

Exploring blood glucose-related problem solving in at-risk emerging adults with type 1 diabetes.

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ABSTRACT

Purpose: To investigate the problem-solving skills of emerging adults with diabetes following hospitalisation for diabetic ketoacidosis (DKA).

Methods: An exploratory study design using the validated Diabetes Problem Solving Interview (DPSI) tool and taped interviews of responses to the DPSI. The DPSI score, covering two vignettes with six questions each coded zero to two, ranged from zero to 12. Scores were provided by two independent raters who analysed the transcribed interviews. Content analysis of the interviewed responses provided insights into self-care choices.

Results: There was no difference between the volunteers (n=11) and non-participants (n=22) in the target group (N=33) in relation to gender distribution or number of DKA events. Mean age for the volunteer sample was 24.1 years and number of DKA events ranged from one to three. The median DPSI scores were 8.5 and 9.0 (max of 12) for hypoglycaemia and hyperglycaemia vignettes respectively.

Conclusion: Participants had a reasonable understanding of what should be done but the qualitative results suggest their application of that knowledge was variable and perhaps contributed to their DKA risk. In seeking to improve services for emerging adults with diabetes when transferring to the adult health care system, the interpretative repertoires from this sample help to reveal the linguistically-expressed logic rules and intuition used.

INTRODUCTION

Diabetes requires persistent self-management to maintain metabolic control. Empirical research indicates adherence to treatment recommendations is lowest in adolescence¹⁻³ where patterns of dietary choices and habits start,⁴ and for a subgroup, persists into emerging adulthood.⁵ Family support at this time was still the strongest predictor of regimen adherence for 1625 year-old cohort.⁶ The juxtaposition and tensions between their developmental stage and the unremitting self-management demands of diabetes are not consistent with their priorities.^{7,8}

One of the seven diabetes self-management behaviours is problem-solving:^{9,10} 'learned behaviour that includes generating a set of potential strategies for problem resolution, selecting the most appropriate strategy, applying the strategy, and evaluating the effectiveness of the strategy'.⁹

Problem-solving is fundamental to food choices, exercise plans, understanding and acting on blood glucose data, and coping with stress – all part of diabetes self-management. Less than ideal problem-solving or strategy choices may lead to poor metabolic control, and long-term diabetes-related complications.¹¹

Diabetic ketoacidosis (DKA) is an acute, potentially life-threatening metabolic complication of uncontrolled hyperglycaemia that accounts for approximately 2–3% of diabetes-related deaths.¹² Apart from loss-to-follow-up^{13,14} and infection,^{15,16} the commonest precipitants are problems related to self-management including:

- Insulin omission;^{17,18}
- Emotional stress and distress; or
- Lack of application of sick-day rules.^{16,19,20}

This has prompted interventions such as an intensive education program for flexible, intensive insulin therapy and dietary freedom for adolescents and young adults²¹ and services such as mobile telephone support for sick-day management.²² Such interventions have proven successful for the emerging adult or 18–24 year-old cohort.

Nevertheless, problems related to self-care choices or lack of application of sick-day rules requires research to understand the logic behind self-management choices. This is especially important in emerging adults who occupy a development stage between adolescents and young adults.²³

Previous studies have examined either children/adolescent cohorts (<18 years) or adults (>24 years or a mean age >30 years).²⁴ Hence, this study investigated blood glucose related problem solving in an at-risk cohort of emerging adults with a prior DKA event.

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RESEARCH DESIGN AND METHODS

This explorative study was undertaken in a large tertiary hospital with its Human Research Ethics Committee approval. Recruitment and informed consent was by letter of invitation. Potential participants aged 18–25 years were identified from hospital records for DKA events between February 2007 and July 2009.

The validated DPSI 25 tool of hypothetical social situations (Table 1) was used to obtain insight into how participants would resolve the problem presented. There were three vignettes for each of the hypoglycaemic and hyperglycaemic vignette-types – one of each type was randomly chosen for each participant.

Interviews, which were undertaken by the same person (GB), were audio-recorded and transcribed verbatim. Using the manual provided²⁵ and meeting to discuss any coding issues, the interview responses to the six questions were scored (02) by two independent Credentialed Diabetes Educators.

The potential score range was 0–12 for each vignette-type with higher scores indicating more appropriate actions. Scores per vignette-type from the two raters were averaged.

