Community Pharmacy Staffordshire & Stoke-on-Trent

Keele University

The Carbon Reduction Impact from Synchronising Prescriptions (CRISPS) Study Final Report

December 2024

Executive Summary

Introduction

Synchronising the dates of patients' repeat prescriptions can reduce monthly community pharmacy visits or home deliveries, which may improve patients' adherence to medicines (Nguyen & Sobieraj 2017). It should also reduce carbon dioxide (CO_2) emissions associated with avoidable travel, but previous research does not appear to have determined the potential size of this reduction. This pilot study therefore attempted to do so using routinely collected data.

Aim

To estimate potential carbon savings from synchronising repeat medicines for a sample of patients from one community pharmacy.

Methods

Initial piloting and feasibility work determined that people with non-synchronised prescriptions who have medicines delivered to their home could be identified from community pharmacy home delivery records. In a subsequent service evaluation, all patients who had prescriptions dispensed four times per month or more from a single medium-sized (approximately 2,500 items dispensed per month) urban community pharmacy in England were identified from the pharmacy's home delivery application. The threshold of four deliveries per month was selected to increase the likelihood of this frequency being due to non-synchronised prescriptions. Data were collected (August 2023) for deliveries in June 2023 as there were no public holidays or events to affect prescription ordering. Data included patients' postcode, delivery dates, and using the Patient Medication Record, the pharmacist collecting the data determined acute or one-off prescription items, that neither the patients nor the repeat medicines were new, and where deliveries were made to supply medicines owing. The pharmacy was selected because it efficiently managed stock to minimise items owing. The distance that would have been travelled was calculated as if the medicines had been collected from the pharmacy as a dedicated journey to and from the patient's home address instead of being delivered. The saving in miles and CO_2 emitted for different vehicle types was modelled by assuming that for each patient, all deliveries that were not for acute items or medicines owing could have been reduced to a single delivery if prescriptions had been synchronised. UK Government conversion factors were used to calculate CO_2 emissions (Department for Energy Security and Net Zero 2022).

Results

Data were collected for 59 patients, of whom 7 patients had 8 deliveries, 4 had 7 deliveries, 6 had 6 deliveries, 5 had 16 deliveries and 26 had 4 deliveries. The total number of deliveries to these patients was 269 but would have been 80 deliveries if the repeat prescriptions had been synchronised (70% reduction). The distance travelled would have been reduced from 842 miles to 241 miles (71% reduction). This would have resulted in a 71% reduction in CO_2 emissions, although the reduction in volume in kilograms of CO_2 emitted would have varied (by an estimated 137 Kg CO_2 or 51%) depending on whether e.g., a small diesel car was used or a large petrol car (reduction of 133kg versus 270 Kg CO_2). An average diesel car was estimated to have reduced CO_2 emissions by 163 Kg.

Conclusions

The findings demonstrate that potential carbon savings from medicines synchronisation can be modelled from routinely collected data, but with limited accuracy, especially as patients receiving home deliveries may not be representative of all pharmacy users. Challenges remain in how to measure actual carbon savings of prescription synchronisation and overcoming barriers to widespread implementation of clinically appropriate synchronisation.

Recommendations

1. Further research on a larger scale should be undertaken to confirm the findings of this study as this can support policymakers to decide whether prescription synchronisation should be contracted through the NHS.
2. Patient Medication Record functionality should be developed that automatically identifies patients who have more than one prescription dispensed per month and can distinguish prescriptions for regular medicines from new prescriptions.
3. Prescription synchronisation activity should target those who have the most collections / deliveries of medicines per month.

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Contents

1. Introduction

There is now a substantial accumulation of evidence that climate change due to human activity is happening and that it will likely have profound adverse consequences for human health worldwide (Godlee 2014). Healthcare makes a substantial contribution to global carbon emissions and health professionals have opportunities to mitigate the effects of climate change, directly by helping to reduce their carbon footprint, and indirectly by influencing others in the societies they serve to do so too (Firth et al 2023, Godlee 2014).

The use of medicines is one of the largest contributors to the carbon footprint of healthcare and there is an increasing body of research literature on the impact of pharmaceutical manufacturing on carbon emissions (Firth et al 2023, Sammut Bartolo et al 2021). Studies have also looked at how the pharmaceutical industry is tacking its impact on climate change (Booth et al 2023, Dehipawala et al 2023). However, far less attention has so far been paid to the contribution of pharmacy service delivery to reducing the carbon footprint associated with the use of medicines.

A literature search conducted as part of this study (summarised in appendix 1) of studies that evaluated pharmacy service delivery initiatives designed for environmental benefit found one published relevant study and another was found in a manual search of conference abstracts. Both studies concerned the implementation and evaluation of initiatives that involved online hospital outpatient clinic consultations with pharmacists combined with home delivery of medicines (Barrett *et al* 2022, Gil-Candel *et al* 2022). These studies reported cardon dioxide emission reductions associated with the initiative, based on modelled reductions in distances travelled using standardised estimates of vehicle emissions and relied on broad assumptions about patients' transport arrangements.

Gil-Candel and colleagues (2022) reported on a hospital outpatient initiative in Helsinki where patients had online consultations with pharmacists and medicines delivered to their home. Reductions in distance travelled and carbon dioxide emissions (105,624 km and approximately 25kg per patient respectively) were reported. However, this modelling assumed that patients would otherwise have travelled to the hospital in their own vehicle rather than by public transport, for example. In addition, the method of converting the fewer kilometres travelled into carbon dioxide was not reported, but it appears to have used some sort of estimation of vehicle type, since data relating to patients' actual vehicle type, if they had one, were not reported.

Similarly, Barrett and colleagues (2022) reported a modelled reduction over 5 years in distance travelled (of 473 miles per patient) and carbon dioxide emissions (of 105kg per patient) from a UK online hospital outpatient pharmacist-led lipid clinic consultation with home delivery of medicines. They reported modelling distances travelled by using an estimated standard distance per delivery of 4 miles and an standard distance between the patient's home and the hospital of 12.2 miles. Estimates of emissions were determined by using UK Government conversion factors for a medium sized car and assumed that all patients would have travelled to the hospital by car rather than using public transport. This study was reported in an abstract at the Royal Pharmaceutical Society's Annual Conference and not published as a full paper. Consequently, details such as how the standard distances were determined were not reported.

These studies in specialised hospital-based pharmacy services suggest that carbon emissions can be reduced by initiatives to reduce travel associated with medicines supply, but research is lacking on whether this could be achieved in other sectors such as community pharmacy. However, there are known to be medicines supply problems in community pharmacy that result in excess travelling to collect or deliver medicines, one of which results from patients' prescriptions for multiple regular medicines not being synchronised to be dispensed at the same time each month (Sinsky & Sinsky 2012). This is a particular problem for patients with long term conditions who often manage numerous prescribed medicines, as this can mean that their prescriptions arrive at their community pharmacy on several different days each month. This then means that they need several home deliveries of medicines each month, or that they or their carers need to go to the community pharmacy several times each month to collect regular medicines (Sinsky & Sinsky 2012).

Synchronising the dates of patients' repeat prescriptions and / or quantities of medicines supplied should reduce monthly community pharmacy visits or home deliveries, which may improve patients' adherence to medicines (Nguyen & Sobieraj 2017). It should also reduce carbon dioxide (CO_2) emissions associated with avoidable travel. However, no previous studies were found of attempts to assess the travel and CO_2 emission reductions associated with prescription synchronisation (search 2 in appendix 1). This study therefore aimed to assess the potential size of the CO_2 reduction that could be achieved through prescription synchronisation in England.

2. Overview of the study

2.1 Study design

This study adopted an exploratory, pragmatic approach due to there being little previous relevant research to steer the study design and because of the methodological challenges that were identified during the first part of the study. These included how to identify people with non-synchronised prescriptions, and how to measure (or estimate) the reduction in distance travelled to collect medicines The work was small-scale and locally driven in line with the funding available.

Part 1 of the study was to undertake a prospective initial pilot study in one community pharmacy in Stoke-on-Trent where the pharmacist identified people with non-synchronised prescriptions at the point of dispensing. Anonymised demographic data and data about the prescriptions was collected by the pharmacist on a data collection form, which was hoped to be a precursor to a PharmOutcomes module[1] to collect data in a larger study. However, key findings of this initial pilot study were that only a small number of people with non-synchronised prescriptions were identified and it was thought unlikely that this accurately represented the proportion of patients who used the pharmacy who had non-synchronised prescriptions. This meant that it was necessary to explore solutions to this problem instead of the intended study design of scaling up the pilot study approach to multiple pharmacies.

Part 2 of the study involved a stakeholder engagement exercise to identify an alternative means of identifying people with non-synchronised prescriptions. The key outcome of this was that whilst it did not appear to be possible to search currently available versions of Patient Medication Records (PMRs) in community pharmacy to find people who had prescriptions dispensed more than once in any given month, this could be identified from home delivery records routinely kept by community pharmacies. The decision was then taken to focus on people with non-synchronised medicines whose medicines were delivered to their home, as accurate, routinely collected data were available.

