York Health Economics Consortium

IETHICO AND EAST MIDLANDS ACADEMIC HEALTH SCIENCE NETWORK

An Early Economic Evaluation of the iEthico Medicine Sourcing Tool

Final Report

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Table of Contents

Executive Summary

1. INTRODUCTION

iEthico and East Midlands Academic Health Science Network (AHSN) commissioned York Health Economics Consortium (YHEC) to conduct an early economic analysis of the iEthico medicine sourcing tool compared with standard care. The analysis was undertaken from the perspective of the National Health Service (NHS) and personal social services (PSS) in England. The key population was hospital pharmacies experiencing drug shortages. Standard care was the existing supply chain process in the case of drug shortages.

2. METHODS

A cost-comparison model was developed to capture incremental pharmacy staff working hours and incremental costs of a case study of six drugs commonly used in hospitals which in the past have been in shortage. Pragmatic literature searches were conducted to obtain parameter inputs. Alongside this, two interviews were conducted with hospital pharmacy staff to validate modelling assumptions and obtain further specific model inputs. Deterministic sensitivity analyses (DSA) were conducted to provide an understanding of the key drivers and the parameter uncertainty within the model.

3. RESULTS

In the base case, iEthico was estimated to be cost saving to the NHS, due to reducing working hours spent on drug shortages and reducing excess drug prices. Compared with standard care, iEthico was estimated to reduce costs by approximately £28,600 per pharmacy per year, translating to approximately £116,000 per trust per year. DSA results indicate that the key uncertainty within the model were the proportion of pharmaceutical suppliers which are on iEthico, followed by the time spent sourcing drugs by pharmacy staff. Two scenario analyses were also carried out; the first estimated the potential annual national cost savings to be over £200 million. The second was a retrospective analysis of the December 2022 Amoxicillin shortage in England, which estimated the excess drug cost to the NHS to be over £2.2 million.

4. CONCLUSIONS

From the cost-comparison model, it is estimated that iEthico is cost-saving to the NHS when compared with current NHS procurement processes within hospital pharmacy. This was largely due to a reduction in staff time needed to source drugs in shortage. As is common in early modelling and in order to increase the clinical accuracy and credibility, this analysis would benefit from further evidence collection, with specific focus on the efficacy of the iEthico software. With further evidence, the results could potentially be tailored to each specific NHS trust. This could be achieved through a parallel study design, comparing results between specific NHS trusts: one where iEthico is implemented compared to one with standard care.

Abbreviations

AI	Artificial Intelligence
CEO	Chief Executive Officer
DHSC	Department of Health and Social Care
DSA	Deterministic sensitivity analysis
EAHP	European Association of Hospital Pharmacists
EMAHSN	East Midlands Academic Health Science Network
eMIT	Drugs and Pharmaceutical Electronic Information Tool
HTA	Health technology assessment
MSO	Medicine Safety Officer
NHS	National Health Service
NICE	The National Institute for Health and Care Excellence
PGEU	Pharmaceutical Group of the European Union
PSNC	Pharmaceutical Services Negotiating Committee
PSS	Personal social services
SCMD	Secondary Care Medicines Data Unit
SPS	Specialist Pharmacy Services
SSP	Serious Shortfall Protocol
YHEC	York Health Economics Consortium

1 Introduction

1.1 Background

Drug shortages are an increasing problem in England, impacting on patient care through delays in care and sub-optimal treatment if a less effective alternative is used [1]. A report by the European Association of Hospital Pharmacists (EAHP) indicated that 95% of hospital pharmacists consider drug shortages to be a material problem [2]. Furthermore, drug shortages may cause increased costs to the health care system due to an increase in treatment length (and/or length of stay) or the requirement to use more costly alternative drugs [3].

There is a lack of understanding of the root causes of drug shortages due to inconsistent and limited reporting. Around half of all cases can be traced back to quality and manufacturing issues [4]. In its 2021 report, the European Commission concluded that the majority of shortages are localised, indicating inequitable distribution and access of drugs, rather than global supply issues [4]. Drug shortages cause an increase in the market price of the drug, especially when demand increases are fuelled by the concern about access to drugs [5]. Current procedures in the event of drug shortages vary widely across the country.

iEthico has created a digital solution that links pharmacists to suppliers using artificial intelligence (AI) technology with the aim of minimising the impact of drug shortages in the UK. The digital technology enables parties such as pharmacists, manufacturers and suppliers to share information and collaborate on the problem, potentially reducing pharmacy staff time waste and improving drug supply chains.

1.2 Objectives

iEthico and the East Midlands Academic Health Science Network (EMAHSN) commissioned York Health Economics Consortium (YHEC) to conduct an early economic evaluation of the drug sourcing software to support hospital pharmacists in the National Health Service (NHS) across England. To achieve this, YHEC have developed a cost-comparison model. The model takes an English NHS and personal social services (PSS) perspective. The model is an early evaluation to estimate whether there is potential value to the NHS and to guide potential future evidence collection. Hence, it is not designed to be used for health technology assessment (HTA).

