TRIPLE BOTTOM LINE ANALYSIS OF EYE MOTILITY SERVICES AT MOORFIELDS EYE HOSPITAL AND ITS SATELLITE CLINICS

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Aim of the Study

To analyse and compare the triple bottom line (TBL) of paediatric and adult eye motility services at Moorfields Eye Hospital (MEH) and its satellite clinics.

Background

In the 21st century the NHS faces numerous challenges. An ageing population, unhealthy lifestyles, new healthcare technologies and higher patient expectations have increased healthcare demand considerably. This has not been met with a proportionate increase in healthcare budgets. Social constraints like staff recruitment, morale and retention are putting additional restrictions on the health service. Moreover, environmental factors are creating constraints. Scarcity of raw materials is increasing whereas natural assets, like clean air, water, fertile soil, green space and a stable climate, which keep the NHS cost burden in check, are decreasing. With climate change as the greatest threat to public health in the 21st century[1], the NHS is legally required under the Climate Change Act (2008)[2] to cut its greenhouse gas emissions by 80% by 2050 to support the UK government's efforts to reduce its climate impact.

To ensure that high value health services continue to be provided despite the myriad of constraints, the current healthcare system needs to be transformed. The Five Year Forward View[3] particularly emphasises the need to strengthen primary and out-of-hospital care and the urgent need to create sustainable health systems. To facilitate this shift, the resource use underpinning the healthcare services provided needs to be fully understood.

$$\text{Sustainable value in healthcare} = \frac{\text{health outcomes}}{\text{whole costs (environmental + social + financial)}}$$

Sustainability in Ophthalmology

In October 2014, leading organisations in eye care, led by the Royal College of Ophthalmologists, set up a sustainable ophthalmology working group and pledged to improve the sustainability of eye care, by designing and delivering services that:

1. Prioritise prevention
2. Empower individuals and communities
3. Improve value
4. Consider carbon

These principles are based on the Centre for Sustainable Healthcare's four principles of sustainable clinical practice[4]. Applying these together, with consistency, can help commissioners and providers to optimize sustainable value by maximizing health outcomes and minimizing environmental, social and financial costs.

For ophthalmology, a sustainable approach (which applies these four principles) may involve providing services close to patients' homes, which the Moorfields' satellite model has already established. However, the impact of the model on health outcomes, and financial, social and environmental costs has not been evaluated in detail.

Moorfields' satellite model

The paediatric and adult eye motility services at Moorfields Eye Hospital (MEH) operate both consultant-led and orthoptist-led clinics at the main site at Moorfields in London, and at ten satellite sites (Bedford, Croydon, Darent Valley, Ealing, Homerton, Northwick Park, Potters Bar, St George's, Stratford and Hackney), some of which have their own affiliated community-based clinics[i]. Offering services not only at Moorfields Eye Hospital, but also at satellite clinics increases Moorfields capacity. Additionally, it moves their services closer to patients' homes.

Pilot Study at Bedford Hospital and three of its community clinics

One of the most common vision deficits in children is amblyopia, affecting 2-4% of the population. Eye assessments take several hours, as many tests are performed: visual acuity, motility, cycloplegia, refraction and fundoscopy, often with significant waiting times for each procedure. Attending hospital eye services (HES) is difficult for families, who often have several children to look after.

To get an idea of the potential difference in the financial, environmental and social impact of service provision at a hospital compared to its community clinics a pilot study was undertaken at Bedford Hospital. This initial work was accepted as a poster presentation at the Royal College of Ophthalmologists' annual conference in May 2016.

The study compared the average distance families travel to attend hospital amblyopia services and the average time spent in the clinics (appointment or arrival time to departure time), at the paediatric clinic at Moorfields at Bedford Hospital, (n=92) and three community clinics (n=71).

Per visit, families travelled a median 6.4 (interquartile range IQR 2.5 to 12.4) miles to the hospital eye clinic, and 3.7 (IQR 1.1 to 5.1) miles to their nearest community clinic. Median time spent in clinic was 82 (IQR 55 to 107) minutes for the hospital clinic (including consultation with an ophthalmologist), and 20 (IQR 17 to 26) minutes for community clinics (orthoptist with or without optometrist).

Community clinics cannot replace hospital clinics, as they do not provide all specialist services. Nevertheless, many appointments, particularly those of the amblyopia care pathway, can be carried out in a community setting, with staff working to agreed protocols.

This TBL study extended the reach of the pilot study to seven of Moorfields satellite clinics and looked at the environmental, social and financial impact of all eye motility services on offer.

[i] Three of the satellite clinics – Potters Bar, Homerton and Hackney – are organisationally and financially independent of Moorfields Eye Hospital; therefore, permission to ask patients to fill in questionnaires could not be obtained in the given time.

Methods

Triple bottom line analysis

The triple bottom line (TBL) is a concept created by John Elkington to describe three factors that should be considered for an organization to remain sustainable: people, planet and profit[5]. TBL requires a cross-disciplinary analysis which uses different methods and metrics to measure the impact of an intervention, a service or system on the three factors.

In this study, the TBL comparison of the Moorfields Eye Hospital with seven of its satellite clinics (Bedford, Croydon, Darent Valley, Ealing, Northwick Park, St George's, Stratford) involves assessing the financial, social and environmental impact of providing paediatric and adult eye motility services.

The metric to assess the financial impact of a service is costs as it is the most straight forward metric to measure. The study looked at the cost of the service provision, to a) the healthcare system, based on the staff involved in the care, b) to the patient, based on the cost of patient travel to and from the appointment and c) to the economy, based on work hours lost due to the appointment.