This routinely collected data included patients' postcodes, which allowed modelling of the reduction in distance travelled using UK Government conversion factors similar to a previous

[1] PharmOutcomes is a secure platform used by community pharmacies in the study location to record and be remunerated for delivery of commissioned services.

study (Barrett et al 2023). This also meant that it was possible to estimate the reduction in CO_2 emissions that would result from synchronising patients' regular medicines to a single delivery per month, but with limitations due to the modelling approach. These included calculating distances on the basis that the delivery of medicines had been direct from the pharmacy to the patient's home and back again, which in reality would not be the case, and that it would be possible to reduce all regular prescriptions to a single monthly delivery. Part 3 of this study was therefore a pilot study to test this approach to modelling the CO_2 reduction impact of synchronising prescriptions for patients who had medicines delivered to their home from one community pharmacy.

2.2 Stakeholder engagement

A Stakeholder Steering Group was established at the start of the study to advise on aspects of study design and to steer the progress of the study. Stakeholders were selected on the basis of being community pharmacists or Integrated Care Board pharmacists with a good knowledge of community pharmacy and were recruited through local pharmaceutical networks.

The Stakeholder Steering Group met online ahead of Part 1 of the study to discuss the planned approach to data collection. Stakeholders also reviewed a draft of the data collection form and discussed whether completing it would be overly burdensome on the pharmacist. A subsequent online meeting was held at the end of Part 1 to discuss the implications of the findings for the direction of the study and to agree a way forward.

This led to the stakeholder engagement exercise, undertaken as Part 2 of the study. The stakeholders who were involved were known to and recommended by Stakeholder Steering Group members and the CRISPS study team. Part 3 of the study was undertaken in a community pharmacy run by one of these stakeholders as the pharmacy had the home delivery software programme that the CRISPS team had observed in Part 2.

The results of Part 3 of the study were emailed to Stakeholder Steering Group members for comment, especially about drafting recommendations. The results of Part 3 were also presented as an oral presentation at the Health Services Research and Pharmacy Practice Conference at University College Cork in April 2024, which led to discussion with delegates both at the session and informally afterwards. Points raised in these discussions helped with drafting the final recommendations made in this report.

3. Part 1: Pilot study of data collection approach

3.1 Introduction

In Part 1, we developed and tested a proposed paper-based method of collecting data on numbers of patients with non-synchronised prescriptions in a community pharmacy and the quantity of medication that would be required to synchronise them.

3.2 Aim and objectives

The pilot study aim was to test the proposed method of evaluating the effect of synchronising multi-item prescriptions for patients in Staffordshire and Shropshire Integrated Care System.

The specific objectives were to develop and test a data collection approach to:

1. estimate the proportion of patients with prescriptions that are non-synchronised
2. estimate the projected saving in carbon dioxide emissions from synchronising prescriptions in terms of reduced distance travelled to and from the pharmacy
3. estimate the medicines costs of synchronising prescriptions
4. make recommendations about data collection in a larger scale version of the study.

3.3 Methods

3.3.1 Study design

The pilot study was conducted in a single independent community pharmacy in Staffordshire over a two-week period in November 2022, where the regular pharmacist completed a paper-based data collection form (a precursor to an intended PharmOutcomes module) for each patient identified as having non-synchronised prescriptions. The pharmacy was chosen because the pharmacist knew about the CRISPS study from local professional networking and was keen to be involved. The short data collection period was necessary to avoid seasonal workload pressures in December, but this was adequate to test whether the approach was likely to be successful when scaled up to a study involving multiple pharmacies over a longer time period.

3.3.2 Data collection

The data collection form was developed by the CRISPS study team, based on the aim and objectives of the study, and their prior experience of project data collection in community pharmacy. The form included a section to record the number of patients with non-synchronised prescriptions and the total number of prescription items dispensed during each week of data collection. It also included a 'case study' section for the pharmacist to record details shown in table 1 for each patient they encountered with non-synchronised prescriptions during the 2-week data collection period. This approach was agreed with the Stakeholder Steering Group and the pharmacist who undertook the data collection.

Table 1: Summary of data collection topics

Case study data collected for patients with non-synchronised prescriptions
▪ How the patient / non-synchronised prescription was identified ▪ How many times the patient or representative visited the pharmacy, or how many home deliveries were made ▪ What the mode of transport was ▪ The distance between the patient's home and the pharmacy (based on postcodes) ▪ Number of items on each prescription ▪ The total number of items on repeat prescription for the patient ▪ The number of extra dispensing sessions required ▪ Detail of the perceived impact on the patient of non-synchronisation ▪ Details of each medicine that would need to be supplied to synchronise the overall medicines regime for the patient

Completed forms were collected from the pharmacy at the end of the data collection period for analysis. At this visit, anecdotal feedback was also sought from the pharmacist on the data collection process. This feedback was written up and collated with the CRISPS study team's observations about the pilot study processes and the usability of the data collected.

3.3.3 Data analysis

Numerical data from the data collection forms were tabulated in Microsoft Excel. An online distance calculator was used to calculate the distance between the patient's home and the pharmacy (Automobile Association 2024). CO_2 equivalent calculations were undertaken using this mileage data and the UK Government's conversion factor reference for greenhouse gas reporting (Department for Energy Security and Net Zero 2021). Points identified in textual data from feedback and observations were grouped by similarity.

3.3.4 Ethics

As a pilot service evaluation, a favourable ethical opinion from a Research Ethics Committee was not required.

3.4. Results

3.4.1 Estimation of the proportion of patients with non-synchronised prescriptions

A total of 5 data collection forms for patients with non-synchronised prescriptions were completed during the pilot study data collection period and collected for analysis. The total number of patients who had prescriptions dispensed at the pharmacy during this period was not recorded, but 24 prescription items were dispensed for the 5 patients identified with non-synchronised prescriptions. The exact number of prescription items dispensed in the period was not made available, but an anecdotal report was made to the study team of approximately 15,000 items having been dispensed at the pharmacy during the pilot study data collection period. The non-synchronised items dispensed for the 5 patients appeared to represent less than 0.2% of the total of dispensed items per week but the pharmacist and the study team thought it unlikely that only 5 patients with non-synchronised prescriptions had had prescriptions dispensed at the pharmacy during the data collection period (i.e., some were likely to have been missed).

3.4.2 Estimation of the projected reduction in travel and carbon dioxide emissions

All 5 patients were reported to have had home delivery of their medicines, which meant that while the distance by road could be calculated using the pharmacy postcode and the patient's postcode, the exact route that the vehicle used by the pharmacy to deliver the medicines was unknown. It was also not known what sort of vehicle was used by the pharmacy for home deliveries, as this was not included in the data collection form.

The distance by road between the pharmacy and the patient's home was therefore used as the mileage, from which carbon emissions (CO_2 equivalence) were calculated by multiplying this by a conversion factor. On the basis of small diesel vans being commonly used by community pharmacies for home deliveries, the conversion factor used was 265.49 g/mile, as listed for a medium sized car, i.e., equivalent to a small diesel van, defined as having an engine size of 1.7 – 2.0 litres (Department for Energy Security and Net Zero 2021). It was that it would be possible to reduce all regular prescriptions to a single monthly delivery through synchronisation.

Table 2 shows the total projected difference in miles and carbon emissions from synchronising prescriptions for the 5 patients to be 14.32 miles and 3.8 kg CO_2 equivalent, or 70% respectively.

Table 2: Impact of prescription synchronisation on home delivery CO_2 emissions per patient

Patient	1	2	3	4	5	**Total**
Distance from pharmacy (miles)	0.68	0.23	0.81	0.99	0.33	
Journey (miles)	1.36	0.46	1.62	1.98	0.66	
With non-synchronised prescriptions						
Number of deliveries in 2 weeks	4	2	5	2	3	**16**
Total journey (miles)	5.44	0.92	8.10	3.96	1.98	**20.40**
CO_2 emissions (Kg) *	1.44	0.24	2.15	1.05	0.53	**5.42**
Projected impact of synchronised prescriptions						
Number of deliveries in 2 weeks **	1	1	1	1	1	**5**
Total journey (miles)	1.36	0.46	1.62	1.98	0.66	**6.08**
CO_2 emissions (Kg)	0.36	0.12	0.43	0.53	0.18	**1.61**
Reduction in journey distance (miles)	4.08	0.46	6.48	1.98	1.32	**14.32**
Reduction in journey distance (%)	75	50	80	50	67	**70**
Reduction in CO_2 emissions (Kg)	1.08	0.12	1.72	0.53	0.35	**3.80**
Reduction in CO_2 emissions (%)	75	50	80	50	67	**70**

* Assumes small delivery van as equivalent to medium diesel car (1.7-2.0 litre engine) = 265.49 g/mile Co2 equivalent (Department for Energy Security and Net Zero 2021)

** Assumes synchronisation results in a single delivery

3.4.3 Estimation of the medicines costs of synchronising prescriptions

Drug Tariff costs, as listed in the British National Formulary (BNF 2024), were used wherever possible to calculate the one-off cost of synchronising prescriptions. The lowest indicative NHS price was used where a Drug Tariff price was not listed. Table 3 shows the calculated costs of the medicines required to synchronise the 5 patients' prescriptions, where the quantity of medicines needed was reported by the pharmacist. This relied on the pharmacist determining a synchronisation date and the feedback about this was that in practice it was time consuming and not always straightforward to do. An example given in the feedback was that not all medicines are not in 28-day packs and this can complicate the setting of synchronisation dates.