ANALYSIS

The SPSS v19 software and its default settings, including significance set at 0.05, were used to calculate descriptive and inferential statistics for the sample. Statistical tests included:

- The Chi-squared test or Fisher's Exact test (used to test for association between categorical variables).
- The Mann-Whitney U test or Kruskal-Wallis Test (used to compare medians across groups).

Testing of DPSI included:

- Calculation of inter-rater reliability for the two DPSI vignette-types.

- A mastery DPSI score and analysis of its associations with demographic variables and DKA events.

RESULTS**Sample**

The gender spread of DKA events in the target group (N=33) was similar. Fifteen males and females had one DKA event each, two males had two events each, and one female had three DKA events.

From the original target group, eight declined to be interviewed, eight did not respond, three were excluded, and one could not be contacted. Reasons for exclusion included an inability to undertake diabetes self-management or relocation interstate.

Chi-square analysis indicated no significant gender differences between the two groups, participant or not, in the study ($p=0.282$). There was no significant difference in the distribution of DKA events between those who were or were not interviewed ($p=0.939$).

Thirteen participants 1827 years ($M=24.1$, $SD=2.9$) agreed to interviews but only 11 could be contacted four males and seven females. The duration of their diabetes ranged from one to 23 years ($M=10.8$, $SD=7.3$). Their educational background was evenly spread between non-tertiary ($n=4$), tertiary student ($n=3$) and completion of a tertiary course ($n=4$) and were of similar age.

DPSI descriptive and reliability statistics

The median hypoglycaemia and hyperglycaemia DPSI scores were 9.0 ($SD 1.1$, range 8.512.0) and 9.5 ($SD 1.0$, range 7.511.0) respectively. The intra-class correlations assessing inter-rater reliability for the hypoglycaemia and hyperglycaemia vignettes were 0.72 and 0.67 respectively. Internal consistencies (Cronbach's alpha coefficient) were 0.72 for the hypoglycaemia vignette and 0.67 for the hyperglycaemia vignette.

DPSI Associations:

- Mann-Whitney U Test indicated no significant gender differences in number of DKA events or either DPSI hypoglycaemia or hyperglycaemia vignette scores ($p=0.64$, 0.054 , 0.29 respectively).
- Further analysis of the hypoglycaemia and hyperglycaemia scenarios DPSI scores indicated a significant difference only for hypoglycaemia DPSI scores across education groups ($p=0.025$).

Table 1: Sample of Diabetes Problem Solving Interview Vignettes and Questions

Sample vignettes:

- Tim played basketball before lunch. Later he was waiting for lunch. He started feeling dizzy, hot, and shaky
- Amanda was supposed to go to soccer practice after uni / work but the coach cancelled it at the last minute. She ate lunch but didn't take any insulin because she thought she would be playing soccer for two hours

Questions for each vignette:

- 1 What is the diabetes problem here?
- 2 Why is this a problem?
- 3 What would happen if he/she did nothing?
- 4 Tell me all the ways this problem could be fixed?
- 5 How would you fix the problem?
- 6 How would that solution work?
- 7 How would you know if you really fixed the problem?

Sample vignettes and questions used with permission of Wysocki et al. (2008)

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- Specifically, the median hypoglycaemia DPSI score for the 'completed tertiary' group was 10.5 compared to 'non-tertiary' and 'tertiary student' group medians of 9.0 and 8.5 respectively.

A DPSI score cut off of 9.6 (80%) or more was used to explore diabetes problem-solving mastery for each vignette type. Mastery was achieved for:

- The hypoglycaemic vignette by four participants, all females.
- The hyperglycaemic vignette by five participants, three of whom were females.
- Both vignette types by two females.

Four participants (two males) did not achieve mastery for either vignette types. The distributions of age and duration of diabetes were not significantly different across the two mastery categories for the two DPSI types ($p > 0.13$).

DPSI interview analysis

Content analysis of interview responses to the DPSI vignettes was completed by an independent researcher (author JP). This researcher has expertise in qualitative data analysis and a background in nursing, education and communications.

Words and phrases were manually coded generating in vivo codes. Coding was crosschecked to ensure consistency, and was congruent with transcript margin notations by the independent raters. Codes were then grouped into content categories of data with similar meaning.

