACONNECT is closest to the patients' perception of an ideal autoinjector – BETACONNECT users are more satisfied than users of the other devices – 56% of patients prefer the BETACONNECT	[14]
myBETAapp				
GfK. Growth from Knowledge (2018) Germany	86 patients, 75 users, 11 former users of the myBETAapp	Satisfaction with myBETAapp	Current users (n = 75): – 92% are very satisfied/satisfied – 93% think the app is helpful for regular injection – Most useful features are 'injection recording', 'last injection sites' and 'calendar' – 45% use the data sharing function former users (n = 11). Reasons for discontinuation: – App did not meet their expectations and needs – Wish to have more flexibility with regard to reminder function and injection site management	[15]

health parameters. To enhance communication, patients can choose to share their injection data with their MS nurse or physician [9].

The third component of the system is the BETACONNECT Navigator, a dashboard application designed for healthcare professionals and specialized MS nurses. The navigator allows the physician/MS nurse to monitor therapy adherence of patients who agreed to data sharing. It groups the patients according to high, moderate and low adherence and marks them with an intuitive 'traffic light system'. The injection history of individual patients can be retrieved and used to generate patient reports [10].

Market research studies on the BETACONNECT system

So far, five market research studies have been conducted in Germany and the USA to evaluate patients' perception of the BETACONNECT, focusing on patients' satisfaction, injection experience with the device as well as comparisons with other autoinjectors for DMD therapy [7,11–14]. One market research study evaluated patients' satisfaction with the myBETAapp [15]. Table 1 provides an overview of the available studies that are described in more detail in the following section.

Satisfaction with the BETACONNECT

Evaluation of the BETACONNECT started during usability testing in the prelaunch phase [7]. A total of 32 patients on IFN- β -1b therapy and 30 caregivers (no healthcare professionals) underwent a human factors test session with the new device, including a simulated injection into an injection pad. Half of the participants were trained beforehand on how to use the device, whereas the other half was not. Afterward, the participants completed a 13-question survey by providing a number on a rating scale from 1 (most negative) to 5 (most positive).

Overall, both patients and caregivers rated most of the features of the autoinjector very positively. Injecting with the device was judged easily (patients: 4.8, caregivers: 4.6), and participants were confident that they could successfully perform an injection with the device (patients: 5.0, caregivers: 4.9). Features like automatic insertion and retraction of the needle or adjustable injection depth and speed were also rated very positively (all ratings ≥ 4.3). Trained and untrained participants gave similar responses, indicating that usage of the device was possible with minimal and informal training. This was the first investigation to indicate that the BETACONNECT may be valuable in supporting patients on IFN- β -1b.

Following the launch of the BETACONNECT in Germany in May 2014, 2299 MS patients using the device and participating in the BETAPLUS nurse support program were asked to participate in a survey with 13 device-related questions during October 2014 [11]. Among the 1365 patients who answered the questionnaire, 69% were women and 21% were men (10% not specified), 30% were aged between 40 and 49 years and 40% were older than 50 years. Half of the patients received IFN- β -1b treatment for more than 5 years and 21% for 2–5 years. Consequently, most patients were experienced in using mechanical devices before switching to the electronic injection device. At the time of the survey, almost half of the participants (48%) had used the BETACONNECT for more than 2 months and 38% for 1–2 months.

Overall, the perception of the BETACONNECT was very positive. 92% rated it as very helpful or helpful. 88% felt that the autoinjector was very good/good and 89% stated that they would most likely/probably recommend it for IFN- β -1b therapy. Asked about the function they considered to be most supportive (open question), most patients indicated the easy handling of the device (23%) followed by comfortable injection (14%). In addition, the participants evaluated the importance of individual features of the device. Among the features that were considered to be important/very important by participants were the adjustable injection depth and speed (90 and 86%, respectively), safety release (82%), optical and acoustic signals at the injection end (92%), as well as features concerning battery function such as rechargeable battery (93%) and the LED display for state of charge (92%). Criticism was mainly related to the contact sensor and 12% of the participants suggested improvements for this feature.

