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## Background

- Initiating and adjusting insulin treatment for people with type 2 diabetes requires several practice visits and frequent telephone calls.
- We explored the use of a telehealth system to offer additional support to these patients.
- Telehealth is a term encompassing healthcare practices, which are supported by innovative telecommunication strategies.
- The study built on a previous trial to support patients with type 1 diabetes.<sup>2</sup>
- We report the way the telehealth system was integrated into clinical care and the experiences of clinical staff and patients.

## Aims

- To integrate the use of a telehealth system with primary care management of type 2 diabetes.
- To establish user feasibility and acceptability of telehealth monitoring and support for insulin initiation and adjustment.
- To conduct a pilot study to explore and identify the training and support requirements of patients and clinicians using the system.

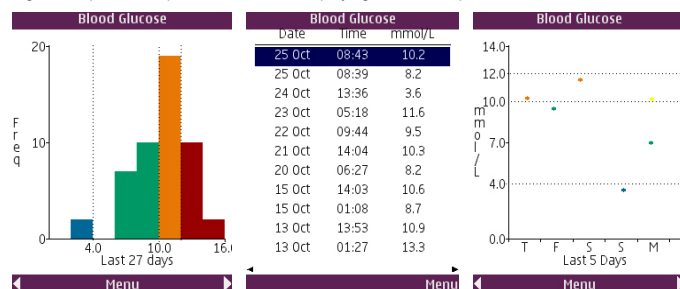
## Methods

- Patients with uncontrolled type 2 diabetes were recruited from fifteen general practices to a small cohort study.
- The intervention included a standard algorithm for self-titration of insulin dose<sup>3</sup>, a Bluetooth enabled glucose meter linked to a mobile phone, an integrated diary to record insulin dose, and feedback on the phone's colour screen of blood glucose data (see Fig. 1 for three displays). The phone and software application 't+ diabetes', were supplied by t+ Medical (Abingdon, UK).
- A telehealth nurse (DSN) working remotely, reviewed results and provided telephone follow-up.
- The study duration was 6 months.
- Additional contact with patients was initiated according to the following criteria:-
  - Failure to receive blood glucose readings (BGR) for >3 days
  - A 7 day trend of higher than usual BGR (fasting BGR >7.5mmol/l)
  - A single record of BGR <4mmol/l
  - Patient specific excursion from usual trend.

### Case Study 1

Patient T029 was contacted by their practice nurse, who had been alerted by the telehealth nurse of the patient's 5 days BGR >11mmol/l. Their insulin regimen was reviewed and they were requested to make weekly visits until a significant reduction in blood glucose levels was achieved. At follow-up visits it became clear that the patient had been missing out insulin doses to facilitate weight loss. They were referred to a dietician.

Fig 1: Sample mobile phone screens for displaying BGR to the patient.



### Case Study 2

Patient T030 had a blood glucose reading of 30.5mmol/l and was contacted by the telehealth nurse to discover that the patient had consumed three cans of coca-cola a few hours before performing the test. Advice was provided regarding the high sugar content of fizzy drinks and the association of sugar and carbohydrate intake, and increased blood glucose levels.

## Results

Table 1: Baseline Patient Characteristics

	n=28	Mean (SD)
Female <sup>1</sup>	18	(n=5)
Age <sup>2</sup>	58	(11)
Diabetes duration <sup>3</sup>	71	(52)
Weight <sup>4</sup>	97	(27)
BMI <sup>4</sup>	32	(6)
Systolic BP <sup>5</sup>	141	(18)
Diastolic BP <sup>5</sup>	83	(8)
HbA <sub>1c</sub> <sup>1</sup>	9.4	(2.2)
Insulin dose <sup>6</sup>	48	(35)

(<sup>1</sup> %, <sup>2</sup> Years, <sup>3</sup> Months, <sup>4</sup> Kg, <sup>5</sup> mm/Hg, <sup>6</sup> Units)

Table 2: Recruitment data

	n (%)
Invites sent	96
Responses	52 (54)
Patients recruited	28 (29)

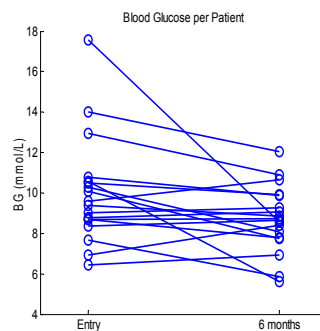
- Interim results show patients (n=18) HbA<sub>1c</sub> was mean 9.5% (SD 2.3), at baseline and decreased at 3 months by 0.5% (0.93) and at 6 months by 0.8% (1.68).
- Insulin dose increased at 3 months by mean 10 units (SD 24) and at 6 months by 15 units (SD 28).

Table 3: Patient technical support protocol

Call type	Action/Recommendation
Technical problems, such as, phone transmission or application errors	Normally resolved by the telehealth nurse or escalated to the application supplier's front line support team.
Ongoing training matters	The telehealth nurse provided telephone training or visited the patient at their home. Additional training materials were provided incl. a step-by-step user guide and training manual.
Mobile phone service provider problems, insufficient signal or lack of phone credit.	Service provider issues normally due to temporary network faults and resolved without action. If signal insufficient patient advised to transmit in area with stronger signal strength. Phone credit topped up remotely.
Bluetooth cradle fault or battery failure.	Cradle replaced by post or by telehealth nurse visit. New battery provided.
General enquiries, such as, I'm going on holiday, will my phone still work?	If patient travelled abroad they were requested not to use their phones but to continue monitoring their blood glucose and to download the results on their return.

Fig 2: Trends in blood glucose by patient

Mean BG drops 2.4mmol/l  
Mean FBG drops 2.3mmol/l



- Clinicians valued three aspects of the telehealth system: (i) the ability to access up-to-date information about patients' blood glucose readings and insulin doses; (ii) the potential to support patients in making their own insulin adjustments; (iii) the opportunity to enhance patients control of their condition.
- Overall, clinicians viewed the technology as having potential to improve patient care.
- Practice nurses reported a reduction in the time required to support people during the initial stages of insulin titration.
- Most patients were able to use the equipment with training and welcomed review of their blood glucose readings by the telehealth nurse.
- Patients were enthusiastic about the additional level of support facilitated by the telehealth system and felt that the service complemented their primary care services.
- Familiarity with use of mobile phones enabled more rapid adoption of the technology.
- Transmission of results is maintained throughout the study.

## Conclusion

Early findings indicate that reductions in HbA<sub>1c</sub> can be achieved through a combination of remote monitoring and real-time feedback of BGR results via the telehealth system.

Although the telehealth concept is unfamiliar to most patients and practice nurses, the technology could improve support for type 2 diabetes patients commencing insulin treatment.

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