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Perceptions and experiences of using automated bolus advisors amongst people with type 1 diabetes: A longitudinal qualitative investigation

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ABSTRACT

Aims: We explored people's reasons for, and experiences of, using bolus advisors to determine insulin doses; and, their likes/dislikes of this technology.

Subjects and methods: 42 people with type 1 diabetes who had received instruction in use of bolus advisors during a structured education course were interviewed post-course and 6 months later. Data were analysed thematically.

Results: Participants who considered themselves to have poor mathematical skills highlighted a gratitude for, and heavy reliance on, advisors. Others liked and chose to use advisors because they saved time and effort calculating doses and/or had a data storage facility. Follow-up interviews highlighted that, by virtue of no longer calculating their doses, participants could become deskilled and increasingly dependent on advisors. Some forgot what their mealtime ratios were; others reported a misperception that, because they were pre-programmed during courses, these parameters never needed changing. Use of data storage facilities could hinder effective review of blood glucose data and some participants reported an adverse impact on glycaemic control.

Discussion: While participants liked and perceived benefits to using advisors, there may be unintended consequences to giving people access to this technology. To promote effective use, on-going input and education from trained health professionals may be necessary.

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1. Introduction

Flexible intensive insulin therapy (FIIT) is now widely used in the management of type 1 diabetes [1]. For people using multiple daily injections (MDI), FIIT comprises long-acting basal insulin injected once or twice daily, and quick acting bolus insulin adjusted according to blood glucose levels and carbohydrate intake at meals. Similar principles are utilised in pump therapy in which the pump infuses a constant basal rate

over 24 h, with patient-activated boluses to cover meals/snacks and to correct high blood glucose. Many people do not determine their bolus doses correctly, which may result in persistent hypoglycaemia and/or hyperglycaemia [2,3] and poor numeracy skills have been implicated [4,5]. Manually calculating bolus doses can be complex and challenging as individuals need to consider various parameters, including their current blood glucose reading, quantity of carbohydrate to be consumed, insulin sensitivity, insulin-to-carbohydrate ratio and target blood glucose. Hence, people who lack numeric skills may resort to guesswork, empirical estimates or even to reinstating fixed prandial doses [5–8].

To aid determination of bolus doses, automated bolus advisors are increasingly being used [7]. These provide recommendations for mealtime and correction boluses based on an individual's current blood glucose reading, planned carbohydrate intake and individualised, patient-specific parameters which are pre-programmed in (e.g. an individual's mealtime insulin-to-carbohydrate ratios, insulin sensitivity and blood glucose targets), as well as taking into account the previous insulin dose. Hence, for dose adjustment advice to be accurate, the correct parameters must be used, and it may take time for individuals' insulin-to-carbohydrate ratios and insulin sensitivity to be established. Furthermore, as insulin sensitivity may change (e.g. due to pregnancy, weight loss/gain, changes in physical activity patterns) the ratios required to determine mealtime and corrective boluses may need to be altered over time [5]. Hence regular review of blood glucose readings and other data is essential to ensure the correct parameters are used.

Research suggests that bolus advisors can lead to short-term improvements in pre-prandial [9] and post-prandial blood glucose levels in pump users [8,9], with a pilot trial involving MDI users observing improved glycaemic control maintained over 12 months [10] and a more recent RCT finding improved glycaemic control at 26 weeks [11]. Improved treatment satisfaction has also been observed amongst bolus advisor users [9,11,12], which has been attributed to reduced burden and stress because individuals are not required to perform complicated mathematical calculations [12,13]. Surveys have also found increased confidence in bolus calculation, improved ability to control blood glucose levels and improved overall wellbeing amongst advisor users [6,13].

While research has focused on clinical and psychological issues, little is known about how people with type 1 diabetes actually use bolus advisors in their everyday lives, their likes and dislikes of this technology, and whether, how, and why, their use of bolus advisors may change over time. In this paper we report findings from a qualitative investigation in which we interviewed participants in a randomised controlled trial which compared people with type 1 diabetes using MDI and pumps respectively – the REPOSE (Relative Effectiveness of Pumps Over MDI and Structured Education) Trial.