The interview was the primary object of research (discourse). Content categories reflected three interpretative repertoires²⁶ used by the emerging adults and the interviewer to organise and talk about self-care choices in relation to diabetes:

- 1 Interpersonal Relationships.
- 2 Treatment or Self-Management.
- 3 Assessment or Monitoring Blood Glucose Levels.

Interpersonal Relationships

The interviews provide insight into participants' views about the relationship between living with T1DM and health professionals, parents or work colleagues. Participant 014f stood out as her response suggested a struggle to establish her own control with regards to diabetes problem solving.

Firstly, she described the problem presented primarily as mismatched perceptions between the character and her parents:

014f: She could fix it by immediately giving herself more insulin to compensate for the, the extra

carbohydrate or she could go, 'No stuff you parents, mum and dad, I think I only had 75 so I'm just going to. . . keep testing my blood sugars and do some extra testing and if they go up then, then I'll give myself more insulin. If they don't then I was right and you were wrong. Naah naah naah'. (Laughs)

So I'd probably end up giving myself an extra 20 units of insulin if I was going to adjust for like going up to a hundred but I wouldn't be adjusting for eating a hundred grams because I'd go, 'No, I only ate 65, you guys don't know what you're talking about'.

Secondly, participant 014f described the approach she would take to such a problem versus health professionals:

014f: If I'm above 20, I give myself five units and then that should bring me down to about 18 maybe. . . if I'm above 20 I usually give myself like 15 units of insulin because that's how much I can. . . . Like I love going to hospital when it's like near 20 and they give you two units. 'How long do you plan on keeping me in here for guys?'

Most participants did not refer to their relationship with others as a struggle for control over who is best qualified to assess the diabetes problem and determine the course of treatment or management. Some did not mention parents and health professionals or the reaction of others in the workplace at all.

Five participants, however, suggested that people with diabetes should alert others to their situation to initiate treatment or manage hypoglycaemia. For example, when asked if there is anything else that the character should do to fix the problem, participant 011m replied: 'Maybe inform somebody that she's feeling like that'.

Assessment or Monitoring Blood Glucose Levels

Checking blood glucose levels (BGL) and being alert to symptoms were the most frequently mentioned assessment or monitoring strategies. Some participants used the building blocks of repertoires from medicine introduced by the interviewer when talking about the vignettes, while there was also evidence of a lay, emerging adult repertoire.

Some participants used medical terminology to name what was wrong with the vignette characters or what was not working properly (diagnosis), for example, 'hyperglycaemia'. Others expressed the diagnosis in lay terms, for example, 'Now she has a blood sugar level that's

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too high' (011m). Other participants employed a style of speech peculiar to them. Participant 015f, for example, talked about boosting up her insulin dose 'a little bit, not too much.'

The strategy most frequently mentioned was testing and re-testing at particular intervals to check BGL. For hypoglycaemic episodes, most reported that in the same situation they would:

- Take a fast-acting sugar followed by a longer-acting carbohydrate food
- Test and re-test their BGL to gauge the effectiveness of treatment.
- Judge the hypoglycaemic episode had been 'fixed' if the target BGL was between 4–8 mmol/L.

For vignettes of hyperglycaemic episodes, most said that the character should check their BGL ahead of administering insulin to correct hyperglycaemia. Here, too, participants reported seven different target readings (from 5–8 to less than 12 mmol/L) for determining if the hyperglycaemic episode had been 'fixed'.

Amongst this group of participants, monitoring symptoms, including paradoxical symptoms, was the next most frequently mentioned strategy for judging the effectiveness of treatment. Most referred to 'feeling' when the symptoms of hypoglycaemia or hyperglycaemia abate following successful treatment or management.

Table 2 lists symptoms of hypoglycaemia and hyperglycaemia commonly mentioned by participants. Only one participant reported having a ketone testing kit at home and another admitted rarely carrying her glucose meter.

Participant 006f would monitor symptoms such as shaking and difficulty concentrating. In contrast, participant 011m said that he would rely on both testing his BGL and knowing his own body. In participant 015f's case, she associated a particular feeling with a specific BGL: 'I feel low early so I have a low at five. . . five would normally be the range to. . . start feeling a little better.'

Treatment or Self-Management

The strategy most frequently mentioned for dealing with hypoglycaemia was dietary therapy.