The cost-comparison component means that the model will estimate costs (or savings) of implementing the iEthico software within NHS hospital pharmacies. The analysis has a focus on pharmacist time and average change in drug prices.

2 Methods

2.1 Decision problem

The details of the decision problem are summarised below in Table 2.1. Costs were applied from the perspective of the English healthcare system, where outcomes were quantified in terms of costs and the difference in pharmacist working hours. A further outcome was estimating the average increase in drug price. This was developed through conducting a case study of 6 commonly used drugs that were in shortage as of March 2023, and calculating the average percentage change in price of these selected drugs. A model time horizon of one year is used, and so discounting was not necessary. The decision problem and model aligned with guidelines for evaluation of medical devices published by the National Institute of Health and Care Excellence (NICE) [6].

Table 2.1: Decision problem

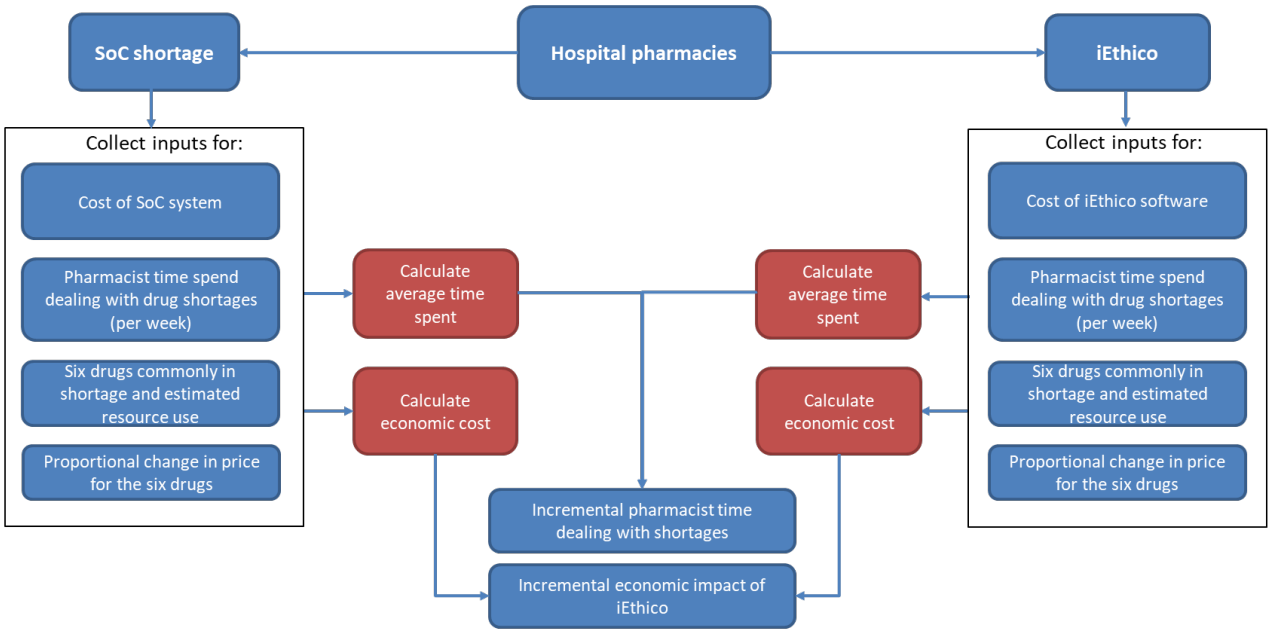
Model element	Description
Population	Hospital pharmacies
Intervention	iEthico medicine sourcing tool
Comparator	Normal supply chain procedure in the event of a drug shortage
Key outcomes of the model	▪ Incremental cost breakdown ▪ Incremental pharmacist resource use ▪ Average change in price of six commonly used drugs (when in shortage)
Time horizon	1 year

2.2 Model structure

The model was developed using a cost-comparison structure. Pharmacist time spent on drug shortages and the respective cost for iEthico, and standard care are totalled up and compared (a cost-comparison model). The model outcomes focused on the average staff time spent dealing with drug shortages and the respective cost, and the economic impact of the differing unit drug costs of iEthico compared with standard care. The primary objective of the model was to capture the differences in hospital pharmacy staff time spent working to resolve drug shortages, and the incremental economic impact of introducing iEthico to the health system.

A diagram of the model is presented in Figure 2.1.

Figure 2.1: Cost-comparison model structure



The following inputs were collected for iEthico and the standard care alert system:

- Cost of system/software.
- Pharmacist time spent dealing with drug shortages (per week).

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- Six drugs commonly in shortage and estimated resource use.
- Proportional change in price for the six drugs.

The pharmacist time spent was calculated from the average time spent by multiple pharmacy staff involved within the drug procurement process. This included time spent by the hospital pharmacist, medicine safety officer (MSO), procurement officer, and administrative staff. The roles and respective time spent were sourced via clinical consultation with two members of staff working within hospital pharmacy. The weekly time spent was then applied to the cost per working hour of each respective member of staff for each arm of the model and the incremental staff-time-associated cost was calculated from the difference in these values.