In the REPOSE Trial, participants were taught how to use bolus advisors during a five day structured education course (DAFNE – Dose Adjustment for Normal Eating [14]) – AccuChek® Aviva Expert meters (Roche Diagnostics) in the case of MDI participants and MiniMed Paradigm® Veo™ Bolus Wizards® (Medtronic) in the case of pump participants. See Box 1 for more details about the instruction and education received.

Box 1. Instruction and education received during DAFNE courses on REPOSE Trial

During their 5 day courses, participants were:

- Taught how to count carbohydrates (expressed as 10-g carbohydrate portions) and calculate mealtime insulin dose requirements as ratios to the number of carbohydrate portions consumed.
- Required to undertake regular review of self-monitoring of blood glucose readings (normally taken pre-meal and pre-bed) and instructed how to interpret patterns and/or changes in readings to calculate and adjust mealtime ratios and insulin dose requirements to meet or maintain pre-prandial and bedtime targets.
- Given instruction on how to calculate and use corrective insulin or additional carbohydrate portions to help maintain blood glucose readings within recommended target ranges (5.5–7.5 mmol/l before breakfast, 4.5–7.5 mmol/l before other meals, 6.5–8.0 mmol/l before bed in the DAFNE programme).
- Encouraged to undertake mathematical calculations mentally for the first two days so that when the bolus advisers were introduced and programmed under the supervision of the course Educators using a trial standard operating procedure (SOP) on day three, individuals could make informed judgements about the advisor calculations for the remainder of the week and begin to make alterations to their personalised settings where relevant.
- Courses were normally delivered by two experienced DAFNE Educators – a diabetes specialist nurse and a dietitian.

Following the courses, participants' routine diabetes care and clinical reviews were provided by their usual health care providers. However, they were required to attend appointments at 6, 12 and 24 months in order for biomedical and quantitative psychosocial data for the trial to be collected and for data from metres and pumps to be downloaded. Educators were also present at data collection clinics to provide support and advice and to respond to any issues that arose during the data collection process (e.g. for participants who were having ongoing problems with glycaemic control, hypoglycaemia or adverse events).

The aim of the qualitative research was to explore participants' experiences of using bolus advisors post course and over time and their likes and dislikes of this technology. The objectives were to aid interpretation of the findings of clinical and psychological research (including the findings of the REPOSE trial) and provide recommendations for supporting patients to use advisors effectively in the future.

2. Subjects and methods

2.1. Rationale for a qualitative design

Qualitative approaches are recommended when little is known about the area of investigation [15,16]. Rather than

seeking to quantify an issue or test a pre-determined hypothesis, qualitative approaches aim to open up and explore new avenues of enquiry by using flexible, open-ended approaches which allow participants to raise and discuss the issues which they perceive as salient, including those unforeseen at the study's outset [15,16]. As such, qualitative approaches provide a powerful and effective method of uncovering and exploring people's perspectives, understandings and experiences; in this particular instance, their experiences of using a bolus advisor. To do this in the current study, a longitudinal design was employed, in which participants were interviewed within two weeks of completing their DAFNE courses (baseline) and 6 months later. This design enabled participants' own understandings and experiences of using bolus advisors to be captured and explored in-depth, and any continuities and changes in their use of this technology to be identified and explored.

2.2. Recruitment and sampling

Participants were recruited from seven REPOSE centres across the UK with roughly equal numbers recruited from each centre. When participants were consented to take part in the trial, they were asked whether they would be willing to be approached to participate in the qualitative research. Participants who gave their agreement were purposively sampled so that both pump and MDI users were interviewed and so there was broad, and roughly equal representation of ages, gender, diabetes duration and occupational/SES groups in the final sample. Sampling was undertaken by the qualitative research team who kept a recruitment log which was updated weekly and who liaised with the trial team in order to select participants for the qualitative study who met the required sampling criteria.