In contrast, insulin therapy and exercise (to a lesser extent) were cited as strategies for treating or managing the hyperglycaemic episodes portrayed.

For vignettes of hypoglycaemia, participants reported that the character should have fast acting sugary foodstuffs close at hand as a short-term solution. Participants reported slower, longer acting foods or carbohydrates like a piece of bread as a longer-term solution 'so it won't come back down again' (Participant 011m).

Most participants said that the character should eat or drink a fast acting sugar before testing their BGL. However, their classification of fast acting sugar was sometimes erroneous.

The two foods most often considered fast acting and ideal for treating an episode of hypoglycaemia were jellybeans and soft drink, with considerable variation in the reported quantity and volume. Other foods considered fast acting (albeit inaccurately) were cake and chocolate.

The interviewer introduced the notion of 'the real world', acknowledging that people may do what is expedient rather than what is 'best'. Participant 001m took up this idea, saying he would continue eating jellybeans so as not to disrupt a work meeting: 'Yes it is the real world so, saves you know, stopping the meeting.' Others reported changing their usual behaviour or plan when circumstances changed, such as eating their lunch sandwich ahead of time.

DISCUSSION

The DPSI vignettes prompt participants to make judgments about diabetes self-management by reference to hypothetical characters and their own experiences. These vignettes helped participants to identify the risks and benefits of their problem-solving processes and strategies.

Vignettes suggest the logic behind the choices participants might make by revealing their:

- Knowledge and understanding in detecting problems, managing diet, and self-monitoring.
- Preventing acute complications – giving some insight into their problem-solving or understanding of recommended self-management.

The interpretative repertoires of Treatment, Self-management and Assessment Monitoring reflect the concern of the structured interview to assess problem-solving of participants with T1DM. Most participants described the problem in the vignettes relatively consistently with reference to these two interpretative repertoires.

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Table 2: Commonly Mentioned Symptoms of Hypoglycaemia and Hyperglycaemia

Hypoglycaemia	Hyperglycaemia
• Feeling 'shaky'.	• 'Ketoacidosis'.
• Feeling 'confused/disorientated/out of it'.	• Feeling 'unwell/sick/yuck'.
• 'Coma/unconscious'.	• 'Thirst'.
• 'Faint/pass out/black out'.	• 'No immediate problems'.
• 'Difficulty concentrating or focusing'.	

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In the course of social interaction participants may maintain, resist or transform the prevailing notion of living with diabetes. Similarly, 'Interpersonal Relationships' emphasises the very different concerns of participant 014f. She spoke about vignette events in terms of the character's relationship with others, and also her own bid to define and manage her diabetes.

Participant 014f offers a view of the emerging adult with T1DM as the 'expert' knowing their own body better than parents or health professionals. Her responses suggest that some struggle to take charge of diabetes problem-solving. For instance, she provides an oppositional reading.

Other participants did not necessarily share participant 014f's view of the negative effects of parents' or health professionals' control. Most did not discuss who is best qualified to assess blood glucose and determine the course thereafter. Nevertheless, parental involvement has been proposed as the 'cornerstone of the model for promoting adherence',¹ particularly, for modelling appropriate problem-solving skills.

Zoffman and Kirkovold²⁷ however, found that adult patients with poor glycaemic control felt health professionals undervalued their experience and knowledge, giving rise to anger, distress (albeit concealed) and resistance. Other participants' personal accounts also indicate that parental questioning of an emerging adult's management decisions, particularly about food, may be a source of conflict that disrupts communication and engenders resentment.²⁸

The reliance on instinctive knowing amongst participants in this study suggests that emerging adults with T1DM may view problem-solving differently to health professionals. The notion of preparedness for testing BGL is indicative. While health professionals likely consider carrying a glucose meter as the corollary of 'being prepared', not carrying a glucose meter does not necessarily indicate a lack of preparedness.

In this group, 'being in tune with your body,' and 'knowing your own body' from previous experiences, were as important a means of being prepared for hypoglycaemic and hyperglycaemic episodes as having a glucose meter available. Despite recent hospitalisation for DKA, participants relied on knowing their own bodies as much as, and sometimes more than, glucose meter readings to gauge their BGL and response to diet, exercise or insulin.