A further German survey-based study investigated the satisfaction of patients with the BETACONNECT, focusing on patients' injection experience [12]. 118 patients using the device for at least 2 weeks and on IFN- β -1b therapy for at least 6 months took part in an online 15-min structured survey. 72% of the participants were women, 50% were aged between 46 and 65 years (average 47.2 years) and the majority (69%) had been using the device for more than 1 month. Most patients were experienced in using a mechanical autoinjector before switching to the electronic autoinjector, 4% injected manually with a syringe.

The vast majority of the participants indicated that they were very confident/confident performing injections with the BETACONNECT (92%), found it very easy/easy to use (89%) and strongly agreed/agreed that they preferred it over their previous injection method (90%). Patients perceived it as a very intuitive device since almost all patients strongly agreed/agreed that it was easy to learn to use the autoinjector (95%), lights and buttons were self-explanatory (94%) and they knew when an injection was complete (97%). 94% strongly agreed/agreed that the automated process makes the injections easier. Using the electronic autoinjector had a positive effect on most patients' injection experience. The vast majority strongly agreed/agreed that its design makes it easy to handle during injections (92%). 67% strongly agreed/agreed that the autoinjector decreases the level of pain at the injection site. 72% strongly agreed/agreed that the invisible needle made injections less stressful and 73% strongly agreed/agreed that the quietness and effortlessness of the autoinjector reduced their level of anxiety. Among patients personalizing injection depth and speed 88 and 81%, respectively strongly agreed/agreed that these features make the injection process more comfortable. As part of the structured interview participants satisfied with the BETACONNECT were asked for their reasons. The unaided answers could be given in writing in an open-ended free text box. The most common answers were ease of use (46%), less skin irritation/pain (33%) and smoother injection (24%) (Figure 2).

Figure 2. Primary reasons for satisfaction with BETACONNECT™ (unaided responses to open-ended questions, n = 85). Base: respondents satisfied with BETACONNECT and who answered: “Why are you satisfied with the BETACONNECT autoinjector?”

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Comparison of the BETACONNECT with mechanical autoinjectors

The first survey to compare the BETACONNECT® (Bayer, Germany) with other autoinjectors was conducted in the USA by Barone *et al.* [13]. Since its launch in the USA in January 2016, the BETACONNECT is the only electronic device available on the US market. Therefore, all other autoinjectors used in the study were mechanical. 90 patients with MS currently using autoinjectors for DMD therapy participated in a 60-min in-person interview. The interviews were conducted in four stages. In stage 1, disease history was recorded. In stage 2, the patients rated the importance of 18 ideal autoinjector attributes on a scale from 1 (least important) to 10 (most important) and the performance of their current device across these attributes (1 = not well, 10 = very well). Then, the BETACONNECT was demonstrated and patients performed simulated injections (stage 3). In stage 4, patients rated the BETACONNECT on the same attributes and compared it with their current autoinjector. 70% (63) of the patients used autoinjectors for Copaxone® (Teva Neuroscience, Inc., MO, USA) (glatiramer acetate (subcutaneous), devices: Autoject®/Autoject 2®), 28% (25) for Rebif® (EMD Serono, Inc., MA, USA) (IFN-β-1a (subcutaneous), devices: Rebiject®/Rebiject II®) and 2 (2%) for Extavia® (Novartis, Switzerland) (IFN-β-1b (subcutaneous), devices: Auto-injector/Auto-injector II), approximately reflecting the market share of these medications in the USA. The top five attributes of an ideal autoinjector were overall ease of use, ability to push the start button easily, device comfortable to hold during injection, ability to use without help and adjustable injection depth (Figure 3).