2.3. Data collection

Recruitment and baseline interviews were staggered, to allow for concurrent data collection and analysis, in line with the principles of Grounded Theory research [17]. This enabled issues arising in earlier interviews to be examined and explored in-depth in later interviews. Interviews were conducted at a time and in a location chosen by participants (mostly their own homes). These interviews were informed by topic guides which contained a series of open-ended questions which helped to ensure the discussion remained relevant to the study aims and objectives, whilst providing the flexibility needed for participants to talk in depth, and in their words, about their experiences. These topic guides were developed in light of literature reviews, observation of courses, input from course educators, and revised in light of on-going data analysis. Relevant areas explored are outlined in Box 2. The same topics were covered with all participants. In addition, each person's baseline account was reviewed before their 6 month interview to enable follow-up of specific issues raised by particular individuals. Interviews averaged 1 h, were digitally recorded and transcribed in full. Recruitment and data collection was stopped when an on-going analysis of the data highlighted that no new findings or themes were emerging from new

Box 2. Topics explored in the interviews

- Historical experiences of diabetes management and health service contact (baseline interview).
- Perceived confidence/ability to undertake mathematical calculations (baseline and follow-up).
- Initial perceptions of bolus advisors (baseline); reasons for choosing/not choosing to use advisor (baseline); reasons for continuing or discontinuing use (follow-up).
- Likes/dislikes of the advisor (baseline and follow-up); changes in perceptions of advisors (follow-up).
- Everyday experiences of using advisor, reasons for following/not following recommended doses; perceived impact of using advisor on diabetes self-management (baseline and follow-up).
- Changes made to settings and individual parameters – by whom, how, and why? (follow-up), contact with health professionals (follow-up).
- Information and support needs to facilitate effective use of advisors (baseline and follow-up).
- Recommendations for how advisor technology could be improved (follow-up).

interviews. Interviews were conducted between June 2012 and June 2013.

2.4. Data analysis

A thematic analysis was undertaken by two experienced qualitative researchers (J.L. and J.K.) who independently reviewed all data before attending regular meetings to compare their interpretations and reach agreement on recurrent themes and findings. Each individual's baseline and 6 month interview was compared, and attention was paid to any continuities and changes in their use of bolus advisors over time, and the reasons for these. Participants' longitudinal accounts were also compared and contrasted, enabling the identification of overarching themes which cut across different people's experiences [18]. Initially, the interviews with MDI and pump users were treated as two distinct datasets and subjected to comparative analyses to see if there were any differences in the experiences reported by the two groups. However, as the main issues and experiences reported by participants were found to be the same in both groups, the two datasets were combined in the final analysis. The final coding frame, which reflected the original questions and emergent themes, was developed once all data had been reviewed and consensus reached on key themes and findings. NVivo9, a qualitative software package, was used to facilitate data coding/retrieval.

The REPOSE clinical trial, including the qualitative substudy, was approved by the North-West Research Committee (Liverpool West), approval number 11/H1002/10. Below, data are tagged with the participant's treatment arm (M for MDI, P for pump), identifying number and interview round (e.g. M7.2 refers to the second interview with MDI participant 7).

3. Results

45 people were recruited but 3 could not be contacted for follow-up interviews; hence, the final sample comprised 42 participants of whom 23 were pump and 19 MDI users – see Table 1. Of these, 36 (86%) reported using their bolus advisors in their baseline interviews, with 32 (76%) still using them 6 months later. Below, we consider the perspectives and experiences of those who chose to use advisors and how their use of advisors changed over time, before outlining why some people decided not to use, or stopped using, this technology. As key findings cut across pump and MDI users' accounts, data from these two participant groups are reported together.

