



SUSQI PROJECT REPORT

Project Title: Improving the environmental impact of patients with diabetes and on insulin.

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Team Members:

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Background:

Diabetes is a condition that causes a person's blood sugar level to become too high due to lack of insulin production from the pancreas or insulin resistance. In 2021, the number of people living with diabetes in the UK hit an all-time high at over 4.9 million, with an additional 13.6 million people at increased risk of type 2 diabetes (1). A common medication for diabetes management of blood sugar levels is insulin, required by all people with type 1 diabetes and many with type 2 diabetes (as well as other types such as gestational diabetes) (1). If left uncontrolled diabetes can lead to serious long-term health problems.

Individuals with diabetes taking insulin will use a pen device with an insulin cartridge inside, administered by the individual or by a third party (e.g. nurse). The majority of insulin pens are single use (with 300 units of insulin per pen), and it isn't possible to know when or how much insulin was last given. Once the 300 units are finished, the needle is removed and the pen disposed of in general waste, therefore creating significant plastic and medication waste, contributing to carbon emissions and climate change. Patients with diabetes are particularly vulnerable to effects of climate change such as extreme weather events and air pollution (2), due to factors such as impaired responses to heat stress, diabetes-related comorbidities, insulin resistance and chronic low-grade inflammation.

At present, we are facing a shortage of a single-use pen device and insulin cartridge provided by Tresiba (called Flex touch). The shortages are due to demand with other products across the world and the companies cannot keep up with this demand and increase in manufacturing. We therefore have no choice but to change all our patients using this product onto a different one. While some options available would bring no environmental or cost benefit such as flex touch pens with more concentrated U200 insulin (usually U100), this provides an opportunity to consider if a change could also bring environmental and cost benefits to our service by making a switch to 'smart pens'.

'Smart Pens' are reusable pens developed by Novo Nordisk, who have been more proactive in tackling the environmental impact of insulin pens. The pens last 5 years and require much smaller (still single use) cartridges compared to single use pens. Smart pens also provide the time and dose of insulin given on the pen. This record

provides practical benefits, as it offers reminders to patients regarding their latest insulin dose. When a third party (e.g., a district nurse) is giving insulin, they may not need to be present for all doses if the device memory supports a person to be more independent. Novo Nordisk has also set up and advertised a recycling system for single use insulin pens called PenCycle (3), aiming to reduce the impact when single use pens are still required.

As a team, we identified an opportunity to improve our practice through the above initiatives. In our roles we run community diabetes clinics, see patients in their own homes and support district nursing teams, therefore the initiatives need to be approached differently in each setting.

Specific Aims:

To reduce the environmental impact of insulin pens by

- 1) Switching appropriate patients from single use pens to reusable 'Smart Pens'.
- 2) Raising awareness of and promoting use of the 'Pen Cycle' recycling scheme for single use insulin pens

Methods:

Studying the system:

We reviewed our community and clinic caseloads, identifying 286 patients on Novo Nordisk insulins eligible to switch to reusable smart pens or recycle their current pens. As some patients are on multiple products, a total of 343 prescribed Novo Nordisk insulin products were identified. All 286 people would be eligible to recycle their single-use pens, and a large proportion of 343 prescriptions could be changed to smart pens to reduce the need for disposable pens. Not all will be changed, as some will benefit from staying on the same insulin in a different strength disposable pen or swapping to a new insulin. This will be assessed by clinical judgement.

Aim 1: Reusable 'smart' pens

Currently, Novo Nordisk provides reusable insulin pens for free, as the concept is new and they are wishing to promote their new product. There is also a shortage of insulin in one product Tresiba starting from early August, forcing more urgent review to ensure individuals will not be left without this insulin. The shortage as well as free smart pens has caused us to move faster with the planned change. The eligibility criteria for change to smart pens is being on an appropriate insulin (i.e. Novo Nordisk) and being able to manage the smart pen (understanding the change). Most individuals will be eligible. In order to change to smart pens, we must also engage the patients GP surgery to make a change to their prescription.

We have kept a list of those patients we have trained and transferred to smart pens.

While not possible in the competition timeframe, we have plans to deliver training on smart pens to district nurses and have allocated the correct number of reusable pens to distribute to each district nursing base to change those on Tresiba insulin (the one in short supply) to smart pens. Assessment of caseload will be required to consider changes of other insulins. We can track the changes on our caseload but would need to ask district nurses for their numbers to be able to track the environmental future impact.