The BETACONNECT was rated highly on all attributes and outperformed both the autoinjectors for Copaxone® and the Rebiject®/Rebiject II® (Figure 3). Due to the low number of users, no direct comparison was made with the Extavia® autoinjector. Interestingly, attributes that were not highly rated in the initial assessment of an ideal autoinjector, such as quietness of injection or ability to adjust injection speed, were highly rated in the assessment of the BETACONNECT. Thus, it seems to provide features meeting patients' needs, of which they were previously unaware. Among the features of the BETACONNECT, patients valued most compared with their current device were the built-in dwell time (97%), the self-check feature improving reliability (84%), greater ability to customize injections (84%) and easier injection process (78%). 83% preferred the BETACONNECT to their current autoinjector. The main reasons were the ease of injection with minimal pressure required to press the injection button as well as user-friendly functions, such as built-in dwell time and automatic needle retraction. In addition, quietness of the injection process was valued as an important benefit as many thought quiet

Figure 3. BETACONNECT™, Autoject® and Rebiject®, compared individually against an ideal autoinjector across 18 attributes. For each attribute, the percentage of patients who selected a rating ≥ 8 for each autoinjector is indicated using symbols (see legend). Numbers are given for the ideal autoinjector (blue bars).

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injections may reduce injection anxiety. In particular, younger patients aged between 18 and 40 years expressed a high (100%) preference for the BETACONNECT. Patients who preferred their current device thought their device was less bulky, placed more trust in mechanical operating modes or were simply used to their injection method and unwilling to change. In summary, this survey showed that the BETACONNECT was closest to the participants' perception of an ideal autoinjector and met the needs of most patients better than mechanical devices [13].

Comparison of the BETACONNECT with the RebiSmart®

There is one other electronic autoinjector for the subcutaneous administration of IFN- β -1a, the RebiSmart [16], which is available in Europe, but not the USA. The RebiSmart features adjustable injection speed and depth, a hidden needle throughout the injection process as well as visible and audible end of dose indicators, similar to the BETACONNECT. However, it features a display and has a somewhat bulkier appearance and is heavier than the BETACONNECT. A market survey study conducted in Germany assessed and compared patients' rating of three autoinjectors for subcutaneous IFN- β formulations – the two electronic devices BETACONNECT and RebiSmart and the mechanic ExtaviPro® [14].

85 MS patients using either the BETACONNECT (n = 39), the RebiSmart (n = 36) or the ExtaviPro (n = 10) answered a validated questionnaire in face-to-face interviews, which were organized and conducted in five German cities through an independent external market research company. Most participants were aged between 18 and 55 years (18–35 years: 29%, 36–55 years: 52%) and 68% of the participants were women.

First, participants were asked to rate their satisfaction with the device currently in use on a scale from 1 to 10. BETACONNECT users expressed the highest levels of satisfaction compared with RebiSmart and ExtaviPro users (8–10 points: BETACONNECT: 82% [mean 8.5]; RebiSmart: 67% [mean 7.9]; ExtaviPro: 60% [mean 7.5]). Among BETACONNECT users ease of handling (41%), reminder for next injection (31%) and quietness of injection (18%) were the most favored features. RebiSmart users mostly appreciated ease of handling (36%), ease of operation (28%) and the design (25%), whereas ExtaviPro users liked most that their device was handy (50%), had an appealing design and easy handling (30% each). Next, patients described their view of an ideal autoinjector by rating the importance of 18 attributes, similar to the study of Barone *et al.* (Figure 4) [13]. The most important features of an ideal device in this study were an overall easy injection process, uncomplicated preparation before use, the possibility of using it without help from others, easy determination of injection start and stop as well as the ease of pressing the start button. In the following step, the participants were introduced to the two devices currently not in use and performed dummy injections. Finally, the participants rated the devices currently not in use and determined their preferred autoinjector. The BETACONNECT achieved the highest valuation from nonusers and received ratings closest to an ideal device among the three autoinjectors (Figure 4). BETACONNECT nonusers valued most the easy handling with an easy-to-push start button, adjustment of injection speed and depths, signals for injection progress and the minimal noise during injection. Points of criticism from nonusers toward the RebiSmart were its weight (43%), difficult handling (33%) and unhandiness (24%). ExtaviPro nonusers disliked the lack of sufficient visual and acoustic functions of the device (24%), the complicated assembly (23%) and the excessive release force (17%). Furthermore, 21% considered the noise during injection unpleasant. Nonusers of the BETACONNECT were concerned about its disposable syringe (20%). Under the assumption that their current medication was suitable for all three autoinjectors, more than half of all participants (56.5%) preferred the BETACONNECT, 36.5% the RebiSmart and 5% the ExtaviPro (2% did not answer). Thus, even if the two electronic autoinjectors share a variety of features as described above, the BETACONNECT seems to meet patients' needs better than the RebiSmart.