3.1. Baseline accounts

3.1.1. Motivations for and perceived benefits of using advisors
Participants reported a variety of reasons for using their advisors and associated benefits, which broadly cohered into three categories. Participants ($n = 14$) who considered themselves to have poor mathematical skills highlighted a gratitude for, and reliance on, their advisors from the outset: "Because I was the worst, I was terrible at maths at school, I rely on it" (M10.1); "I absolutely live by that machine; it's fantastic, it's been invaluable" (M8.1). Indeed, these participants, who were mostly older/retired and from unskilled or semi-skilled occupational groups, questioned how they would have successfully implemented a FIIT regimen without access to this technological support:

"I mean, for example, this morning my blood was 10 and I knew I was having a bowl of quick porridge, that's 3 units, so I had the six for the three lots of carbs, and then it, my machine said you need 2, 2 more units, so I had 8 this morning, I don't know how I would have managed to work that out." (M8.1)

Other participants ($n = 17$) who expressed greater confidence in their mathematical skills described choosing to use

advisors because they saved time and effort: "it just makes it less work, to be honest" (M20.1); "I'm just lazy with the maths really. I don't want to be working that stuff out, so if it's going to do it for me, that's fine, it's much easier to let it do it" (P23.1). In addition, by virtue of being fast and easy to use, these participants described bolus advisors as facilitating accurate determination of doses when they experienced poor concentration due to hypo or hyperglycaemic excursions. As a consequence, participants worried less about miscalculating doses:

"Cos, like I've just said, if I were running 4 points high, I'd be trying to think back, how many units I need and then you start getting flustered, and start trying to, which makes you worse, your sugars are going up, and because your sugars are high you start feeling ratty anyway, and then you start thinking "Oh, I can't work this out" so you dial too many on then, before you know it, your sugars have dropped." (P30.1)

The remaining participants ($n = 5$) claimed their primary reason for using their advisors was because they had a data storage facility:

"because I'm on a 1:1 ratio it's pretty simple... I mean the main reason I'm using it is because when I get round to downloading my results onto my laptop or whatever, it will offer me more information, it has all my dosages and carbohydrates on there as well." (M15.1)

Hence, as M15 further suggested, using a paper diary, which would have been more burdensome and time-consuming, was not necessary.

3.1.2. Initial experiences of using advisors and calculating doses
With the exception of those who highlighted very poor mathematical skills, participants, at baseline, described undertaking their own mental or manual calculations alongside using their advisors, because as P4 pointed out, "I don't want to rely on something to do the maths, I try to work it out myself first and then just check it against the wizard" (P4.1), or, as P43 suggested, because, "I don't quite trust it yet, won't accept what it says for truth sort of thing. I always make the measurements in my head, just to be sure it's right" (P43.1).

In general, participants claimed to agree with, and administer, the recommended doses. However, several ($n = 12$) highlighted occasions when they had made slight adjustments to take account of planned physical activity or because the blood glucose targets they were aiming for were higher or lower than those programmed in during their courses:

"If it gives me 6.5 and I think to myself I'm going to go and sort the shed out and all that, 0.5 might be a bit too much. So I tend to, I might take 6, and I think well, if it's a little bit higher in an hour and a half, I can do a correction." (P26.1)

"The only time I've not taken its advice has been at bedtime when I've been high and it's told me to take 2 units, I've

Table 1 – Demographic characteristics, diabetes prevalence and glycaemic indicators of 42 adult patients.	
Age (years)	41.3 ± 12.5; range 24–66
Gender (%)	47.6% female
Diabetes duration at baseline (years)	17.8 ± 12.9; range 1–41
Occupation (% at baseline)	
-Professional	31
-Semi-skilled	36
-Unskilled	9.5
-Student	7
-Unemployed	16.5
HbA$_{1c}$ (mmol/l, IFCC; %, NGSP)	
Baseline	71 ± 14, range 46–104; 8.6 ± 1.3, range 6.4–11.7

taken 3 or even 4 because I'm not worried about having hypos.'' (M10.1)