The economic cost was calculated by comparing the average price increase of six drugs commonly in shortage for each arm of the model. These costs were multiplied by the average resource use of each drug (originally reported on a “per trust” basis before being converted to a “per pharmacy” basis). The total incremental economic cost was then derived by summing the drug and resource-associated costs for both arm of the model and finding the difference between them.

2.2.1 Key modelling assumptions

Due to a paucity of published data on hospital pharmacy, key assumptions were made on various model inputs, and the overall model structure. Table 2.2 below details the assumptions made and rationale behind them.

Table 2.2: Key modelling assumptions

Assumption	Rationale
In the base case, it is assumed that all hospitals are split evenly between trusts, and that there is one pharmacy per hospital.	This assumption was made for the purpose of determining the number of pharmacies entering the model. Furthermore, the resource use data sourced was reported on a per-trust basis and so there was requirement to convert this to a "per-hospital" basis in order to apply these to individual pharmacies. The model included functionality for the user to change the population set up values if they want to determine the outcomes for a specific hospital trust.
In the base case, the number of hospitals in England is inclusive of private hospitals. It is assumed that this is appropriate for the purpose of this model	This value was used as a value excluding private hospitals could not be sourced. Many private hospitals carry out NHS services, and so it is assumed that NHS prescriptions may be delivered within private hospitals on occasion.
When a pharmacy cannot source a drug at or below the Drug Tariff Price, the Pharmaceuticals Services Negotiating Committee (PSNC) can request a price concession from the Department of Health and Social Care (DHSC). It is assumed that the drugs that are granted a price concession are those in shortage.	These assumptions were made as there is a paucity of publicly available data on hospital pharmacy shortages. These assumptions were validated via clinical correspondence with two members of staff working within hospital pharmacy.
The price concession list is generated for the community pharmacy setting, and so it is assumed that drugs in shortage within the community pharmacy setting are also in shortage within the hospital pharmacy setting.	
The efficacy of iEthico is 50% in the base case.	Due to a paucity of data, the assumption is made that the efficacy of iEthico is set at 50% in the base case. This implies that iEthico will reduce excess staff time and excess drug costs by 50%. These values are placeholder assumptions and are not a reflection of how iEthico will impact the market. This value is amendable by the model user.
The proportion of suppliers that are on the iEthico software is 80% in the base case.	Due to a paucity of data, it is assumed that 80% of suppliers are available for hospital pharmacies to access on the iEthico software. This implies that 80% of the drugs sourced through iEthico result in commercial sources being identified. This value is a placeholder assumption and is not a reflection of how iEthico will impact the market. This value is amendable by the model user.

Assumption	Rationale
iEthico is not associated with any deployment or maintenance cost to the NHS and it can be deployed to every NHS pharmacy in England immediately without training costs.	Clinical correspondence with iEthico suggested that there was no cost to the NHS. Due to a paucity of data staff-time-associated training costs were assumed negligible, however, the model includes functionality to incorporate a cost to the NHS of using iEthico when this data becomes available.

2.3 Interview process

Following targeted literature searches, limited data information was found on the current supply chain process, and current alert systems that exist for when drug shortages occur. Two interviews were conducted with NHS hospital pharmacy staff in April 2023 to gain a better understanding of current practices and systems in place in the event of a drug shortage.

These interviews helped to inform key parameters, alongside validating modelling assumptions. Further to this, these conversations highlighted some of the inefficiencies and variances in the current drug shortage systems. Due to a lack of data, it is not possible to captured all of what was discussed quantitatively in the model. This is detailed qualitatively in Section 4.2.

The six drugs chosen for inclusion in the analysis were amoxicillin 500mg capsules, co-trimoxazole 80/400mg tablets, gabapentin 600mg tablets, paracetamol 500mg soluble tablets, phenoxymethylpenicillin 250mg tablets and venlafaxine 75mg tablets. These drugs were selected as a case study to estimate the impact that drug shortages have on drug prices and costs to the NHS. These drugs are commonly used in hospitals and as of March 2023 had been granted price concessions for at least six out of the previous twelve months by DHSC [7] [8]. Furthermore, phenoxymethylpenicillin had a Serious Shortage Protocol (SSP) registered from 16th December 2022 to 12th May 2023 [9], indicating a serious shortage. There is functionality for the model user to add one additional drug to the model, and all respective inputs can also be inputted for use in the model.

2.4 Model input parameters

2.4.1 Population characteristics

According to the Kings Fund there are 215 trusts in England as of 2023 [10]. There are approximately 875 hospitals in England [11]. This number includes both private and NHS hospitals, due to data availability. Within this model, it is assumed there is an average of 1 pharmacy per hospital. The total number of pharmacies in an average trust is 4. This is calculated by dividing the number of hospitals by the number of trusts. The base case is 1 pharmacy entering the model.