Evaluation of the myBETAapp

Recently (July 2017 to January 2018) a market research study among patients using the myBETAapp evaluated perception and satisfaction with the application [15]. The study was conducted by an independent market research company (GfK). Among the participants 84 used the BETACONNECT, one a mechanical autoinjector and one injected manually. 75 patients currently using the myBETAapp and 11 patients previously using it but who discontinued usage answered an online survey with 50 questions. Current users of the myBETAapp tended to be young (average age 42 years) and 58% were females. Almost 95% used the app on a mobile device. In accordance with the IFN- β -1b dosing scheme, the majority (86%) used the app every other day, 4% used it daily. On a scale from 5 (totally unsatisfied) to 1 (very satisfied), 92% of current users stated that they were very satisfied or satisfied with the myBETAapp. Satisfied users thought that it was easy to handle and simplifies documentation of injection and injection sites, relieving them of bookkeeping with a diary. Correspondingly, virtually all current users applied the 'injection recording' feature (99%). Other frequently used features were the injection site rotation scheme and the injection calendar (68%). 57% activated the email reminder function via the app and most of them found it to be very useful. Features that were not directly linked to actual or upcoming injections, such as the injection history or the 'wellness tracker' function, were clearly less important to the users of the app (46 and 16%, respectively). Data transfer from the BETACONNECT autoinjector to the app seemed to work well, as 85% of the patients currently using the app transferred their data either via Bluetooth (78%) or via USB (7%). Overall, nearly all users agreed that the myBETAapp was helpful (93%) and 87% thought that it was supporting their therapy.

Besides supporting self-management of the patient, the myBETAapp was designed to enhance communication between patients and their physicians and healthcare providers (in the EU patients are required to actively give their consent to share the data, while in the USA patients have to opt-out of the default setting of sharing their data with their doctor). In this market research study, 45% of current users decided to transfer their data to their nurse (32%), or their nurse and/or physician (13%) [15]. Among those, 80% rated data transfer as very useful or useful and mentioned security, control and timely support by the nurse as main reasons in free text answers. Among the patients transferring their data, 74% indicated that they agreed to data sharing since they think it is a good cause and 44% want to show their physician or MS nurse that they use their medication as prescribed.

The main reasons not to agree to data transfer included "data sharing does not help me" (46%), "my doctor or MS nurse is not interested in my data" (31%) and "I do not want to be controlled" (26%) [15].

Figure 4. Comparison of ideal device features and availability of these features in the BETACONNECT™, RebiSmart® and ExtaviPro®. Patients' top three rankings (8–10 points on rating scale); b, c p < 0.05 comparing the respective device with device A, B, or C, respectively. For example, regarding "easy injection process," the Betaconnect (device A) was significantly rated better than the RebiSmart (device B) and the ExtaviPro (device C).

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A total of 8% of the current users indicated only moderate satisfaction with the app. They criticized connectivity problems with the autoinjector, missing information about dosage and the need to re-enter the password every 90 days. The 11 patients who discontinued use of the myBETAapp had very diverse reasons to do so. The majority felt that the app did not support them as they hoped or did not make matters easier. Some had technical problems or found it cumbersome to always unlock the app [15].