Table 3: Summary of the one-off cost of prescription synchronisation

Patient	Medicine	Strength	Drug Tariff Price (£)	Pack Size	Qty Needed	Cost (£)	Cost / patient (£)
1	Folic acid	5mg	0.84	28	14	0.42	2.01
	Bisoprolol	7.5mg	0.90	28	14	0.45	
	Calcitriol	250ng	5.41	30	4	0.72	
	Digoxin	62.5mcg	1.47	28	8	0.42	
2	Mirtazapine	30mg	1.12	28	8	0.32	1.71
	Vagifem	10mcg	16.72	24	2	1.39	
3	Vagifem	10mcg	16.72	24	6	4.18	40.25
	Levothyroxine	50mcg	0.83	28	15	0.44	
	Levothyroxine	100mcg	0.82	28	15	0.44	
	Colecalciferol (cheapest unit price)	400 units	1.99	120	11	0.18	
	Freestyle Libre 2	-	35.00	1	1	35.00	
4	Pregabalin	200mg	7.19	84	10	0.86	13.64
	Levothyroxine	25mcg	0.88	28	5	0.16	
	Levothyroxine	100mcg	0.82	28	5	0.15	
	Metformin	500mg	0.71	28	20	0.51	
	Colecalciferol	800 units	5.01	30	5	0.84	
	Citalopram	10mg	0.79	28	26	0.73	
	Famotidine	20mg	20,01	28	13	9.29	
	Bisoprolol	2.5mg	0.69	28	20	0.49	
	Simvastatin	40mg	0.87	28	20	0.62	
5	Etoricoxib	60mg	3.04	28	10	1.09	4.45
	Alendronic acid	70mg	0.81	4	1	0.20	
	Lansoprazole G/R	30mg	1.12	28	10	0.4	
	Zomorph	30mg	8.30	60	20	2.77	
TOTAL (£)						**62.07**	

3.4.4 Recommendations about data collection in a larger scale version of the study

Key findings of this initial pilot study were that only a small number of people with non-synchronised prescriptions were identified but it was thought that this probably did not accurately represent the proportion of patients who used the pharmacy during the data collection period who had non-synchronised prescriptions. This suggests that a solution to the problem of identifying people with non-synchronised prescriptions was needed and then further piloting and feasibility studies of potential solutions ahead of any larger scale study.

Table 4 shows that the pharmacist reported identifying patients with non-synchronised prescriptions by multiple means for each patient. This suggests that the PMR and awareness of patients with prior instances of non-synchronised medicines were important sources. However, the accuracy of the reports of the 'patient' mentioning the non-synchronisation issue during a visit to the pharmacy is not clear, since all patients identified had home deliveries of medicines.

Table 4: Summary of how non-synchronised prescriptions were reported as being identified

Means of identifying non-synchronised prescriptions	**Patient**					
	1	**2**	**3**	**4**	**5**	**Total**
It was discovered during the dispensing process, i.e., using the PMR	✓	✓	✓	✓	✓	**5**
I / we knew about the patient from past instances of non-synchronisation	✓	✓	✓	✓		**4**
The patient mentioned it during their visit to the pharmacy				✓	✓	**2**
The patient mentioned it when the medicines were delivered to their home from the pharmacy	✓				✓	**2**
The patient telephoned the pharmacy to order more items	✓	✓	✓			**3**
A pharmacy team member brought it to your attention						**0**
The home delivery records showed multiple visits			✓			**1**
Total	**4**	**3**	**4**	**3**	**3**	

This suggests that rather than relying on opportunistic identification of patients during processes such as dispensing, it may be better to identify patients from routinely collected data in the pharmacy, such as home delivery records, since all 5 patients had home deliveries.

3.5 Discussion

This pilot study achieved the aim of testing the proposed method of evaluating the effect of synchronising multi-item prescriptions for patients in Staffordshire and Shropshire Integrated Care System. The findings suggest that is feasible to estimate the reduction in CO_2 equivalent emissions from reduced vehicle travel associated with synchronising multiple-item prescriptions for individual patients and calculate the additional (one-off) medicines costs of doing so. For the five patients identified, the total projected reduction in distance travelled and carbon emissions from synchronising prescriptions was 14.3 miles and 3.8 kg CO_2 equivalent, or 70% respectively. The cost of the medicines required to achieve this was calculated to be £62.07.

The modelling approach to estimating reductions in CO2 emissions deployed a similar approach to that used in a previous study (Barrett et al 2023), which assumes that a return journey was made directly between the patient's home and the pharmacy. This was necessary as the mileage that would be saved by taking deliveries out of a series of deliveries that would otherwise be made by a delivery driver that day was not known. Given that it is likely that these deliveries would be replaced by others, it is not clear whether it would be possible to calculate the exact mileage that could be saved by prescription synchronisation but it is acknowledged that the effect of the modelling is to over-estimate the mileage saved.

However, whilst calculating the quantities of medicines presented challenges in determining the date to synchronise prescriptions to, the bigger challenge was in how to identify patients with non-synchronised prescriptions. The five patients had all been identified opportunistically during dispensing but in a variety of ways – i.e., there did not appear to be a systematic way for the pharmacist to identify patients. This suggests that some patients were simply not identified by the approach to patient identification that was adopted in this study. As such, whilst the objective to test an approach to estimate the proportion of patients with non-synchronised prescriptions was achieved, the outcome was that the approach was found not to work.

This suggests that a systematic rather than an opportunistic approach to identifying instances of prescription non-synchronisation may be needed. Since all five patients had their medicines delivered to their home by the community pharmacy, the home delivery records kept by pharmacies seemed to be one way to do it. This would depend on the information necessary to determine this being routinely collected by the pharmacy, and so further feasibility and piloting was therefore recommended to establish this.

4. Part 2: Feasibility of routinely collected data

4.1 Introduction

In Part 2, we undertook a stakeholder engagement exercise to explore the feasibility of using community pharmacy home delivery records to identify patients with non-synchronised prescriptions. This approach was agreed with the CRISPS Stakeholder Steering Group (section 2.2).

4.2 Aim and objectives

To aim of this feasibility study was to assess the feasibility of using home delivery records to identify patients with asynchronised prescriptions and to determine whether and how routinely collected data could be used to assess potential carbon savings from prescription synchronisation.

The specific objectives were to:

1. Determine common ways that community pharmacies use to record home deliveries of medicines
2. Assess whether any of the ways of recording home deliveries would be suitable for identifying patients with non-synchronised prescriptions
3. Determine whether the information that would be needed to assess potential carbon savings from prescription synchronisation is available in routinely collected data in the pharmacy.

4.3 Methods

4.3.1 Study design

The feasibility study adopted two main approaches: initial community pharmacy local network-based stakeholder engagement, followed by observation of a potentially suitable community pharmacy home delivery recording system. This was undertaken because of being a readily usable and time-efficient means of doing so, since CRISPS study team members are in everyday contact with community pharmacists in the Staffordshire and Shropshire Integrated Care System.

4.3.2 Data collection and analysis

Community pharmacy local network-based stakeholder engagement involved online and face-to-face discussion with pharmacists to identify commonly used community pharmacy home delivery recording systems and gain an overview of the functionality of them. This resulted in a list being compiled of commonly used systems that local community pharmacies use to record home deliveries of medicines, together with details about their functionality.

Criteria were developed to assess whether any of these home delivery recording systems might be suitable for identifying patients with non-synchronised prescriptions and whether the information that would be needed to assess potential carbon savings from prescription synchronisation would be available in routinely collected data in the pharmacy. These criteria were based on the features that the CRISPS study team and the Stakeholder Steering Group deemed necessary for systematically identifying patients with non-synchronised prescriptions and the information needed to calculate carbon savings in the initial pilot study. These criteria are shown in table 5 below. Each community pharmacy home delivery recording system on the list was assessed against the criteria and only those that met all criteria were explored in more detail.

Table 5: Features of pharmacy home delivery recording systems needed to identify patients with non-synchronised prescriptions

Features	Criteria
Recording of patients who may have non-synchronised prescriptions	Functionality that allows patients who have more than one home delivery in a month to be automatically identified (e.g., by generation of a specific report)
Recording of patients' demographic details	Routine collection of patients' name and home postcode (so that the distance between the patient's home and the pharmacy could be calculated)
Recording of delivery details	Routine collection of the date and time of each delivery
	Routine collection of details of what was delivered on each delivery – details of the medicines that were included in each delivery was deemed preferable but some means of cross checking against the PMR was considered acceptable.

Exploring the functionality of a home delivery recording system in more detail involved an observational visit to a local community pharmacy that had been identified as having that particular home delivery recording system. During the visit CRISPS study team members were given a demonstration of the functionality of the system and had a discussion with the pharmacist about whether and how it could be used to identify patients with non-synchronised prescriptions. This included looking at whether it was possible to determine the actual reduction in distance travelled to and from the pharmacy or whether some form of modelling would be necessary. It also included looking at the functionality that allows patients who have more than one home delivery in a month to be automatically identified and whether the home delivery system recorded details of the medicines that are delivered or whether this had to be cross checked with the PMR. After the visit, the CRISPS study team members discussed what they had seen and talked about with the pharmacist to the point of agreement about the feasibility study findings.

4.3.3 Ethics

As a stakeholder engagement exercise, a favourable ethical opinion from a Research Ethics Committee was not required.

4.4 Results

4.4.1 Common ways that community pharmacies record home deliveries of medicines

Many community pharmacies record home deliveries manually in a book or file that is kept in the dispensary, sometimes just by sticking in a dispensing bag label and writing the date of delivery. Patient Medication Record (PMR) systems do not tend to be used for recording home deliveries, but some pharmacies use a pharmacy delivery application that is separate to the PMR or integrated into the PMR, depending on the PMR system used. There are various applications available either on a subscription or contract basis.