3.2. Six month accounts

3.2.1. Dependency and deskilling

Participants with poor mathematical skills reported an on-going and heavy dependence on their advisors at 6 months, a situation which became apparent when equipment broke or was misplaced, with individuals reporting being ''absolutely at a loss'' (M14.2). Amongst other participants, there were notable changes in how they used their advisors over time. While some (n = 6) continued to do their own calculations, the majority, like M13, who had initially ''double-checked everything'', discussed how, ''lately I don't do any calculations at all'' (M13.2). As these participants suggested, having access to technology which was fast and easy to use had led to their becoming ''lazy'' (P39.2) and to their administering the doses recommended by their advisors in increasingly unreflective and unquestioning ways:

''It probably does make you lazy, because I don't really have to think about it much, you know, you can do your blood and then put in what you're having, have a quick look at it and not really think any more about it.'' (P39.2)

''I'll click it and I enter the amount of carbs and that's it, I just go with whatever the wizard tells me, without really thinking about it.'' (P31.2)

By virtue of no longer doing their own calculations, participants also described how easy it was to forget what their ratios actually were: ''the only thing I could forget is the ratios of DAFNE, but the machine knows that'' (M9.2); ''they're not in my mind but they're programmed into the machine'' (M 9.2). Hence, these participants had inadvertently become dependent on their advisors to determine their doses for them.

3.2.2. Impact on disease self-management

In some cases (n = 14), reliance on an advisor and/or unreflective practices of administering ''whatever the wizard tell me'' were later found to have had a detrimental impact on glycaemic control. This included, P2, who described recently attending a routine diabetes review appointment where, ''they found out I was having readings of 20 and 25 [mmol/l] and they got in touch with [course educator] and she hauled me in and had a look at the machine and altered it [ratio], from 1:1 to one and a half to one'' (P2.2). Likewise, P3, who had ''always followed what it [advisor] is suggesting'' described how, over a period of several months, he had had to ''give myself an extra 2 or 3 [units] every other hour to try and bring it down late morning.'' This problem was not identified and addressed until P3 attended a 6 month trial data collection appointment where, with input from educators, his morning mealtime ratio was changed.

Only a minority of participants (n = 3) reported having independently altered their ratios since their courses. In most cases, as P2 or P3 reported above, if changes had needed to be made, these had not occurred until a routine diabetes review or trial follow-up appointment. In most cases, participants implicated a lack of confidence, poor analytical skills, and/or

deferential attitudes towards health professionals to account for not considering or making any independent adjustments: ''I suppose I'm kind of subconsciously waiting for somebody with more expertise to sit down with me and suggest these changes'' (M13.2); ''I'm the kind of person that, as I said, I don't like to do stuff on my own, I'm afraid in case I do something wrong and I don't want to go hypo'' (P24.2).

However, participants also implicated their bolus advisors. Some (n = 6), for instance, reported not knowing how to change the settings on their advisors, and, hence, described leaving their ratios unchanged until they received health professional input. Others (n = 8) shared a misperception that, by virtue of being pre-programmed into their advisors at the time of their courses, their ratios and targets would never need to be altered: ''well, it's permanently pro-grammed into the software … so I'd just assumed that everything would stay the same'' (P27.2); ''I haven't ever changed it [ratio settings] because it was set up for me and I thought that was it'' (P42.2). Hence, when these participants did identify or attempt to address problems with their blood glucose readings, they focused on physical activity patterns or on altering background/basal doses: ''it's your basal's that going to have to be tweaked… cos your bolus, I don't really think you have to tweak'' (M18.2). Poor recollection of ratios and/or targets by virtue of them being pre-programmed was also implicated by some individuals (n = 11): ''they're [targets] not in my mind, they're programmed into the machine, hence I wouldn't know what numbers are [in order] to change them'' (M14.2).