2.4.2 Resource use

The following tables list the parameters for resource use used in the model.

Table 2.3: Time spent sourcing drugs (per week)

Time spent sourcing drugs in shortage	Value	Source
Hospital pharmacist	6.68 hours	Pharmaceutical Group of European Union (PGEU) Survey 2022 [12]. Assumes value for hospital pharmacists is equivalent to community pharmacists.
Medicine safety officer	7.50 hours	Expert elicitation from interview with Associate Director of Pharmacy on 12.04.23.
Procurement officer	7.50 hours	Expert elicitation from interview with Associate Director of Pharmacy on 12.04.23.
Administrative staff	3.75 hours	Expert elicitation from interview with Associate Director of Pharmacy on 12.04.23.
Proportion that iEthico will reduce drug shortages		
Staff time reduction	50.0%	Assumption
Excess drug cost reduction	50.0%	Assumption
Proportion of suppliers on iEthico	80.0%	Assumption

Table 2.4: Case study drugs in shortage – estimated resource use per hospital trust

Drug use per hospital	Value	Source
Capsules per trust (monthly)		
Amoxicillin 500mg (21 capsules)	5,209	Secondary Care Medicines Data (SCMD) - Average of monthly usage January-December 2022. Unit of measure is per capsule / tablet [13]. Data calculated as an average of up to 187 hospital trusts across England. Please see supplementary materials for calculations.
Co-trimoxazole 80/400mg (28 tablets)	4,336	
Gabapentin 600mg (100 tablets)	263	
Paracetamol 500mg soluble (24 tablets)	2708	
Phenoxymethylpenicillin 250mg (28 tablets)	4,095	
Venlafaxine 75mg (56 tablets)	410	

Capsules per Pharmacy (yearly)		
Amoxicillin 500mg (21 capsules)	15,359	Calculated by the number of capsules per trust / Total number of pharmacies in an average trust * 12.
Co-trimoxazole 80/400mg (28 tablets)	12,786	
Gabapentin 600mg (100 tablets)	776	
Paracetamol 500mg soluble (24 tablets)	7,985	
Phenoxymethylpenicillin 250mg (28 tablets)	12,074	
Venlafaxine 75mg (56 tablets)	1,210	
Number per pack		
Amoxicillin 500mg (21 capsules)	21	Drugs used for case study. Commonly used in hospitals and have had price concessions granted for at least 6 out of the last 12 months (March 2022-March 2023) by the DHSC.
Co-trimoxazole 80/400mg (28 tablets)	28	
Gabapentin 600mg (100 tablets)	100	
Paracetamol 500mg soluble (24 tablets)	24	
Phenoxymethylpenicillin 250mg (28 tablets)	28	
Venlafaxine 75mg (56 tablets)	56	

Table 2.5: Packs per pharmacy (yearly)

Packs per pharmacy (yearly)	Value	Source
Amoxicillin 500mg (21 capsules)	732	Calculated by the number of capsules per pharmacy / number of tablets capsules per pack.
Co-trimoxazole 80/400mg (28 tablets)	457	
Gabapentin 600mg (100 tablets)	8	
Paracetamol 500mg soluble (24 tablets)	333	
Phenoxymethylpenicillin 250mg (28 tablets)	432	
Venlafaxine 75mg (56 tablets)	22	

2.4.3 Costs

Table 2.6 and Table 2.7 below list the cost parameters for NHS staff involved in the drug shortage process and unit drugs costs, respectively.

It is assumed the cost of implementing iEthico software is £0. This was derived through email correspondence with Debra Ange, Chief Executive Officer of iEthico: “There is no implementation or access cost for pharmacies. Revenue is generated from commission on any sale paid by the seller”. It is also assumed the current alert system incurs a £0 cost.

Table 2.6: NHS staff costs

Cost per hour to the NHS of staff involved in drug shortage process	Value	Source
Hospital Pharmacist	£53.00	PSSRU 2022 [14]. 11.1. Hospital-based scientific and professional staff. Hospital pharmacist = Band 6.
Medicine Safety Officer (MSO)	£73.00	PSSRU 2022 [14]. 11.1 Hospital-based scientific and professional staff. Medicine Safety Officer (MSO) = Band 8a.
Procurement Officer	£34.00	PSSRU 2022 [14]. 11.1 Hospital-based scientific and professional staff. Procurement Officer = band 4.
Administrative Staff	£34.00	PSSRU 2022 [14]. 11.1 Hospital-based scientific and professional staff. Assumption that administrative staff are band 4.