4.4.2 Suitability of delivery records for identifying non-synchronised prescriptions

Manual, paper-based home delivery record systems do not meet the criteria on the basis of not automatically identifying patients with non-synchronised prescriptions. Manual identification of patients by comparing delivery addresses is very time consuming, even if home delivery numbers are very small.

Pharmacy delivery applications however do have much more potential for identifying patients with non-synchronised prescriptions. In the local network-based stakeholder engagement exercise we found a community pharmacy that used the PHARMDEL application but independently from the PMR. Scrutiny of the functionality of this application during a visit to the pharmacy found that it records each package that is sent as a separate 'delivery' and a report can be produced that shows the number of patients who received two or more 'deliveries' for a given month (a Monthly Customer Order Report). The report shows the number of patients at each delivery frequency above a single delivery and the operator can click on these numbers to view details of each delivery.

However, there are instance when the items dispensed for a patient need to be put into several packages, for example when multiple items, or bulky items are prescribed. The application will still record each package as a separate delivery even when two or more packages are delivered to a patient at the same time. The numbers listed in Monthly Customer Order Reports also include instances where deliveries were not actually made (e.g., if no-one was at home when the driver arrived), but these are not differentiated in the report, although they are recorded in the application as failed deliveries in the data about each delivery.

As such, the Monthly Customer Order Reports cannot be used on their own to determine the number of actual journeys that were made in that month to each patient's home due to prescription non-synchronisation. However, they can be used as a starting point to cross reference with the data held in the application about each delivery and against the PMR.

4.4.3 Availability of the information needed in routinely collected data in the pharmacy

Assessing the potential carbon savings from synchronisation, requires determining which deliveries were due to non-synchronisation of prescriptions and which deliveries were due to patients being prescribed medicines for acute illnesses or one-off prescriptions and items owing. Owings data is available in the PMR but determining whether prescriptions are for acute illness or one-off items requires a professional judgement from a pharmacist or other appropriately qualified health professional and even then, this may not always be apparent from the data recorded in the PMR.

The PHARMDEL pharmacy delivery application, in common with other such applications, calculates the most efficient route for delivery drivers to take each day. This means that it is not possible to determine the distance reduction if one or more deliveries had not been made that day, without recreating the entire delivery schedule for that day and the route, which is not routinely available. However, even if this were done, it would not take account of substitute deliveries that the application would routinely insert in place of those removed to make the most efficient use of the van and driver each day.

An alternative approach would be modelling of the distance travelled for each delivery. The simplest way to do this, as was done in the initial pilot study, is calculate it as if the patient or a carer had travelled to the pharmacy by road as a dedicated journey to collect the medicines.

4.5 Discussion

The findings of this feasibility study suggest that using a pharmacy delivery application Monthly Customer Order Reports, cross referenced to the delivery details held by the application and the data in the PMR about medicines supplied should allow a pharmacist or other suitably qualified health professional to determine in the majority of instances when deliveries are made due to non-synchronised prescriptions. Collection of patients' postcodes and the pharmacy postcode would allow a simple modelling approach to estimate the travelling distance that could be reduced from prescription synchronisation and the associated reduction in carbon emissions, as was done in the initial pilot study. The data needed is routinely collected by pharmacies but collating it for the purpose of the CRISPS study and interpreting it for analysis is likely to be time intensive.

The analysis may also allow for the scale of non-synchronised prescription impact on carbon emissions to be estimated if it is possible to calculate the proportion of deliveries that are due to non-synchronised prescriptions. This may mean that the issue can be compared to other issues affecting the carbon footprint of the NHS in England, if not the whole UK.

However, it would have to be acknowledged that at best the analysis from this approach to data collection would be a rough estimate and would not be accurate. This is at least partly because of the modelling of distance travelled, which is based on assumptions that may not be correct and that it concerns journeys that could potentially have been saved rather than journeys actually saved. Nevertheless, the findings of this study suggested that it appeared to be feasible to use routinely collected data by community pharmacies to assess potential carbon savings from prescription synchronisation.

5. Part 3: Piloting use of routinely collected data

5.1 Introduction

The feasibility study in Part 2 suggested that using data from a pharmacy delivery application, cross referenced to the PMR should allow a pharmacist or other suitably qualified health professional to determine in the majority of instances when deliveries are made due to non-synchronised prescriptions. Collection of patients' postcodes and the pharmacy postcode allows a modelling approach to estimate the reduction in travelling distance from prescription synchronisation and the associated reduction in carbon emissions, as was done in Part 1 of the study. Therefore, in Part 3 we tested this approach in a larger evaluation of the potential carbon saving from synchronising prescriptions.

5.2 Aim and objectives

To estimate potential carbon savings from synchronising repeat medicines for a sample of patients with medicines from non-synchronised prescriptions delivered from one community pharmacy.

The specific objectives were to use routinely collected data in the pharmacy to:

1. Determine the travelling distance by road between the pharmacy and patients' homes
2. Estimate the effect of prescription synchronisation on the distance travelled to and from the pharmacy
3. Estimate the reduction in CO_2 emissions from travelling associated with prescription synchronisation.

5.3 Methods

5.3.1 Study design

Based on the work undertaken in the pilot study and the feasibility study, this study involved the use of a pharmacy delivery application, cross referenced with the PMR to identify patients with non-synchronised prescriptions. The reduction in distance travelled between the pharmacy and patients' homes due to prescription synchronisation and the associated CO_2 emissions reduction was estimated using a simple modelling approach described below. This approach used routinely collected data by the pharmacy but for a different purpose than originally collected for. This allowed a retrospective analysis to be undertaken, which allowed a time period to be selected that was not affected by public holidays or other events that may have altered the usual dates for prescription issuing and home deliveries. June 2023 was subsequently chosen on this basis. The use of a single month allowed all monthly regular deliveries to be captured, but it is recognised that there may be monthly variance in acute / one-off item and owing item deliveries. It was not possible to examine this would require a longer time period than was available for the project.

The study was undertaken in an urban community pharmacy in North Staffordshire that was considered by the CRISPS study team to be of medium size in terms of the number of items dispensed per month (i.e., approximately 2,500 items dispensed per month). The choice of pharmacy was based on it being known to operate an efficient stock management system (to minimise deliveries of owing items) and because it used the PHARMDEL pharmacy delivery application. The choice was also based on the pharmacy not being unusual in any other way (e.g., in terms of location or size). It was a different community pharmacy to the one used in Part 1 of the study.

5.3.2 Data collection

During August 2023 a pharmacist member of the CRISPS study team accessed the PHARMDEL pharmacy delivery application in the community pharmacy to identify all patients who had prescriptions dispensed four times or more in June 2023. The threshold of four deliveries per month was selected to increase the likelihood of this frequency being due to non-synchronised prescriptions.

The data collection process started by producing a Monthly Customer Order Report for June 2023 from by the PHARMDEL application and then clicking on the links to scrutinise the details of each delivery in turn, starting with those with the highest number of deliveries. These details included the date and time of each delivery, the patient's postcode and whether the delivery was successfully made. Failed deliveries (e.g., where no-one was home) were subsequently excluded (on the basis of being avoidable) and the threshold of 4 deliveries per month was applied at this point. This meant that patients recorded on the Monthly Customer Order Report as having fewer than 4 deliveries in June 2023 were not included and their delivery details were not scrutinised. However, the number of patients who received 2 or 3 deliveries that month were recorded for a separate part of the data analysis.

The details of each delivery for patients with 4 or more deliveries in June 2023 were then cross referenced with the PMR to establish whether the medicine(s) in that delivery were solely for acute rather than chronic illnesses (e.g., an antibiotic for an infection), a one-off prescribed item (e.g., an analgesic for an injury or other non-chronic pain) or for items owing to the patient. These types of delivery were included in the count of monthly deliveries but were differentiated from deliveries of repeat medicines on the grounds of the delivery probably being unavoidable.

Multiple deliveries to the same patient at the same time on the same day were counted as a single delivery and the number of patients in each frequency category of delivery was adjusted accordingly. This meant that patients with a delivery frequency of less than four after the adjustment were excluded from the main part of the analysis, but those who had 2 or 3 deliveries after the adjustment were added to the overall numbers of those who had 2 or 3 deliveries that month that were recorded separately.

New patients were excluded and deliveries solely for medicines that appeared to be newly prescribed for chronic illnesses were also excluded. The pharmacist collecting the data made a professional judgement about these issues, based on having extensive (20+ years) experience of working in community pharmacy. Patient numbers in each frequency category of delivery were similarly adjusted again at this point accordingly and those with less than four deliveries were excluded from the main analysis, but those with 2 or 3 deliveries were added to the separately recorded overall numbers of those who had 2 or 3 deliveries that month. The process of applying these inclusion and exclusion criteria for patients and individual deliveries is summarised in table 6.