Meeting patients' needs

The expectations of an ideal autoinjector provided by patients both from the USA and Germany clearly indicate the most important aspect that such a device must address that the injection process should be generally easy [13,14]. Users of the BETACONNECT acknowledged the easy use of the device in all the available studies [7,11–14]. Furthermore, for the majority of patients, the BETACONNECT meets this need better than mechanical autoinjectors or the electronic RebiSmart [13,14]. BETACONNECT users appreciated the intuitive handling of the device. In particular, they indicated that visual and audible signals made it easy to recognize injection start and end and thus they were confident of knowing when the injection device could be displaced [11,13,14]. The ergonomic, easy-to-hold design in combination with a smooth running start button enables patients to use the device without help from others and to easily reach different injection sites [13,14] – certainly an important benefit for the many patients for whom staying independent is a major concern. Features aiming to make the injection process as comfortable as possible including adjustability of injection depth and speed, as well as minimal noise, were also highly valued by the users [12–14] and most likely contributed to the overall very high level of satisfaction with the device.

Tools aiming to improve adherence

Achieving adherence to long-term treatment with injectable DMDs is challenging [3,5,17,18] and mainly related to patient factors and satisfaction with both medication and application systems [6]. Since higher satisfaction with a device may positively impact on adherence, the BETACONNECT, being highly valued by its users, has the potential to improve long-term adherence to IFN- β -1b treatment.

Measuring adherence in an objective manner is difficult. Patient reports or other indirect methods may be biased [19] and claims data/data based on prescriptions indicate patients' supply, however, suffer from assumptions about the actual injections. In this context, the BETACONNECT offers a unique benefit since it automatically records every injection, thus permitting a largely unbiased evaluation of adherence. The first study employing this feature and showing its usability was the observational BETA EVAL study prospectively investigating adherence, satisfaction and functional health status over 24 weeks among BETACONNECT users [20]. At the end of the 24 weeks' follow-up time, 74.8% of 143 patients included in the analysis still used the BETACONNECT. Among patients with injection data available at the scheduled visits at 4, 12 and 24 weeks, the proportion of patients injecting $\geq 80\%$ of their prescribed doses remained higher than 80% throughout the study course [20]. In accordance with the survey-based studies mentioned earlier, satisfaction with the BETACONNECT was very high and most patients agreed that the device was user-friendly, and they felt confident using it. An additional study, using the same methodology, but with longer follow-up is currently ongoing [21].

Since patients can transfer their injection-related data from the BETACONNECT into myBETAapp, where they can document wellness-related symptoms and also share their data with their HCP, the entire system offers three advantages: first, patients can self-monitor their treatment and disease course. Second, healthcare professionals can receive timely information on their patients' treatment course and can respond with targeted feedback if necessary. Finally, self-monitoring and communication is feasible in between-office appointments for time-saving and cost-effective disease management.

Future perspective

Smartphones and apps have largely changed the ways we communicate and obtain information in our daily lives. Although a vast number of health-related apps have been developed, apps have so far been barely integrated into therapeutic concepts. However, communication and data sharing may develop into a powerful add-on to the classical face-to-face contact of patient and physician, especially for long-term treatment of chronic diseases, where successful therapy demands a high level of patient self-management. Data-sharing enables the physician or nurse to identify irregularities in the treatment scheme even between scheduled appointments and to provide timely support to the patients.

Current data from the presented studies show that many patients' needs are addressed with the BETACONNECT system, although, also indicate areas for improvement. For example, one of the most common reasons for nonadherence to DMD therapy is simply forgetting to take the medication [18,22]. While the BETACONNECT as well as the myBETAapp include a reminder function, it was nevertheless not perceived as an important feature of the autoinjector and only about half of the users of the app indicated having used it [15]. Hence, better understanding the nature of 'forgetting' will help with the re-evaluation of the reminder function.