Table 2.7: Unit drug costs

Unit drug costs	Value	Source
Standard unit drug costs (when not in shortage)		
Amoxicillin 500mg (21 capsules)	£0.70	eMIT [15]. Accessed 17.05.23.
Co-trimoxazole 80/400mg (28 tablets)	£1.54	
Gabapentin 600mg (100 tablets)	£4.05	

Paracetamol 500mg soluble (24 tablets)	£1.16	
Phenoxymethylpenicillin 250mg (28 tablets)	£1.63	
Venlafaxine 75mg (56 tablets)	£3.49	
Average unit drug cost (when in shortage)		
Amoxicillin 500mg (21 capsules)	£3.45	Calculated weighted average from Pharmaceutical Services Negotiating Committee (PSNC) price concessions archive [8].
Co-trimoxazole 80/400mg (28 tablets)	£3.54	
Gabapentin 600mg (100 tablets)	£15.68	
Paracetamol 500mg soluble (24 tablets)	£3.31	
Phenoxymethylpenicillin 250mg (28 tablets)	£2.98	
Venlafaxine 75mg (56 tablets)	£13.63	

2.4.4 Scenario Analysis

The model includes two different scenarios. The first was to explore the potential impact that iEthico could have on a national level, through reducing the rapid increases in drug prices when drug shortages occur. This included an estimation of the potential yearly savings on drug shortages if iEthico were to be implemented in England. This value was calculated through estimating the annual spend on drug shortages in NHS England, and the potential annual spend on drug shortages if the iEthico software was implemented in English hospital pharmacies. This scenario only considers minimising changes in drug prices and does not include the impact of reducing wasted staff time.

Following multiple conversations with pharmacist staff, it was suggested that the Specialist Pharmacy Service (SPS) Medicines Supply Tool did not capture the magnitude of drug shortages that hospital pharmacists were regularly facing. Therefore, this scenario was broken down into part A and part B. Part A used the magnitude of drug shortages from the SPS Medicines Supply Tool list, where part B applied a multiplier factor of four to reflect the suggested underestimation.

The second scenario considers a retrospective case study of the Amoxicillin shortage in December 2022. This scenario models the potential savings had iEthico been used in English

hospital pharmacy prior to the Amoxicillin shortage in England. The tables below list the parameters for the scenario analyses used in the model.

Table 2.8: Scenario 1 inputs

Scenario 1	Value	Source
Proportion of drugs currently in shortage	2.02%	British Generics March 2023 - Estimate of the proportion of generic medicines listed in March 2023 SPS Medicines Supply Tool as a proportion of the number of presentations listed in the Drug Tariff [16].
Proportion of drug shortages on Specialist Pharmacy Service (SPS) list	25.0%	Email correspondence with Deputy Operations Manager, Pharmacy Support Services on 27.04.23.
Annual spend on drugs in hospitals	£8.77 billion	NHS Business Services Authority - Prescribing Costs in Hospitals - England 2021/22 [17].
Average overall price increase of drugs in shortage	244.3%	Taken from an average price increase of 171 drug in shortage between March 2022-March 2023. Price in shortage taken from PSNC [8]. Standard price taken from eMIT [15].

Table 2.9: Scenario 2 inputs

Scenario 2	Value	Source
Average price of Amoxicillin 500mg (21 capsules)	£0.70	eMIT [15]. Accessed 17.05.23.
December 2022 price of Amoxicillin 500mg (21 capsules)	£5.34	Price concession data December 2022 from the PSNC [8].
December 2022 estimated resource use of Amoxicillin 500mg (21 capsules) per trust	8,556	Secondary Care Medicines Data (SCMD) - Average of monthly usage December 2022. Unit of measure is per capsule / tablet [13]. Data calculated as an average of up to 187 hospital trusts across England.

December 2022 estimated resource use of Amoxicillin 500mg (21 capsules) per pharmacy	2,102	Calculated by the number of capsules per trust / Total number of pharmacies in an average trust.
December 2022 estimated resource use of Amoxicillin 500mg (21 capsules) packs per pharmacy	101	Calculated by the number of capsules per pharmacy / number of tablets capsules per pack.

2.5 Sensitivity analysis

2.5.1 Deterministic sensitivity analysis

In order to account for first-order uncertainty around the data used for all input parameter values, cost resource use parameters were tested in deterministic sensitivity analysis (DSA). DSA involves altering the value used for individual parameters, within plausible ranges, to see the impact on the model results. The main output from the DSA was a tornado diagram, which summarises the impact of changes to each parameter on the model results. This enables the user to quickly identify the parameters that have the most significant impact on the results. Given the early nature of the analysis, many inputs did not have confidence intervals associated with them. In this case, parameters were adjusted ± 20% of the mean value.

2.5.2 Slider chart

A slider chart is also included, to conduct further scenario analyses on the impact of the select parameters or combination of parameters on the total incremental costs. Slider charts allow the user to vary multiple inputs at once using slider bars to adjust inputs to the desired levels. This is a user-friendly way to display sensitivity analysis and is particularly useful if several input parameters are questioned. The slider chart allows you to quickly adjust all parameters at once and see the effect on the results.

3 Results

3.1 Base case results

The results of the base case analysis are summarised below in Table 3.1. All results capture a one-year time horizon. The base case results suggest that implementing the iEthico software within hospital pharmacies in England would lead to cost savings. The estimated yearly cost saving per pharmacy is £28,598 and the estimated yearly cost saving per trust is £116,387.