Table 6: Summary of the application of the inclusion and exclusion criteria for the main analysis

Stage	**Patients**		**Deliveries**	
	Inclusion criteria	**Exclusion criteria**	**Inclusion criteria**	**Exclusion criteria**
Screening from the Monthly Customer Order Report	4 or more deliveries in the month	Fewer than 4 deliveries	-	-

Scrutinising delivery details in PHARMDEL	4 or more successful deliveries	Patients with less than 4 deliveries when failed deliveries were excluded	Successful deliveries	Failed deliveries
		Patients with less than 4 deliveries when multiple deliveries at the same time on the same day were counted as one delivery		
Cross-referencing with the PMR	Patients with repeat medicines delivered	New patients	Deliveries of medicine(s) solely for acute illnesses or one-off items (but differentiated from other deliveries)	Deliveries solely for newly prescribed medicines for chronic illnesses
			Deliveries of medicine(s) solely for owing items (but differentiated from other deliveries)	

The following data was recorded in a dedicated Excel spreadsheet for the main analysis:

- Distance between the patients' home and the pharmacy (calculated from postcodes)
- Total number of successful deliveries in June 2023 as recorded in PHARMDEL
- Instances when the patient received multiple deliveries at the same time on the same day (date and the number of deliveries each time)
- Instances when a patient received a delivery solely for an acute prescription item / one-off prescription item
- Instances when a patient received a delivery solely for an owing item.

5.3.3 Data analysis

Since the PHARMDEL records each package that is sent as a separate 'delivery', the term 'package' will be used in place of the term 'delivery' to refer to deliveries recorded in PHARMDEL and to differentiate these from the number of actual deliveries that patients received in June 2023. The following analyses were undertaken on the data collected:

The total number of patients who received 4 or more deliveries in June 2023 according to the above definition and the inclusion criteria was determined and broken down by delivery frequency.

For each delivery frequency category, a summary of the distance that would have been travelled in June 2023 was calculated as if the medicines had been collected from the pharmacy as a dedicated journey to and from the patient's home address instead of being delivered. Determination of the travelling distance by road between the pharmacy and patients' homes was done by converting postcodes into mileage using an online distance calculator (Automobile Association 2024). This was doubled to give the total distance travelled between the patient's home and the pharmacy in June 2023. The journeys made were also broken down into those that were solely due to acute / one-off prescription items, those that were solely due to owing items.

The effect of prescription synchronisation on the distance travelled to and from the pharmacy was then modelled from these findings by assuming that for each patient, all deliveries that were not for acute / one-off items or medicines owing could have been reduced to a single delivery if prescriptions had been synchronised.

CO_2 equivalent calculations were undertaken using this mileage data and the UK Government's conversion factor reference for greenhouse gas reporting to estimate the reduction in CO_2 emissions from travelling associated with prescription synchronisation (Department for Energy Security and Net Zero 2021). This was determined for different vehicle types in terms of approximate size and whether they used petrol or diesel as the fuel.

To explore the potential wider significance of the findings but for illustrative purposes only, rather than claiming generalisability, the findings were extrapolated / modelled in three ways:

Firstly, the potential impact of prescription synchronisation in terms of the reduction in distance travelled and CO_2 emissions was modelled for patients who had three and two packages of medicines delivered in June 2023 as recorded in the PHARMDEL application. This required estimating proportions of patients who may have been excluded, numbers of packages delivered at the same time, and acute / one-off item deliveries and owing item deliveries according to the mean values calculated in the other delivery frequency categories.

Secondly, The CO_2 equivalent emissions calculated for June 2023 were extrapolated to annual emissions and then the annual CO_2 emissions were calculated as if the impact of prescription synchronisation and potential reduction in emissions could be achieved by all 11,414 community pharmacies in England at that time (Statistica 2023).

Finally, the CO_2 equivalent emissions calculated were converted into megatonnes (i.e., millions of tonnes) to allow broad comparison with a 25 megatonne calculation of the carbon footprint of the NHS and the 10% component of this that was attributed to NHS staff commuting and patient and visitor travel (Tennison et al 2021a and 2021b). This calculation of the carbon footprint of the NHS was chosen on the grounds of being the most recent (published in 2021 but reporting on the NHS in 2019) and comprehensive currently available. In addition, the authors argued that patient and visitors travel would not normally be included in an organisation's carbon footprint, which made the calculation more useful for comparison, especially as it claimed to include patient travel to community pharmacies for collection of prescription medicines (Tennison et al 2021b).

5.3.4 Ethics

As a service evaluation, a favourable ethical opinion from a Research Ethics Committee was not required.

5.4 Results

5.4.1 Modelling of the distance travelled for prescription deliveries

The Monthly Customer Order Report for June 2023 from the community pharmacy recorded the numbers of packages sent as shown in table 7 below.

Table 7: Summary of deliveries for patients in June 2023

Number of packages sent	8	7	6	5	4	3	2	**Total**
Number of patients	7	4	6	18	38	90	175	**338**

When failed deliveries were excluded from delivery numbers and the threshold of 4 deliveries per month was applied, data were collected for 59 patients. Table 8 below shows the breakdown of this per delivery frequency category. The total number of packages delivered to these patients was 304 but this equated to 269 deliveries when the number of instances where more than one package being delivered at a time was taken into account.

Table 8: Adjusted summary of deliveries for patients in June 2023

Number of packages sent per patient in June 2023	8	7	6	5	4	**Total**
Number of patients	7	4	6	16	26	**59**
Number of packages sent	56	28	36	80	104	**304**
Number of deliveries with 2 or more packages	11	2	5	7	8	**33**
Number of deliveries	45	26	31	71	96	**269**

The breakdown of delivery numbers per patient by type (i.e., deliveries with two or more packages, acute / one-off item deliveries and owing item deliveries) and the distances travelled is shown for each delivery frequency category in tables 9 - 13 below.

Table 9: Summary of deliveries and distance travelled for patients who had 8 packages delivered in June 2023

Patient No.	**Distance from pharmacy (miles)**	**Total distance / delivery (miles)**	**Deliveries with 2 or more packages**	**Total number of deliveries to patient**	**Acute / one-off item deliveries**	**Owing item deliveries**	**Total distance travelled (miles)**
1	2.0	4.0	1	7	1	0	28.0
2	0.9	1.8	3	5	0	0	9.0
3	0.4	0.8	1	7	1	0	5.6
4	1.0	2.0	2	6	0	1	12.0
5	4.0	8.0	2	6	0	0	48.0
6	0.5	1.0	2	6	1	0	6.0
7	2.7	5.4	0	8	1	0	43.2
Total	-	**23**	**11**	**45**	**4**	**1**	**151.8**

Table 10: Summary of deliveries and distance travelled for patients who had 7 packages delivered in June 2023

Patient No.	Distance from pharmacy (miles)	Total distance / delivery (miles)	Deliveries with 2 or more packages	Total number of deliveries to patient	Acute / one-off item deliveries	Owing item deliveries	Total distance travelled (miles)
1	0.9	1.8	1	6	0	0	10.8
2	0.2	0.4	1	6	0	0	2.4
3	3.9	7.8	0	7	0	0	54.6
4	3.6	7.2	0	7	1	0	50.4
Total	-	**17.2**	**2**	**26**	**1**	**0**	**118.2**

Table 11: Summary of deliveries and distance travelled for patients who had 6 packages delivered in June 2023

Patient No.	Distance from pharmacy (miles)	Total distance / delivery (miles)	Deliveries with 2 or more packages	Total number of deliveries to patient	Acute / one-off item deliveries	Owing item deliveries	Total distance travelled (miles)
1	2.5	5.0	0	6	1	0	30.0
2	2.3	4.6	1	5	0	0	23.0
3	0.7	1.4	1	5	0	0	7.0
4	1.1	2.2	0	6	0	1	13.2
5	1.2	2.4	1	5	0	0	12.0
6	0.5	1.0	2	4	0	0	4.0
Total	-	**16.6**	**5**	**31**	**1**	**1**	**89.2**

Table 12: Summary of deliveries and distance travelled for patients who had 5 packages delivered in June 2023

Patient No.	Distance from pharmacy (miles)	Total distance / delivery (miles)	Deliveries with 2 or more packages	Total number of deliveries to patient	Acute / one-off item deliveries	Owing item deliveries	Total distance travelled (miles)
1	3.0	6.0	0	5	0	0	30.0
2	0.5	1.0	0	5	1	0	5.0
3	2.3	4.6	0	5	1	0	23.0
4	0.7	1.4	0	5	0	0	7.0
5	0.5	1.0	1	3	0	0	3.0
6	0.6	1.2	1	4	1	0	4.8

7	1.3	1.6	1	4	1	0	10.4
8	3.7	7.4	0	5	0	0	37.0
9	1.6	3.2	0	5	0	0	16.0
10	2.6	5.2	1	4	1	0	20.8
11	0.8	1.6	0	5	0	0	8.0
12	0.8	1.6	0	5	0	0	8.0
13	0.6	1.2	1	4	0	0	4.8
14	0.5	1.0	0	5	0	0	5.0
15	0.8	1.6	1	4	0	0	6.4
16	1.0	2.0	1	3	0	0	6.0
Total	-	**42.6**	**7**	**71**	**5**	**0**	**195.2**

Table 13: Summary of deliveries and distance travelled for patients who had 4 packages delivered in June 2023

Patient No.	Distance from pharmacy (miles)	Total distance / delivery (miles)	Deliveries with 2 or more packages	Total number of deliveries to patient	Acute / one-off item deliveries	Owing item deliveries	Total distance travelled (miles)
1	1.1	2.2	1	3	0	0	6.6
2	0.6	1.2	0	4	1	0	4.8
3	0.6	1.2	0	4	0	1	4.8
4	0.5	1.0	1	3	0	0	3.0
5	0.6	1.2	0	4	0	1	4.8
6	0.2	0.4	0	4	0	0	1.6
7	1.3	2.6	1	3	0	0	7.8
8	2.0	4.0	0	4	0	0	16.0
9	0.3	0.6	1	3	0	0	1.8
10	2.1	4.2	0	4	0	0	16.8
11	1.3	2.6	0	4	1	0	10.4
12	3.3	6.6	0	4	0	0	26.4
13	0.5	1.0	0	4	0	0	4.0
14	2.2	4.4	0	4	0	0	17.6
15	2.0	4.0	1	3	0	0	12.0
16	1.9	3.8	0	4	0	0	15.2
17	2.1	4.2	0	4	0	0	16.8

18	3.3	6.6	0	4	1	0	26.4
19	2.0	4.0	0	4	0	0	16.0
20	2.1	4.2	1	3	0	0	12.6
21	1.7	3.4	1	3	0	0	10.2
22	2.9	5.8	0	4	1	0	23.2
23	0.4	0.8	1	3	0	0	2.4
24	0.6	1.2	0	4	0	1	4.8
25	2.0	4.0	0	4	0	1	16.0
26	0.7	1.4	0	4	0		5.6
Total	-	**76.6**	**8**	**96**	**4**	**4**	**287.6**

Table 14 below shows the mean, median and range of the distances between the pharmacy and patients' homes. This highlights the highly localised nature of home deliveries.