Aim 2: Recycling via PenCycle

Only Novo Nordisk products can be recycled using the PenCycle scheme, however within our service, this is the majority of the insulin we use. PenCycle works by ordering small cardboard boxes from the Novo Nordisk dedicated ordering website. Each box holds 12 pens and once full, the box is posted either by the patient or participating pharmacies via letterbox to the freepost address. Novo Nordisk then sends the pens to a specialist facility in Denmark and the pens are recycled into other products e.g. furniture and repurposed lamps.



At insulin safety week 15th - 19th May 2023 we promoted insulin safety to the four community district nursing teams within north Warwickshire. This engagement presented a good opportunity for us to introduce insulin pen recycling. We ran a competition between the district nursing teams, providing Novo Nordisk 'pencycle' recycling boxes (which fit 12 pens per box), and encouraging teams to collect as many disposable insulin pens as possible in a set timeframe. A prize would be offered to the district nursing team who collected the most, encouraging recycling and building awareness of the scheme to recycle pens on a larger scale in the future. Pencycle data was collected by e-mail with total numbers of pens collected at the end of the specified time frame.

We also identified that we could promote the pencycle project with clinic patients and individuals at home. We have started to do this by discussing in the clinic and handing out pencycle recycling boxes and leaflets.

Measurement:

Patient outcomes:

Aim 1: Reusable 'smart' pens

In the 10 week competition timeframe we have not had time to measure patient outcomes. In the future we could measure the number of visits from district nursing to patients and quality of life for the individuals as Smart pens may increase independence and reduce reliance on others to monitor doses.

High quality care continues in accordance with guidelines and continues to be provided as we have not changed the doses or types of insulin being used when switching to reusable Smart Pens. We have highlighted potential and/or expected outcomes in the results section

Aim 2: Recycling via PenCycle

Recycling will have no impact on patient care or outcomes.

Environmental sustainability:

Aim 1: Reusable 'smart' pens

Novo nordisk provided the following data for carbon footprinting via email. Based on 1000 people using pens for a year

- Disposable pen – i.e. flexpen = 15,000kgCO₂e
- Durable (smart pen) = 8,200 kgCO₂e lasting 5 years

We have therefore assumed a carbon footprint of 15 kgCO₂e per patient per year using a disposable pen, and 8.2 kgCO₂e per year for a patient using reusable pens. However, we do not know what assumptions were used to calculate this data, such as how many pens are used by a patient per year. We also do not have information on what was included or excluded in the carbon footprint (e.g. raw materials, insulin medication, waste disposal, etc).

There is a possibility that use of smart pens will reduce the number of appointments required by some patients and therefore CO₂e associated with travel, however measurement of this was outside the scope of this project.

Aim 2: Recycling via PenCycle

The pencycle system returns the pens for recycling in Denmark. Novo Nordisk is in the process of completing a full life cycle assessment report for their PenCycle programme which will measure the CO₂e from Pencycle (pen collection and the recycling process) vs. the best-case alternative (disposal in clinical waste - incineration). Once we have this data, this report and savings estimations will be updated.

As the company data is not currently available, we completed a processed based carbon footprinting analysis including the weight and types of materials used for the pens and packaging, and transport. For current waste disposal methods we used an emission factor for domestic waste from the UK Gov database (4). For recycling, we



excluded emissions associated with the manufacturing and delivery and return posting of the pencycle boxes. We assumed patients would walk to post their return pens. We excluded recycling of the pens as the CO2e from this process would be attributed to the new product developed from the recycled materials.

Economic sustainability:

Aim 1: Reusable 'smart' pens

The 'smart pen' devices for use with insulin cartridges were supplied directly by Novo Nordisk without charge at this stage. We do not know for how long Novo Nordisk will be providing these pens free of charge. The financial data to compare single use vs reusable pens in the future has been obtained from the insulin company.

Smart pens last for 5 years, so at this point a new pen will need to be issued at the cost of the patient's GP surgery. We have assumed only one pen is required every 5 years (however some pens may break or be lost).

Financial data for district nursing time has been obtained from the Trust.

Aim 2: Recycling via PenCycle

The pencycle boxes were also supplied free of charge by Novo Nordisk and the return postage was pre-paid so there were no charges incurred to the Trust when posting the empty pens back for recycling.

Social sustainability:

We did not formally measure social sustainability however have detailed potential impacts in the results section.

Results:

Patient outcomes:

Aim 1: Reusable 'smart' pens

Use of reusable smart pens may improve patient care as the pens remind patients of when the last dose was given and the time given, providing reassurance when they gave their last insulin dose and how many units were administered. This is helpful for patients who are unsure if they took their insulin, preventing duplicate or omission of insulin doses. This may be useful for vulnerable groups such as the frail or elderly but also for the younger population with busy lives.