Table 3.2 provides a breakdown of the model results. The reduction in costs is driven by the pharmacy staff time costs, from reducing the time wasted on drug shortages. The results suggest that with the iEthico software, hospital pharmacies could save approximately £26,781 in staff costs on a yearly basis, saving 530 lost work hours. Furthermore, iEthico could reduce excess drug prices by up to 91%. The results are also presented graphically in Figure 3.1.

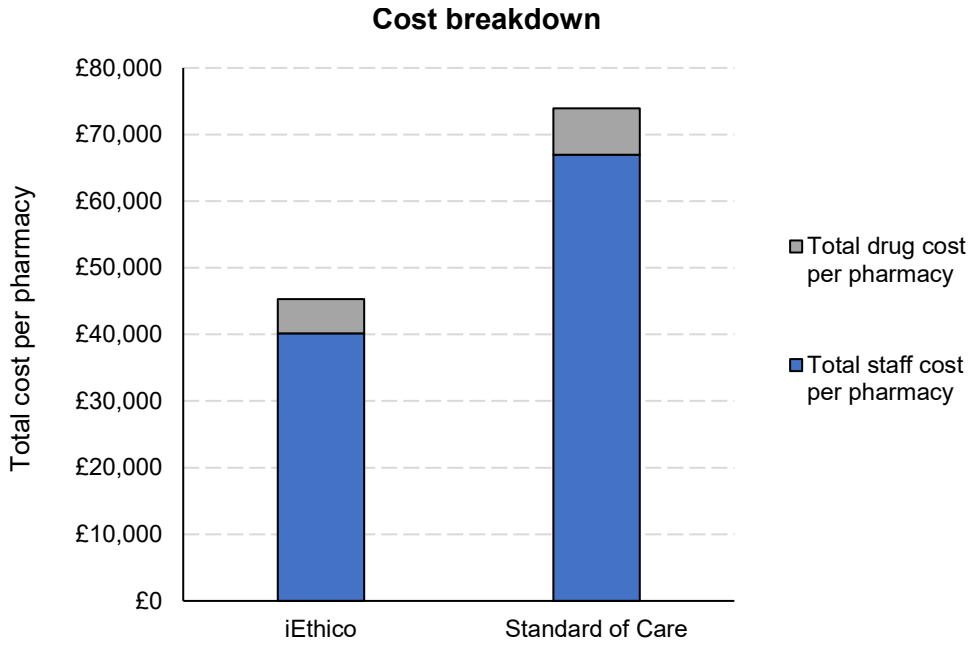
Table 3.1: Summary of base case results (per year)

Result	iEthico	Standard of Care	Incremental
Total cost per pharmacy due to drug shortage	£45,313	£73,911	-£28,598
Total cost per trust due to drug shortage	£184,413	£300,800	-£116,387

Table 3.2: Breakdown of results (per year)

Result	iEthico	Standard of Care	Incremental
Total staff cost for drugs in shortage per pharmacy	£40,172	£66,954	-£26,781
Total drug cost per pharmacy (for the six drugs used in case study only)	£5,141	£6,957	-£1817
Average change of drug price in concession (for the six drugs used in case study only)	137%	228%	-91%
Total time spent per pharmacy (hours)	796	1,326	-530