Furthermore, whilst during their courses, participants kept a manual (diary) record of the blood glucose readings and other data (e.g. carbohydrate portions consumed) and received training on how to review these data in order to adjust their ratios and other parameters, many described manual record keeping as burdensome. Hence, the majority (n = 27) reported how, over time, they had taken advantage of, and become reliant on, the data storage facilities on their advisors: ''I'm basically now entering everything into the advisor rather than writing stuff down'' (M13.2). However, use of this automated feature, as such participants further reflected, also resulted in them reviewing their data less frequently, and sometimes not at all: ''I haven't looked at the data really'' (M13.2); ''Um, I'm relying too much on the meter's memory for that rather than making a record and going through it, trying to figure out patterns'' (M16.2). Hence, it was not until a review appointment was attended that individuals, such as M13, actually recognised that there was problem with their blood glucose readings which required a ratio or other parameter to be changed:

''since the course I've never once set down and looked at the data myself so the meeting [6 month follow-up] was the first time I actually saw the data, and things were…the figures weren't as good as I anticipated.'' (M13.2)

3.2.3. Reasons for stopping/never starting

While two participants chose not to use an advisor from the outset because they were worried it would deskill and disempower them: ''I did feel like it was talking the control

out of me, I mean they spend a lot of time teaching you DAFNE, the principles and then it's suddenly said, 'now forget about that; the machine will do it for you''' (P28.1), the remainder (n = 4) highlighted practical and logistical reasons. This included a couple of MDI users who discussed how they had preferred their old metres, which did not have built-in advisors, because they were smaller, lighter and hence easier to transport: "I know this is quite silly but it's too big for me, I feel I already carry so much in my bag" (M22.1).

Some participants (n = 2) reported stopping using their advisors because they did not know how to change the settings or they found data entry too time-consuming and burdensome:

"you know it takes quite a long time to type all the numbers in and it's quite fiddly and stuff. I just want to do a blood test, see what I am, wallop some insulin in . . . I think if I used it, I would get tighter control. It's just that, in using it, it interferes with life more than I want it to. It would be, you know, a frequent inconvenience" (M32.2).

A few (n = 2) also discontinued use in light of their experiences of administering recommended doses, observing repeated high or low blood sugar levels and, hence, losing trust in the technology:

"It was calibrated to a certain level, that other meter I got, you know, they did your carbohydrates and then your insulin and I kept questioning it and thinking "something's not right here, I knew in my head if I give myself 2 [units] and my sugar's nine and a half, I'm going to end up hypoing. . . so I lost faith in it and I stopped using it." (M29.2)

4.   Discussion

This is the first study to explore in-depth and over time people's experiences of using bolus advisors. Our findings suggest that most people, if given access to advisors, use them and perceive this technology as being beneficial. Not only did bolus advisors ease the burden of determining bolus doses, in many cases, a perceived benefit was that advisors eased the burden of data recording. Amongst participants who questioned their mathematical ability or whose concentration could be compromised by high/low blood glucose, use of advisors also offered reassurance that they were administering correctly calculated doses.

Hence, these findings lend support to earlier survey work which found improved overall wellbeing, confidence in dose determination and treatment satisfaction amongst people using bolus advisors [6,11,13]. However, by focusing on individuals' everyday experiences of using advisors and following the same people up over time, our findings suggest that there may be unintended and erstwhile unrecognised, adverse consequences to giving people access to this technology. Very few participants reported independently reviewing and altering their ratios and blood glucose targets over the 6 months of study, and, in some cases, this was described as having led to periods of poor glycaemic control.

In keeping with findings from earlier qualitative work undertaken with people on FIIT regimens who were not using advisors and who had received DAFNE training [5,19], participants in the current study implicated lack of confidence and/or deferential attitudes to health professionals. However, our findings also suggest that use of bolus advisors may reinforce some of the problems encountered. Specifically, we have seen how some people simply did not know how to change the settings on their advisors, whereas others reported a (mis)conception that, by virtue of individual parameters being pre-programmed, these would never need to be altered. Follow-up of individual participants has also highlighted how, by virtue of allowing advisors to do the calculations for them, people could become 'deskilled' and forget what their ratios actually were (which increased their reliance on their advisors), and administer doses in increasingly unreflective ways.