Some patients will be more safe due to the insulin memory in the smart pen device helping assist individuals and carers provide the last insulin dose details preventing double dosing or no insulin given. Ensuring the correct insulin doses can optimise management of blood sugar levels and therefore reduce the long term complications of poorly controlled diabetes such as heart attack, stroke, neuropathy and retinopathy among others, reducing hypoglycaemic episodes, high sugars and possible DKA or even hospital admissions.

The above may lead to more independence as individuals, as if appropriate patients can be left to give their own insulin at times carers/district nurses were previously required to perform checks. This has been the case for one patient. The patient has twice daily insulin and previously required a district nurse to visit for both doses as there was uncertainty about him remembering to give the dose. The SmartPen allows district nurses to see when the last insulin injection was given and to visit once per day as the earlier dose could be checked. This could also improve the effectiveness of his insulin and diabetes control as he can give insulin at meal time instead of when the nurse arrives.

Aim 2: Recycling via PenCycle

Recycling of insulin pens does not have any direct outcomes for the patient.



Environmental sustainability:

At baseline, we identified 286 people who could recycle disposable pens and 343 prescriptions which could be changed to reduce the need for disposable pens.

Aim 1: Reusable ‘smart’ pens

Of the 343 eligible patients, we have changed 6 to smart pens. We have a further 23 patients planned to change their Tresiba from single use pens to reusable pens.

Based on Novo Nordisk's data, we will save 6.8 kgCO₂e per year for each patient that we switch to reusable pens. Based on switching 29 patients, we will save 197.2 kgCO₂e. As we step up the changeover to smart pens, we aim to switch 100 people in the next 4-6 weeks, with a reduction of 680kgCO₂e for the trust.

If we switched 80% of suitable prescriptions in the next year (274 patients), we could save **1,863.2 kgCO₂e per year**.

Aim 2: Recycling via PenCycle

Whilst we did not record the number of recycling boxes or leaflets handed out, the number of disposable pens collected by the district nurses as part of the competition for insulin safety week was 143 in 8 weeks.

We calculated the following:

- Disposing of one pen at home (black bag, energy from waste): 0.004128 kgCO₂e
- Sending one pen back to Denmark to be recycled: 0.0041347 kgCO₂e
- Difference = 0.00001 kgCO₂e (almost carbon neutral).

Therefore, 143 pens recycled is an increase of 0.00143 kgCO₂e. This means there is no real benefit for the Trust in using pencycle with an aim to reduce the Trust's carbon footprint.

However, there is a wider environmental benefit in recycling and use of less virgin materials. According to the Government factors database, using 1 tonne of recycled plastic rather than 1 tonne of virgin plastic saves on average 780 kgCO₂e. Novo Nordisk is in the process of completing a full life cycle assessment report for their PenCycle programme and we are told by contacts at NovoNordisk that preliminary results show that from a CO₂e perspective PenCycle has lower emissions, however more data could not be shared at present.

Economic sustainability:

Aim 1: Reusable ‘smart’ pens

Some of the insulins have a cost saving attributed when swapping from pre-filled pens to insulin cartridges. Other insulins such as Tresiba and Levemir are the same price regardless of format so are cost neutral. Estimated financial savings per month from switching to reusable pens, assuming 5 boxes of pens used per month (usual prescription).

Insulin	Monthly saving £	Number of patients on caseload	Theoretical saving if all patients changed	Actual savings number changed/monthly cost saving (£)
Tresiba	0	97	0	28/0
Novorapid	3.82	113	431.66	3/ 11.46



Fiasp	2.29	11	25.19	2/4.48
Novomix 30	1.10	117	128.70	1/1.10
Levemir	0	5	0	0/0
Total		343	585.55	36/£17.04

If we switched 80% of suitable prescriptions in the next year (274 patients), there would be a cost saving of £468.44. This excludes the cost of the Smart Pen (£26.86 per pen lasting 5 yrs) with a monthly cost of £0.45p. Including this would still be a cost saving for Novomix, Novorapid and Fiasp.

There has been a reduction in district nursing costs observed for one patient as mentioned in the patient outcomes section. Estimated costs of district nursing time saved.

- Smart Pen 30 minute training for district nurses from band 7 specialists nurse at £24.33 per hour - £12.16 per nurse attending training for 30 minutes, this is one off training.
- District Nurse costs are £45 per visit for insulin administration.

Assuming 28 appointments reduced a month, there is potential saving of £1,260 per month, or £15,120 per year for one patient alone.

Aim 2: Recycling via PenCycle

There have been small costs attributable to postage of smart pens (held by ourselves and posted to patients not handed over in the clinic setting) in small numbers, mostly these are provided in person in clinics or home visits.