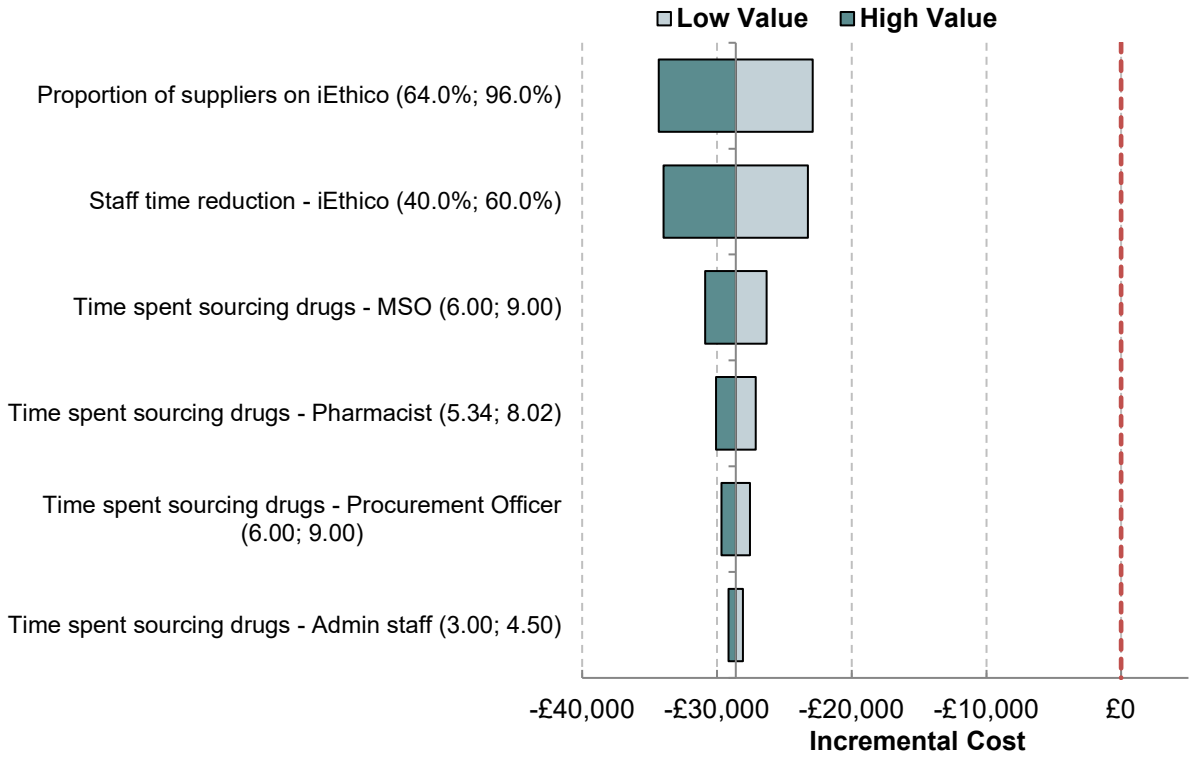
Figure 3.1: Breakdown of costs



3.2 Sensitivity analysis

A tornado plot was built to summarise the impact of changes to key parameters on the model results. Figure 3.2 shows the tornado plot. As can be seen, the key driver of the results was the proportion of suppliers which are on iEthico. The next highest driver is the proportion that iEthico reduces staff time by, set at 50% in the base case. Following this, the time spent sourcing drugs by the Medicine Safety Officer, Pharmacists, Procurement Officer and Administrative staff were also key drivers of the results. However, none of the inputs cause the results to change to a large enough extent (by themselves) that iEthico is no longer cost saving (i.e., the incremental cost of implementing iEthico is below £0). For instance, in the case where only 64% of drug suppliers are available to access through iEthico, there would still be cost savings of £439.

Figure 3.2: Deterministic sensitivity analysis results: Tornado plot



3.2.1 Scenario analysis

Two scenario analyses were conducted as described in Section 2.3.4. The first was to explore the potential impact that iEthico could have on a national level, through reducing the rapid increases in drug prices when drug shortages occur. This was split into part A and part B and the results are presented in Table 3.3. These results indicate the vast amount of money that is spent on annual drug shortages, and the potential savings that could be generated if iEthico were to be implemented.

Table 3.3: Summary results of Scenario 1

Result	iEthico	Standard of Care	Incremental
Scenario 1a	£126,873,753	£177,154,000	-£50,280,247
Scenario 1b	£507,495,014	£708,616,000	-£201,120,986

The second scenario analysis conducted was a retrospective case study of the December 2022 Amoxicillin shortage in England. The summary results are presented below in Table 3.4, and a further breakdown per pharmacy in Table 3.5. These results indicate that had iEthico been implemented prior to the Amoxicillin in December 2022, the NHS could have potentially saved £2,557 per hospital pharmacy, £10,404 per trust and £2,236,9540 nationally. The highest driver

of this result is the staff cost as a result of the total work hours lost, at 45 hours per hospital pharmacy.

Table 3.4: Summary results of Scenario 2

Result	iEthico	Standard of Care	Incremental
Total additional cost per pharmacy	£3,600	£6,157	-£2,557
Total additional cost per trust	£14,653	£25,057	-£10,404
Total additional cost (England)	£3,150,380	£5,387,320	-£2,236,940

Table 3.5: Breakdown results per pharmacy of Scenario 2

Result	iEthico	Standard of Care	Incremental
Total staff cost per pharmacy	£3,413	£5,688	-£2,275
Total drug cost per pharmacy	£188	£469	-£281
Average change in drug price	265%	663%	398%
Total time lost per pharmacy (hours)	68	113	-45

4 Discussion

4.1 Discussion of results

Drug shortages are a growing issue with many negative consequences. These include increased costs to the NHS through staff time spent dealing with shortages and increasing drug prices while in short supply. Market prices may be exacerbated by stockpiling, causing further spikes in demand. Furthermore, drug shortages may impact on patient care through delays in treatment, brand or drug switching which may result in sub-optimal patient care. There are multiple factors contributing to increasing drug shortages, including COVID-19, Brexit and other current global issues [18].

Under base case assumptions, iEthico was estimated to be cost saving to the healthcare system, saving approximately £28,598 per pharmacy per year, translating to £116,387 per trust per year. This was largely as a result of reduced staff time spent dealing with drug shortages.

Through conducting sensitivity analysis, the key drivers of the model results were found to be:

- The proportion of suppliers that can be accessed using iEthico.
- The efficacy of iEthico in reducing staff time spent on shortage.
- Time spent sourcing drugs by all staff involved in drug shortage management.