Furthermore, the option to transfer injection data via the myBETAapp directly to the nurse or physician was used by only approximately half of the patients in a market research study [15]. Nevertheless, fostering communication between patients and their healthcare providers is a means toward improving adherence. Thus, in addition to simply explaining and communicating the advantages of digital data sharing to both parties, a deeper analysis of the communication between patients and healthcare professionals, the healthcare system and cultural aspects appear to be warranted in order to adapt the solutions to the needs. Recent and ongoing investigations conducted on the BETACONNECT system, as referenced here, and on other digital approaches will ensure that experiences, views and further needs of patients are collected in a time-efficient manner. This information is essential to improve such systems in an iterative way, thus developing novel and targeted treatment options. Finally, beyond the user experience in particular satisfaction with the devices future studies need to focus on outcomes. The BETAEVAL study has investigated adherence among BETACONNECT users over 6 months [20], however, longer follow-ups are warranted. While some studies are available for the RebiSmart [23,24], a study involving the BETACONNECT is ongoing [21]. Investigations looking at the impact of the BETACONNECT system both on adherence and also on clinical parameters are needed to fully understand the potential of such digital systems on MS.

Executive summary

Background

- Adherence to long-term disease-modifying drug (DMD) treatment in MS is challenging.
- Integrating digital communication tools into the therapy concept may improve patients' adherence.

Components of the BETACONNECT™ system

- The BETACONNECT system comprises a user-friendly autoinjector, the myBETAapp™, supporting patients' self-management and communication with their healthcare provider and a dashboard application for physicians/MS nurses. The three components are connective.

Market research studies on the BETACONNECT system

- Five survey-based studies investigated patients' satisfaction with the BETACONNECT™ autoinjector, including studies that compare the BETACONNECT with other devices.
- One study determined if patients are satisfied with the myBETAapp.

Satisfaction with the BETACONNECT

- Most patients were highly satisfied with the BETACONNECT. They agreed that it was easy to use and made injections more comfortable.

Comparison of the BETACONNECT with mechanical autoinjectors

- Patients in the USA newly introduced to the BETACONNECT thought that it was very close to their perception of an ideal autoinjector.
- More than 80% preferred the BETACONNECT to their current mechanical device.

Comparison of the BETACONNECT with the RebiSmart®

- The RebiSmart is the only other electronic autoinjector available (not in the USA).
- BETACONNECT users were more satisfied with their device than RebiSmart users.
- The BETACONNECT received the highest ratings among nonusers. More patients preferred the BETACONNECT than the RebiSmart.

Evaluation of the myBETAapp

- Users of the myBETAapp were very satisfied with the app.
- Virtually all users applied the 'injection recording' tool and felt it was a relief in bookkeeping.
- Only 45% of the users chose to share their data with their physician/MS nurse.

Meeting patients' needs

- Viewed overall, the BETACONNECT autoinjector seems to meet patients' needs better than other mechanical or electronic devices.

Tools to improve adherence

- A 24-week prospective study demonstrated high adherence among BETACONNECT users.
- Long-term studies evaluating treatment adherence with the BETACONNECT are currently ongoing.

Author's contributions

V Limmroth, T Schreiner and P Kusel did data collection. V Limmroth, P Kusel, T Schreiner and M Schürks did study compilation and data extraction. V Limmroth, T Schreiner, M Schürks, I Bartzokis and E Bonmann did conception and planning of the review. V Limmroth, I Bartzokis, E Bonmann, P Kusel, T Schreiner and M Schürks drafted the work or revised it critically for important intellectual content. V Limmroth, I Bartzokis, E Bonmann, P Kusel, T Schreiner and M Schürks did final approval of the version to be published. V Limmroth, I Bartzokis, E Bonmann, P Kusel, T Schreiner and M Schürks were in agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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