An additional area of concern is how participants' use of the data storage facilities on their advisors could result in their not reviewing their data, which mitigated their identifying problems and patterns in readings which could prompt them to adjust their parameters and/or seek health professional advice. Thus the data suggest that use of bolus calculators may undermine one of the underlying principles of DAFNE and similar programmes; namely, that patients should reflect on diary recordings of their blood glucose and carbohydrate intake to make adjustments to insulin doses in order to maintain pre-prandial glucose targets.

These findings suggest that, to promote effective use of advisors, people would benefit from on-going education and input from health professionals themselves trained in use of bolus advisors to remind them of the principles of use and to help ensure the correct ratios and parameters are programmed in and being used. Health professionals could also use their contacts with patients to address any misperceptions individuals might have about ratios and other settings never needing to be changed. However, given that health professional input is a costly option, consideration could also be given to developing and offering people more technologically advanced advisors, which contain pattern recognition software, which could offer prompts and alerts when problems with blood glucose control occur which patients may themselves fail to recognise. One component of acceptability of technology is trust [20,21]. If a device gives incorrect advice then an individual is less likely to trust it, and may stop using it, when in fact they could be prompted to re-examine their settings. As with many healthcare-related technological devices, bolus advisors may be of more use if real-time feedback was made available, analytics were more clinically meaningful [22] and if they included decision support capabilities [23].

The accounts of those who chose not to use their advisors also provide useful insight into how equipment might be improved. This includes making the devices used by those on MDI regimens compact and light-weight so they are easy to transport or incorporating advisor technology into devices individuals already use, such as mobile phones. Given that some people conveyed difficulties manually entering data into their advisors, they might also benefit from having access to voice recognition software.

Our findings also call for more critical appraisal of the research which has reported clinical benefits amongst people on pump and MDI regimens who use advisors. In the studies undertaken by Klupa et al. and Shashaj et al., the duration of follow-up was extremely limited – 7 days and 2 weeks respectively [8,9]. In addition, in both studies, physicians set individual parameters into the advisors. Garg et al. and Ziegler et al. followed patients up for considerably longer (one year and 6 months respectively), but not only did these patients receive regular and intensive input and support over the period of follow-up, they also had their parameters programmed into their advisors by health professionals at initial and follow-up visits [10,11]. Given the findings reported in this study, we would question whether the same improvements in blood glucose levels and/or glycaemic control would have been observed if patients had been followed up for longer and with less intensive health professional input.

A key study strength is the use of an open-ended, longitudinal, exploratory design as this has enabled us identify a number of potentially important issues relating to bolus advisor usage which have not been recognised or reported in previous (quantitative) research. An additional strength is the inclusion of people on both pump and MDI regimens, which increases the potential generalisabilty of our findings, not least because key issues cut across both groups. A potential limitation is that we did include health professionals in our study. Our participants' accounts suggest that they have been inadequately supported by their routine health care providers after completion of their DAFNE course, possibly because these professionals lacked knowledge and understanding of bolus advisor technology. Hence, future research exploring what the issues are for health professionals and how they might be better trained and supported to support patients in using advisors could be considered. Furthermore, since we used a qualitative approach, our study was, by design, small-scale. Hence, to better determine the extent of the issues and potential problems identified in our study we would recommend a larger scale, longitudinal, quantitative study be undertaken with patients who use bolus advisors in a variety of health care settings. Longer-term follow-up of participants could also be considered to establish and explore whether the issues identified in this study extend over time.

Conflict of interest

The authors declare that they have no conflict of interest.

Acknowledgements

Appendix A. REPOSE Group

The REPOSE Group comprises:

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