Table 14: Summary of the distances between the pharmacy and patients' home

Number of packages delivered	Total distance (miles)	Distance between the pharmacy and the patient's home (miles)		
		Mean	Median	Range
8	151.8	1.6	1.0	0.4 – 2.7
7	118.2	2.2	2.3	0.2 – 3.9
6	89.2	1.4	1.2	0.5 – 2.5
5	195.2	1.3	0.8	0.5 – 3.7
4	287.6	1.5	1.5	0.2 – 3.3
Mean	168.4	1.6	-	-

5.4.2 Estimation of the effect of prescription synchronisation on the distance travelled

If the repeat prescriptions had been synchronised, this could have been reduced to 80 deliveries (i.e., a 70% reduction) and the distance travelled would have been reduced from 842 miles to 241 miles (71% reduction), as shown in table 15.

Table 15: Summary of the reduction in distance travelled that prescription synchronisation could achieve

Parameter	No. packages delivered to the same patient in June 2023					Total	
	8	7	6	5	4	No.	% of patients
Number of patients	7	4	6	16	26	59	-
Number of acute / one-off item deliveries	4	1	1	5	4	15	25%
Number of deliveries for items owing	1	0	1	0	4	6	10%
Current situation (with non-synchronised prescriptions)						**No.**	**Mean**
Total number of deliveries	45	26	31	71	96	269	4.6
Total distance travelled (miles)	151.8	118.2	89.2	195.2	287.6	842.0	14.3
Projected impact of synchronised prescriptions						**No.**	**Mean**
Total number of deliveries excluding acute / one-off items and owing items (assumes one delivery per patient)	7	4	6	16	26	59	-
Total number of deliveries (i.e., when acute / on-off and owing deliveries included)	12	5	8	21	34	80	1.4
Total distance travelled (miles)	36.2	24.4	23.8	59.8	97.2	241.4	4.1
Reduction in distance travelled (miles)	115.6	93.8	65.4	135.4	190.4	600.6	10.2
Reduction in distance travelled (%)	76%	79%	73%	69%	71%	**71%***	

* When calculated as % overall reduction in miles travelled - i.e. (600.6/842)/100 rather than a mean of the % reduction in distance travelled for each delivery frequency

5.4.3 Estimation of the reduction in CO_2 emissions from prescription synchronisation

This would have similarly resulted in a 71% reduction in CO_2 emissions, although the reduction in volume in kilograms of CO_2 emitted would have varied (by an estimated 137 Kg CO_2 or 51%) depending on whether e.g., a small diesel car was used or a large petrol car (reduction of 133kg versus 270 Kg CO_2), as shown in table 16. An average diesel car was estimated to have reduced CO_2 emissions by 163 Kg (table 16).

Table 16: Summary of estimated CO_2 emission reduction due to prescription synchronisation per vehicle type

Vehicle type	**Kg CO_2 / mile**	**CO_2 emissions (Kg)**			**Difference Kg CO_2 (%)**
		Non-synchronised	**Synchronised**	**Reduction**	
Small car - diesel	0.22143	186	53	133	-
Small car - petrol	0.24052	203	58	145	**11 (8%)**
Medium car (or small van) - diesel	0.26549	224	64	160	**26 (17%)**
Medium car (or small van) - petrol	0.30231	255	73	182	**49 (27%)**
Large car - diesel	0.33348	281	80	200	**67 (34%)**
Large car - petrol	0.44914	378	108	270	**137 (51%)**
Average car - diesel	0.27108	228	65	163	**30 (18%)**
Average car - petrol	0.28053	236	68	169	**36 (21%)**

5.4.4 The potential wider significance of synchronisation on reducing CO_2 emissions

To estimate the projected impact of prescription synchronisation on distance travelled for the delivery frequency categories of 3 packages and 2 packages delivered in June 2023, the following estimations were made:

- The proportion of patients remaining after exclusions for failed deliveries was extrapolated from the proportions in the other delivery frequencies (as shown in table 17).
- The percentage of patients who had deliveries solely for acute / one-off prescription items was assumed to be 25% as this was the mean percentage across the other delivery frequency categories (as shown in table 15)
- The percentage of patients who had deliveries solely for owing items was assumed to be 10% as this was the mean percentage across the other delivery frequency categories (as shown in table 15)
- The total number of deliveries in June 2023 was calculated by reducing the maximum number possible (i.e., number of packages multiplied by the number of patients) by 8% because this was the mean percentage reduction in the other delivery frequency categories due to multiple packages being delivered to the same patient on the same date and time.
- The distance travelled was estimated using the mean distance between the community pharmacy and the patient's home of 1.6 miles shown in table 14 (i.e., 3.2 miles per delivery).

Table 17: Summary of the projected impact on distance travelled in June 2023 of prescription synchronisation (all delivery frequency categories above a single delivery)

Parameter	**Packages delivered in June 2023**							**Total**
	8	**7**	**6**	**5**	**4**	**3**	**2**	
Number of patients (taken from table 7)	7	4	6	18	28	90	175	338
Proportion of patients remaining after exclusions	1.0	1.0	1.0	0.9	0.9	0.9	0.9	-
Patient numbers after exclusions	7	4	6	16	26	81	158	298
Number of acute / one-off item deliveries	4	1	1	5	4	20	39	75
Number of deliveries for items owing	1	0	1	0	4	8	16	30
Current situation (with non-synchronised prescriptions)								
Total deliveries in June 2023	45	26	31	71	96	224	290	782
Distance travelled (miles)	151.8	118.2	89.2	195.2	287.6	715.4	927.4	2484.8
Projected impact of synchronised prescriptions								
Total number of deliveries excluding acute / one-off items and owing items (assumes one delivery per patient)	7	4	6	16	26	81	158	298
Total number of deliveries (i.e., when acute / on-off and owing deliveries included)	12	5	8	21	34	109	213	402
Total distance travelled (miles)	36.2	24.4	23.8	59.8	97.2	349.92	680.4	1271.7
Reduction in distance travelled (miles)	15.6	93.8	65.4	135.4	190.4	365.5	247.0	1213.0
Reduction in distance travelled (%)	76%	79%	73%	69%	66%	51%	27%	49%

This is further summarised in table 18, which shows that the delivery frequency categories 8 – 4 when grouped together represent approximately a third of the estimated total number of deliveries and the estimated distance travelled in miles for patients who had more than one home delivery of medicines in June 2023. However, prescription synchronisation in these higher delivery frequency categories is projected to account for approximately half of the reduction in distance travelled and CO_2 emissions that might be achieved.

Table 18: Summary of the projected reduction in distance travelled due to prescription synchronisation by grouping

Parameter	**Delivery frequency categories 2 & 3 combined (%)**	**Delivery Frequency categories 4 - 8 combined (%)**	**Total**
Number of patients	239 (80%)	59 (20%)	298
Number of deliveries	513 (66%)	269 (34%)	782
Miles travelled (non-synchronised)	1642.8 (66%)	842 (34%)	2484.8
No. deliveries (synchronised)	322 (80%)	80 (20%)	402
Miles travelled (synchronised)	1030.3	241.4 (19%)	1271.7
Reduction in miles travelled	**612.4 (50%)**	**600.6 (50%)**	**1213.0**

Table 19 shows that the disproportionately larger contribution of prescription synchronisation in the higher delivery frequency categories compared to the lower delivery frequency categories in terms of reduction of CO_2 emissions, as estimated for a small diesel van (see table 16 above).

Table 19: Summary of the projected reduction in CO_2 emissions due to prescription synchronisation by grouping

Parameter	**Delivery frequency categories 2 & 3 combined (%)**	**Delivery Frequency categories 4 - 8 combined (%)**	**Total**
CO_2 emissions (Kg) from non-synchronised prescriptions	436 (66%)	224 (34%)	660
CO_2 emissions (Kg) from synchronised prescriptions	274 (81%	64 (19%)	338
Projected reduction in CO_2 emissions	**163 (50%)**	**159 (50%)**	**322**

Table 20 below shows the CO_2 equivalent emissions calculated for patients with 4 or more home deliveries of medicines in June 2023 scaled up to annual emissions and then in terms of the annual CO_2 emissions if the impact of prescription non-synchronisation, synchronisation and potential reduction in emissions could be achieved by all 11,414 community pharmacies in England (at the time of the study).