Two scenarios were run within this analysis. The first provides an approximation of the potential national savings in reducing the costs driven by excess drug prices. This was estimated to be over £50 million annually, in the case where the current SPS reported list of drug shortages is accurate. This is a conservative estimation and may be up to four times higher. The second scenario estimated the potential economic savings had iEthico been in place prior to the December 2022 Amoxicillin shortage. Here, it was estimated that, annually, the NHS could have potentially saved £2,557 per hospital pharmacy, £10,404 per trust and over £2.2 million nationally.

As this is an early economic model, the model was designed to be as flexible as possible for the model user. As a result, all model inputs are adjustable through inputting a value into the ‘User-defined’ cell. Where assumptions have been used, these values can also be updated when future evidence has been collected.

4.2 Qualitative analysis

Following conversations with hospital pharmacy staff, it was apparent that current drug shortage notification systems are inefficient, and practice varies largely between individual trusts. Often, pharmacists are not aware of upcoming shortages until it is too late to make the necessary preparations and as such are put under time pressure to source the drug by alternative means, such as by contacting manufacturers directly. This is an inefficient and timely process and uses up significant working hours of various hospital pharmacy staff.

The communication with hospital pharmacy staff highlighted key outcomes which were not quantifiable within this economic model. These results do not capture the excess pharmacy staff resource use in terms of the trade-off for other work that is not completed as a result of substantial working hours being lost to the drug procurement process. In addition, the current procurement system may generate extra tasks to be completed by procurement staff, for example reimbursement contracts to be filed to compensate the pharmacy when they pay an excess drug price due to the drug shortage. Tasks such as this may not be completed due to not being a priority in the time-pressured work environment. This suggests that the model results may be a conservative estimation of the true benefits that iEthico could bring to the health care service, as there are aspects that cannot be captured through the model.

Furthermore, this analysis only involves a case study of a selected six drugs, as it would not be possible to capture every type of drug and its respective resource use. Therefore, this analysis only provides a snapshot of the potential savings.

4.3 Limitations

As with all economic evaluations, simplifications or assumptions were made in order to evaluate the decision problem. Firstly, the set-up of the population was based on the average number of hospitals per trust, and it was assumed that there is one pharmacy per hospital. This assumption was used due to a paucity of specific NHS trust data. The resource use data was accessed through SCMD; however, this dataset was incomplete as it did not include entries for every trust for all drugs. Therefore, the results are provided as an estimation per average hospital and trust and are likely to vary between different trusts. The model has been built flexibly to allow for the user to generate the results for a particular trust. This would require knowing the number of hospitals and pharmacies, and the appropriate resource use, which can be input using the ‘User-defined’ cell.

Secondly, various assumptions were made surrounding the six drugs that were in shortage for the drugs selected for the case study in the model. It was assumed that the drugs granted a price concession are in shortage, and that those granted concessions in community pharmacy were reflective of shortages within hospital pharmacy. These assumptions were verified in the pharmacy staff interviews and were deemed appropriate due to the confidential nature of hospital pharmacy drug contracts. However, further evidence generation could be beneficial in order to further clarify these assumptions.

Thirdly, the model currently uses naïve assumption of 50% as the expected efficiency due to a lack of efficacy data. This value should be updated within the model once further evidence has been generated surrounding the impact of iEthico on hospital pharmacy staff time and drug prices. In order for the results to be clinically credible, real world trial data is required.

While all economic models will have some degree of uncertainty in the outputs generated, steps were taken to mitigate this. The project incorporated expert clinical advice at key conceptualisation stages of the model development, through the pharmacy staff interviews. All economic models are simplifications of reality, but it was deemed that this model structure was appropriate in its assumptions, and that its structure allowed the main differences in cost and benefits to be captured. Clinical validation combined with various sensitivity analysis supports in reaffirming the results of this economic evaluation.

5 Conclusion

Using the best available evidence to inform our assumptions, we have estimated that iEthico is likely to be cost-saving to the NHS when compared with standard care. The model design and assumptions were validated by experts through interviews with hospital pharmacy staff. The model results were robust under deterministic sensitivity analysis.

Due to the growing problems of drug shortages, iEthico may offer a potential solution to support hospital pharmacy staff in sourcing drugs that are in shortage through improving efficiency within the drug procurement process. As a result, this may bring cost savings to the NHS through saving and redeploying work hours and reducing excess drug prices. Furthermore, this may have a positive impact on patient care.

Given the nature of this early analysis, future evidence collection will be important to improve the robustness of the results. The impact of iEthico could be elicited using a parallel study design, where iEthico is introduced to a specific NHS trust and compared with a different trust without iEthico. Furthermore, there may be greater benefits associated with iEthico not quantified in this analysis, which could be highlighted if a comparative study was conducted. Finally, data collection could look to include community pharmacy alongside hospital pharmacy, in order to determine the total impact iEthico may have on drug procurement throughout England.

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