Social sustainability:

Aim 1: Reusable 'smart' pens

As per the example in the above sections, Smart Pens may support a decrease in the frequency of district nursing visits and specialist nursing input required to administer insulin. This could have benefits for patients, carers and staff. For patients and carers, It can provide reassurance and reduce concern and anxiety that doses are given correctly. It may allow patients and carers to have more independence and freedom to be out of the house for longer as no need to wait for nursing appointments. It could reduce hospital admissions for severe hypo or DKA for under or overdosing.

For staff, this could help improve the efficiency of district nursing care and reduce the amount of visits required, mileage undertaken, reducing staff stress. We have two upcoming dates for wider training and distribution of smart pens to the district nursing bases, this will enable us to work on reducing nursing visits further.

There may be an initial time cost for establishing this change including requests to GPs to change prescriptions and training district nurses on the new pen device.

Aim 2: Recycling via PenCycle

The use of PenCycle will possibly improve individuals' well-being by making them feel positive about reducing the environmental impact of their care, by seeing their medical device repurposed into a new product. Actively encouraging patients to recycle their insulin pens, this could increase awareness around recycling and encourage them to be more mindful with waste elsewhere in their lives.

Discussion:

One of the main challenges encountered was the time required for multiple aspects of the project, including

- to find everyone on the caseload on Novo nordisk insulin and establish if they would be suitable to change to reusable pens or more suitable to encourage recycling with pencycle boxes. (We cannot use our EMIS patient electronic record to filter insulins as this is not recorded in our EMIS templates in a way this could be filtered).
- time to write letters to the GPs to change prescriptions once established who could be swapped to reusable pens and cartridges.
- training of district nurses as we will be working collaboratively to distribute the reusable pens and train patients on how to use them
- pressure to change patients on Tresiba due to their insulin going out of stock.

We identified that for some patients a switch to Smart Pens may improve their independence and reduce the number of district nursing visits they require. However, this may be a risk to other patients. Some patients may live alone, with nurse visits their only social contact in the day providing an opportunity for a wider wellbeing check. Reducing district nursing visits may therefore impact the mental wellbeing of some individuals. Reduction in visits needs to be considered holistically and in decisions made jointly with patients on a case by case basis.

Whilst many of our patients use Novo Nordisk insulin products, many use other brands. Novo Nordisk recycling is only available for Novo Nordisk pens. Whilst we cannot recycle other brands' insulin products as yet, successful use of the pencycle boxes could demonstrate to other brands the benefits of this initiative. Additionally, achieving high numbers of filled PenCycle boxes could encourage other Trusts to recycle more themselves.

With the Pencycle scheme, it could be possible that motivation to continue recycling decreases with time. We may need to consider ways to remind and encourage people to continue doing this. We used insulin safety week this year to educate staff on the pencycle project so we could continue to use this as an annual reminder. We plan to continue to encourage the district nurses to obtain their own PenCycle boxes, and will encourage individuals in clinic and on home visits with a conversation about the benefits and providing a leaflet on how to obtain their own. We need to develop a method for recording the number of boxes and leaflets (advertising pencycle) out so we can monitor the impact of changes of PenCycle.

This project focussed on the community diabetes team in North Warwickshire which patients predominantly have type 2 diabetes. By informing our acute diabetes colleagues in George Eliot Hospital and other teams within the foundation group eg colleagues in South Warwickshire and Warwick Hospital, we could expand this work and have greater environmental benefits. This would be particularly relevant as our colleagues in secondary care have a greater number of patients on their caseload with type 1 diabetes so will have much larger numbers of insulin prescriptions they can influence.

Conclusions:

A key learning point in this project was understanding the numbers of patients we were dealing with and the scale of influence that could be possible. Whilst we did not recycle or swap large numbers during this project, we only had a short space of time so it has helped us recognise the amount of change possible going forward and the beneficial environmental, social and financial impacts this may have.

One changed onto a smart pen, the environmental benefits of the reduced waste of cartridges compared to disposable pens will be ongoing and provide benefits for every prescription changed. It is difficult to estimate the potential savings on a larger scale, however we do know 8% of the diabetes population have Type 1 diabetes and therefore will be on insulin. While not specifically Novo Nordisk insulin, we can still assume the financial and environmental benefits are huge if scaling up across the whole UK.

References and Resources

1. [Diabetes and climate change: current evidence and implications for people with diabetes, clinicians and policy stakeholders - PubMed \(nih.gov\)](#)
2. [Diabetes diagnoses double in the last 15 years | Diabetes UK](#)
3. <https://www.pen-cycle.co.uk/healthcare-professionals.html>
4. [Greenhouse gas reporting: conversion factors 2023 - GOV.UK \(www.gov.uk\)](#)