The table also shows how the CO_2 equivalent emissions calculated (when converted into megatonnes) may compare with a 25 megatonne calculation of the carbon footprint of the NHS and the 10% component of this that was attributed to NHS staff commuting and patient and visitor travel (including collection of prescription medicines from community pharmacies).

Table 20: Estimated CO_2 emission reduction annually and as a percentage of the carbon footprint of the NHS

Parameter	**Non-synchronised**	**Synchronised**	**Reduction**
Total delivery distance travelled in June 2023 (miles)	842.0	241.4	600.6
Total annual delivery distance (miles)	10,104.0	2,896.8	1,913.0
Annual emissions (Kg CO_2) – small diesel van	2,683	769	1913
Annual emissions if this applied to all 11,414 community pharmacies in England (tonnes CO_2)	30,618	8,778	21,840
Annual emissions if applied to all community pharmacies in England (megatonnes CO_2)	0.031	0.009	0.022
Percentage of the 25 megatonne carbon footprint of the NHS	0.12%	0.04%	0.09%
Percentage of the 10% staff & patient travel component of the NHS's carbon footprint	1.22%	0.35%	0.87%

This suggests that the saving could potentially be doubled if repeat prescriptions were also synchronised for patients with lower delivery frequencies (2 and 3 deliveries per month), i.e., potentially around 1.75%% of the staff and travel component of the NHS's carbon footprint.

5.5 Discussion

This study aimed to estimate potential carbon savings from synchronising repeat medicines for a sample of patients with medicines from non-synchronised prescriptions delivered from one community pharmacy (i.e., those with four or more home deliveries of medicines in June 2023). The objectives were to use routinely collected data in the pharmacy to determine the travelling distance by road between the pharmacy and patients' homes, estimate the effect of prescription synchronisation on the distance travelled to and from the pharmacy, and estimate the reduction in CO_2 emissions from travelling associated with prescription synchronisation.

The travelling distance by road between the pharmacy and patients' homes was calculated from patients' postcodes, which were available in routinely collected data. The findings indicated that the mean distance between the pharmacy and patients' homes was 1.6 miles for the 59 patients for whom detailed data was collected. The effect of repeat prescription synchronisation for these patients was estimated to be a 70% reduction in the number of deliveries (i.e., from 269 to 80), 71% fewer miles travelled (i.e., 842 to 241.4) and a 71% reduction in CO_2 emissions. The reduction in volume of CO_2 depends on the type of vehicle used, for example, for a small diesel car a 133kg reduction was estimated (186kg reduced to 53Kg), whereas for a medium diesel car or small van the reduction was estimated at 160Kg (224kg reduced to 64Kg) but for a large petrol car the saving was estimated to be 169Kg (236Kg reduced to 169Kg).

When the potential reduction in distance travelled and CO_2 emissions were modelled for patients receiving 2 or 3 packages in June 2023 (since detailed data were not collected for these patients), the findings suggested disproportionately lower reductions compared to the group with 4 or more deliveries in June 2023. The 59 patients in the 4 or more deliveries group comprised approximately 20% of the total, but the projected saving in distance travelled and CO_2 emissions in this group accounted for approximately 50% of the total projected savings.

When the annual reduction in CO_2 emissions were estimated from synchronising repeat prescriptions for these 59 patients with 4 or more home deliveries of medicines per month, the volume of CO_2 estimated was nearly 2000Kg. For the illustrative purpose of giving a sense of scale (rather than claiming generalisability), we estimated what the reduction might look like if this was achievable at all 11,414 community pharmacies in England and the finding was nearly 22,000 tonnes of CO_2. Whilst this represents a tiny proportion of the overall carbon footprint of the NHS, it may represent close to 1% of the component of the NHS's carbon footprint that has been attributed to staff and patient travel (Tennison et al 2021b). This suggests that the saving could potentially be doubled if repeat prescriptions were also synchronised for patients with 2 and 3 deliveries per month.

This model is more developed than previously reported models (Gil Candel et al 2022, Barrett et al 2022) and we have included full details of about the assumptions made and how carbon dioxide emissions were calculated – e.g. by modelling for a range of vehicle sizes. To our knowledge, this is the first study in community pharmacy and the first study that has attempted to quantify the environmental impact of prescription synchronisation.

However, whilst such estimations and extrapolations of the data give a sense of scale, especially considering the small numbers of patients this would concern, we do not claim that these data are either accurate or generalisable. This is partly because these data are from a single pharmacy and for a single month in a single year. It is also because these data only concern those patients who have home deliveries of medicines, and such patients only represent a fraction of the total number of patients each community pharmacy dispenses repeat medicines for. Since we have no data on the non-synchrony of prescriptions for those who collect their medicines from community pharmacies, we do not know whether they are similarly non-synchronised as those who have their medicines delivered. However, given that there is no widespread system in the UK for ensuring synchrony of prescriptions, as there is for example in the US (Nguyen and Sobieraj 2017), it does not seem unreasonable to suppose they are broadly similar, in which case the actual number of patients who have non-synchronised prescriptions is likely to be many times higher than our estimate.

In addition, it is probable that we have overestimated the reduction in the distance travelled per delivery (and CO_2 emissions reduced), since we modelled it on the basis of the distance that would have been travelled if the patients had collected their medicines from the pharmacy as a dedicated journey. This does not reflect any actual reduction in distance travelled by the delivery driver, and it does not take into account that many people combine collecting their medicines from community pharmacies with other tasks (e.g., shopping), rather than making dedicated journeys to collect medicines. Other limitations of the study include assuming that it would be possible and clinically appropriate to reduce all regular prescriptions to a single monthly delivery.

Nevertheless, the findings of this study represent a probable first attempt at estimating the potential impact of prescription synchronisation on CO_2 emissions from excess travelling and in any case, they reflect the difficulty of obtaining the data to do so from community pharmacy. As such, whilst the findings of this study demonstrate that potential CO_2 emissions reductions from prescription synchronisation can be modelled from routinely collected data, challenges remain in how to measure actual carbon savings of prescription synchronisation. These findings have implications for policy makers in terms of whether and how to implement prescription synchronisation schemes as have been implemented in the US, for example (Nguyen and Sobieraj 2017). The findings also have implications for those wishing to measure reduction in CO_2 emissions from prescription synchronisation, particularly in terms of how to measure this and whether data routinely collected in community pharmacy can be routinely harnessed to assist with such measurement.

6. Summary of key findings and recommendations

6.1 Summary of key findings

- Potential CO_2 emissions reductions from prescription synchronisation can be modelled from routinely collected community pharmacy data.

- Prescription synchronisation may reduce mileage and CO_2 emissions by approximately 70%, although the reduction in CO_2 depends on the type of vehicle used.

- The one-off medicines cost of prescription synchronisation may be small (e.g., less than £70).

- Proportionately greater CO_2 reductions can be made in those who have the most deliveries per month before synchronisation (The patients in the 4 or more deliveries group comprised approximately 20% of the total number of patients receiving 2 or more deliveries per month, but the projected saving in mileage and CO_2 emissions in this group accounted for approximately 50% of the total projected reductions).

- Challenges remain in how to measure carbon savings of prescription synchronisation:
    - Pharmacy delivery applications such as the one used in this study, can automatically identify patients receiving more than one delivery per month, but currently cannot automatically identify whether deliveries are due to non-synchronisation of prescriptions.
    - The reduction in distance travelled can be modelled but data on this is not routinely collected and it can be difficult to differentiate and measure mileage that is solely attributed to medicines collection or delivery for individual patients.

6.2 Recommendations

The following recommendations from this study are aligned to the key findings, as shown in table 21.

Table 21: CRISPS study key findings mapped to the recommendations

Key finding	**Recommendation**
Potential CO_2 emissions reductions from prescription synchronisation can be modelled from routinely collected community pharmacy data.	Further research on a larger scale should be undertaken to confirm the findings of this study as this can support policymakers to decide whether prescription synchronisation should be contracted through the NHS.
Prescription synchronisation may reduce mileage and CO_2 emissions by approximately 70%, although the reduction in CO_2 depends on the type of vehicle used.	
The one-off medicines cost of prescription synchronisation is likely to be small (i.e. less than £70).	
Challenges remain in how to measure carbon savings of prescription synchronisation.	PMR functionality should be developed that automatically identifies patients who have more than one prescription dispensed per month and can distinguish prescriptions for regular medicines from new prescriptions.
Proportionately greater CO_2 reductions can be made in those who have the most deliveries per month before synchronisation.	Prescription synchronisation activity should target those who have the most collections / deliveries of medicines per month.

Table 22 shows who should act on these recommendations and ways in which they might be able to do so. This should not be assumed to be exhaustive as there may be other ways to implement the recommendations than those listed and there may be other groups, organisations or individuals who are also able to take action.

Table 22: Suggested summary of who should implement the recommendations and how

Recommendation	**Who for**	**Suggested actions**
Further research on a larger scale should be undertaken to confirm the findings of this study as this can support policymakers to decide whether prescription synchronisation should be contracted through the NHS.	Researchers	Submit applications to appropriate research funding programmes / competitions.
	Research funding bodies	Issue topic specific calls for applications and / or invite prescription synchronisation funding applications in existing programmes / competitions.
PMR functionality should be developed that automatically identifies patients who have more than one prescription dispensed per month and can distinguish prescriptions for regular medicines from new prescriptions.	PMR software companies	Develop prescription synchronisation functionality and include it in new versions of PMR software.
	Department of Health or NHS organisations with strategic / contracting responsibility for community pharmacy services Community pharmacy companies	Add prescription synchronisation functionality to the specifications for new versions of PMR software to be purchased.
Prescription synchronisation activity should target those who have the most collections / deliveries of medicines per month.	Community pharmacists Community pharmacy companies	Consider facilitating prescription synchronisation on an *ad hoc* basis or as part of a service.
	Department of Health or NHS organisations with strategic / contracting responsibility for community pharmacy services	Decide whether prescription synchronisation should be contracted through the NHS.