Our findings were consistent with:

- Rasmussen et al.²⁹ which showed that learning

from previous experience to recognise and act on body cues is an important form of strategic thinking and planning integral to young adults successfully managing T1DM.

- The notion that non-compliance is the norm.^{30,31}
- Findings by Stewart et al.² that self-regulatory behaviours rather than compliance with fixed instructions were more likely to improve glycaemic control. The inference being that the individual uses problem-solving skills to vary recommended self-management and still achieve desired glycaemic level.

Because each of the participants in our study had had at least one DKA event in the preceding two years, our findings suggest that what they learned from 'listening to their own bodies' was not fool-proof in preventing short-term diabetes-related complications. Such inaccurate estimates are most often associated with 'dangerous' failure to treat.^{32,33} Blood glucose discrimination training in which participants attend to both internal cues (symptoms) and external events (insulin, food, and exercise) may improve the accuracy of their self-estimation of BGL^{25,34} and possibly reduce the risk of DKA.

The language of some participants suggests that particular idioms form units of meaning for this demographic at odds with the perspective of health professionals. Referring to insulin dosages in descriptive terms instead of by specific dosage, for instance, implies an intuitive approach much like loosely following a cooking recipe.

A 'boost' of insulin cannot be directly equated with a specific number of units of insulin. Yet the participant who used this descriptor used previous knowledge and her BGL to adjust her insulin dose to reach the desired BGL.

This participant's approach is analogous to fuzzy logic, in which if-then rules are applied to linguistic variables (words) instead of numbers and overlapping fuzzy sets. Fuzzy logic tolerates uncertainty, imprecision and approximations in complex situations yet can produce precise, repeatable results.³⁵

This study had two main limitations:

- 1 Sample size. The participant and non-participant groups did not differ in relation to gender, education or number of DKA events. However, as volunteers they were not representative of this age group.
- 2 Low inter-rater reliability for the hyperglycaemia vignette. This occurred despite the good face validity of

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DPSI vignettes and ratings were completed independently using a coding manual.³⁶

If problem-solving is one of the seven diabetes self-management behaviours,³⁷ more work is needed to find a reliable assessment measure.²⁴ This study provides preliminary data for a replication study with a larger group, including a control non-DKA cohort, for further psychometric testing of the DPSI in this age-group.

On a larger scale, given that fluctuations in glycaemic control can be caused by variables beyond the medical regimen itself, the ability to self-regulate or problem-solve becomes paramount. Over time, direction for an intervention study to improve problem-solving skills may be provided by exploring changes in the relationship between:

- A problem-solving score;
- An objective measure of adherence; and
- Selected health outcomes.

CONCLUSIONS

In this study, participants appeared to have a reasonable understanding of what should be done in the vignettes provided. However, the participant's application of that knowledge seems variable and may contribute to their risk for problems. That is, they knew about the importance of blood glucose monitoring but still chose to make judgments on 'how they felt'.

In addition, the participant's approach to treatment and self-management varied greatly and not always appropriately. The apparent lack of parental involvement is also of concern given its importance in the advancement of the emerging adult's autonomous self-care behaviours.^{1,6}

Diabetes-specific responsibility and parent-conflict have important implications for improving health outcomes. Interventions targeting responsibility and conflict while keeping parents involved may help prevent the deterioration in glucose control.³⁸ The emerging adult-parent dyad warrants further study as the transition to adulthood may well be an emergent process rather than a linear path towards self-sufficiency.³⁹

This study reminds diabetes health professionals that emerging adults rely more on internal cues to estimate their BGL, despite demonstrating quantitative problem-solving such as calculating:

- Food portions.
- Carbohydrate coverage ratios.
- Correction rates for insulin dose.

Increasing the dose of knowledge given to young adults with T1DM may not lead them to make the 'right' self-care choices. Also, there may be more than one 'right' choice and understanding the problem-solving process used enables the clinician to remedy flawed assumptions.

Information from this study can be used to improve services for emerging adults with diabetes when they move from paediatric to adult health care. The interpretative repertoires from this sample may help to reveal the linguistically-expressed logic rules and intuition they use.

However, emerging adults are likely to react against health information targeted to a set of demographic characteristics and that which emphasises control. Recognising this, clinic staff could use strategies that are individualised, affirming, respectful of their autonomy, and that accommodate a level of messiness.

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