References

Automobile Association (2024). Mileage calculator. Available at: https://www.theaa.com/driving/mileage-calculator.jsp (Last Accessed: 24/03/25).

Barrett S, Tucker C, Pattman S (2022). Estimate of the reduced travel and CO2 emissions through utilisation of video software in a remote pharmacist-led outpatient lipid clinic. *International Journal of Pharmacy Practice*; 30 (Issue Supplement 2): ii5-ii6, https://doi.org/10.1093/ijpp/riac089.005 (Last accessed 24/03/2025).

Booth A, Jager A, Faulkner SD, Winchester CC, Shaw S (2023). Pharmaceutical Company Targets and Strategies to Address Climate Change: Content Analysis of Public Reports from 20 Pharmaceutical Companies. *International Journal of Environmental Research and Public Health*; 20: 3206. doi: 10.3390/ijerph20043206.

British National Formulary (2024). Available at: https://bnf.nice.org.uk/ (Last accessed: 24/03/25).

Dehipawala S, Goldman S, Hwang E, Shah P, Shroff A, O'Hara M (2023). OP21 The Pharmaceutical Industry's Carbon Footprint and Current Mitigation Strategies: A Literature Review. *Value in Health*; 26: S311. DOI https://doi.org/10.1016/j.jval.2023.03.2723.

Department for Energy Security and Net Zero (2021). *Greenhouse gas conversion factors 2021* (last updated January 2022). Available at: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2021#full-publication-update-history (Last Accessed 24/03/2025).

Firth, I., Hitch, J., Henderson, N., & Cookson, G. (2023). Moving towards a more environmentally sustainable pharmaceutical industry: recommendations for industry and the transition to green HTA. *Expert Review of Pharmacoeconomics & Outcomes Research*, *23*(6), 591–595. https://doi.org/10.1080/14737167.2023.2214730 (Last accessed 24/03/2025).

Gil-Candel M, Solana-Altabella A, Vicente-Escrig E, Puplà-Bartoll A, Bodega Azuara J, Pérez-Huertas P, Ferrando Piqueres R (2022). Developing a telepharmacy programme with home medication dispensing and informed delivery in a tertiary hospital: description of the model and analysis of the results. *European Journal of Hospital Pharmacy*; Published Online First 20 April 2022: doi 10.1136/ejhpharm-2021-003194.

Godlee F (2014). Climate change. *British Medical Journal* 2014; 349: g5945.

Nguyen E, Sobieraj D (2017). The impact of appointment-based medication synchronization on medication taking behaviour and health outcomes: A systematic review. *Journal of Clinical Pharmacy and Therapeutics*; 42: 404-413.

Sammut Bartolo N, Azzopardi L, Serracino-Inglott A (2021). Pharmaceuticals and the environment. *Early Human Development*; 155, https://doi.org/10.1016/j.earlhumdev.2020.105218.

Sinsky T and Sinsky A (2012). A streamlined approach to prescription management. *Family Practice Management*, Available at: http://www.aafp.org/fpm/2012/1100/p11.html (Last accessed 24/03/25).

Statistica (2023). *Number of community pharmacies in England from 2006/07 to 2022/23* (release date October 2023). Available at: https://www.statista.com/statistics/418071/community-pharmacies-in-england/ (Last Accessed 12/12/24).

Tennison I, Roschnik S, Ashby B, Boyd R, Hamilton I, Oreszczyn T, Owen A, Romanello M, Ruyssevelt P, Sherman J, Smith A, Steele K, Watts N, Eckelman M (2021a). Health care's response to climate change: a carbon footprint assessment of the NHS in England. *Lancet Planet Health*; 5: e84-92.

Tennison I, Roschnik S, Ashby B, Boyd R, Hamilton I, Oreszczyn T, Owen A, Romanello M, Ruyssevelt P, Sherman J, Smith A, Steele K, Watts N, Eckelman M (2021b). Health care's response to climate change: a carbon footprint assessment of the NHS in England. *Lancet Planet Health*; 5: e84-92, Appendix 1 (Table S8. Summary of accounting for transport-related emissions – page 35.

Appendix 1: Summary of literature search strategy

Search 1

Review question	What research has been published that evaluated pharmacy service delivery initiatives designed for environmental benefit?
Population	Providers or users of pharmacy services
Intervention	Pharmacy service delivery initiatives
Context	Environmental impact / carbon dioxide emissions
Search terms	Pharmacy AND carbon footprint OR environmental impact
Databases	Via EBSCo Host: AMED - The Allied and Complementary Medicine Database, MEDLINE, APA PsycInfo, SPORTDiscus with Full Text, AgeLine, CINAHL Plus with Full Text, APA PsycArticles
Dates	From inception – end January 2025
Inclusion criteria	Interventional primary research
Exclusion criteria	Research that has not attempted to measure environmental impact / carbon emissions Studies where the full paper has not been published (e.g., conference abstracts) Literature reviews / systematic reviews
Limits applied	English language only
Hits	105
After duplicates removed	87
Papers included	1 (Gil Candel *et al* 2022)

Search 2

Review question	What research has been published on the environmental impact of prescription synchronisation in primary care?
Population	Patients taking regular medicines
Intervention	Prescription synchronisation
Context	Community pharmacy Environmental impact / carbon dioxide emissions
Search terms	Refill alignment OR prescription synchronization OR medication synchronization

Databases	Via EBSCo Host: AMED - The Allied and Complementary Medicine Database, MEDLINE, APA PsycInfo, SPORTDiscus with Full Text, AgeLine, CINAHL Plus with Full Text, APA PsycArticles
Dates	From inception – end January 2025
Inclusion criteria	Interventional primary research
Exclusion criteria	Research that has not attempted to measure environmental impact / carbon emissions Studies where the full paper has not been published (e.g., conference abstracts) Literature reviews / systematic reviews
Limits applied	English language only
Hits	218
After duplicates removed	152
Papers included	0

Appendix 2: Conference abstract

Carbon Reduction Impact from Synchronising PrescriptionS (CRISPS): A pilot study

Introduction: Synchronising the dates of patients' repeat prescriptions can reduce monthly community pharmacy visits or home deliveries, which may improve patients' adherence to medicines.[1] It should also reduce carbon dioxide (CO_2) emissions associated with avoidable travel, but previous research does not appear to have determined the potential size of this reduction. This pilot study therefore attempted to do so using routinely collected data.

Aim: To estimate potential carbon savings from synchronising repeat medicines for a sample of patients from one community pharmacy.

Methods: All patients who had prescriptions dispensed four times per month or more from a single medium-sized (approximately 2,500 items dispensed per month) urban community pharmacy in England were identified from the pharmacy's home delivery application. The threshold of four deliveries per month was selected to increase the likelihood of this frequency being due to asynchronised prescriptions. Data were collected (August 2023) for deliveries in June 2023 as there were no public holidays or events to affect prescription ordering. Data included patients' postcode, delivery dates, and using the Patient Medication Record, the pharmacist collecting the data determined acute or one-off prescription items, that neither the patients nor the repeat medicines were new, and where deliveries were made to supply medicines owing. The pharmacy was selected because it efficiently managed stock to minimise items owing. The distance that would have been travelled was calculated as if the medicines had been collected from the pharmacy as a dedicated journey to and from the patient's home address instead of being delivered. The saving in miles and CO_2 emitted for different vehicle types was modelled by assuming that for each patient, all deliveries that were not for acute items or medicines owing could have been reduced to a single delivery if prescriptions had been synchronised. UK Government conversion factors were used to calculate CO_2 emissions.[2]

Results: Data were collected for 59 patients, of whom 7 patients had 8 deliveries, 4 had 7 deliveries, 6 had 6 deliveries, 5 had 16 deliveries and 26 had 4 deliveries. The total number of deliveries to these patients was 269 but would have been 80 deliveries if the repeat prescriptions had been synchronised (70% reduction). The distance travelled would have been reduced from 842 miles to 241 miles (71% reduction). This would have resulted in a 71%

reduction in CO_2 emissions, although the reduction in volume in kilograms of CO_2 emitted would have varied (by an estimated 137 Kg CO_2 or 51%) depending on whether e.g., a small diesel car was used or a large petrol car (reduction of 133kg versus 270 Kg CO_2). An average diesel car was estimated to have reduced CO_2 emissions by 163 Kg.

Conclusion: The findings demonstrate that potential carbon savings from medicines synchronisation can be modelled from routinely collected data, but with limited accuracy, especially as patients receiving home deliveries may not be representative of all pharmacy users. Challenges remain in how to measure actual carbon savings of prescription synchronisation and overcoming barriers to widespread implementation of clinically appropriate synchronisation.

References:

1. Nguyen E, Sobieraj D. The impact of appointment-based medication synchronization on medication taking behaviour and health outcomes: A systematic review. J Clin Pharm Ther, 2017; 42: 404-413.
2. Department for Energy Security and Net Zero. *Greenhouse gas conversion factors 2021* (last updated January 2022). Available at: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2021#full-publication-update-history (Accessed 10/10/2023).