In most cases, the measurement of greenhouse gas emissions (GHGs) is used as a proxy to estimate the environmental impact of a service or product. The emissions are calculated based on use of resources, such as energy, water, waste disposal and procured goods. In addition, the GHGs caused by patient and staff travel feed into the overall assessment of a service carbon footprint. Pollution is currently popular as a metric for environmental impact, as it has a direct health impact. However, it is a different measure from that used to the standard method of calculating GHGs and therefore we have not included it.

There is no single method and metric for measuring social impact in healthcare. Health services can influence the social circumstances of patients, carers, dependents, staff, local and distant communities (e.g. people working in the supply chain). The types of impact can be diverse and may affect housing status, poverty, education, employment status, safety and security, satisfaction/happiness & quality of life, participation in society/social inclusion. It is not practical to measure every type of impact on every group for each service. The aim is to identify those people likely to be most affected, the nature of any impacts and their importance to the people concerned. In this study, patient and staff satisfaction, the travel time of patients and staff, paediatric patient time off school and adult patient's and paediatric patient's guardian's off work were used as indicators for social impact.

Currently, there is no standard methodology which allows you to combine the different metrics for financial, environmental and social impact into one (TBL) metric. Potentially, greenhouse gas emissions could be translated into costs via the cost of a tonne of carbon. However, it is difficult to put a monetary value on social impacts like staff and patient satisfaction.

The TBL of a service, in combination with the service's health outcomes, defines the service's sustainable value. If TBL is minimized and health outcomes maximised the sustainable value of a service is high. Therefore, in addition to measuring TBL, the study looked at health outcomes and the quality and safety of the health service provided at Moorfields Eye Hospital and the satellites.

Measuring the environmental impact - Carbon footprinting

To estimate the environmental impact of paediatric and adult eye motility services at MEH and its satellites, the greenhouse gas emissions embedded in the provision of these services were analysed.

The sum of direct and indirect greenhouse gas emissions which are produced throughout the supply chain of activities and products is also called the carbon footprint of a product or service. The terms carbon footprint, carbon emissions and greenhouse gas emissions are often used interchangeably, as they are in this report.

Carbon footprinting methodologies

There are two main carbon footprinting methodologies: Process-based life cycle analysis (PBLCA) and environmental input output analysis (EIOA).

The process-based life cycle analysis (sometimes referred to as a 'bottom-up' approach) is the most common type of carbon footprinting. It involves mapping the pathway in the supply chain of a product or service, measuring the resource utilization at each step and estimating the emissions attributable to each resource use. It is a straightforward concept that can look in detail at specific supply chains. However, the number of processes involved in creating a product or service is infinite - whereas any analysis only has the resources to consider a finite number. The result is that boundaries must be set defining the processes to be included in the carbon footprinting. This will lead to 'truncation errors'.[6]

The environmental input output analysis (or 'top-down' carbon footprinting) is a robust alternative method using macroeconomic modelling.[7] Although the results from this method rely on average carbon emissions for each category of spend, this approach does not incur truncation errors and is relatively easy to apply to yield broadly realistic and comparable results.

In most cases, carbon footprinting research uses a combination of the two methodologies. This is also the case for the comparative analysis of eye motility services at MEH and its satellite clinics.

Six main components can be identified in the provision of paediatric and adult eye motility services:

1. Patient travel to the appointment
2. Registration at reception
3. Waiting
4. Consultation with consultant or orthoptist
5. Diagnostic tests
6. Prescriptions

Components two to six all use the following resources to varying degrees: building energy use, water use, waste disposal, medical equipment, consumables and staff. As it was outside the scope of this study to measure the resource use for each component separately, a hybrid carbon footprinting methodology – using both PBLCA and EIOA - was used.

Boundaries

As in any carbon footprint analysis, boundaries need to be set. The aim of the study and the collectability of data influence the way boundaries are decided. In this study GHGs associated with the following have been included:

- Building energy use: use of gas and electricity, which can be affected by building insulation
- Water use: water supply and treatment
- Waste disposal
- Procurement for adult and children's eye outpatient services
    - Medical equipment
    - Consumables
        - Other procurement, e.g. dressings, wipes
        - Prisms and Bangerter foils
- Patient travel: return travel to outpatient appointments based on distance between home and hospital postcode
- Staff travel: commuting to work

The carbon emission associated with the following were excluded:

- Procurement of non-medical items
- Commute of non-health professionals who support the eye motility clinics

Greenhouse Gas Protocol

To measure the combined climate change effect of GHGs the Kyoto protocol has identified seven different greenhouse gases which, based on their weight and global warming potential, are expressed in carbon dioxide equivalents (CO2e)[8]. The Greenhouse Gas Protocol (GHGP,) developed by World Resources Institute (WRI) and World Business Council on Sustainable Development (WBCSD) has grouped emissions into three categories: Scope 1, 2 and 3 for company reporting[9].

- Scope 1: all direct emissions, e.g. vehicle emissions, emissions from energy generation, anaesthetic gases
- Scope 2: indirect GHG emissions from consumption of purchased electricity, heat or steam
- Scope 3: emissions embedded in the supply chain, travel and waste disposal

Table 1 shows how the carbon emissions associated with the resource use for paediatric and adult eye motility services at MEH and its satellites can be categorized into Scope 1, 2 and 3 emissions.

Table 1: Categorisation of emissions associated with adult and children's eye motility services

Resources	Emissions		
	Scope 1	Scope 2	Scope 3
Energy use - gas	V		V
Energy use - electricity		V	V
Water use			V
Waste disposal	V		V
Procurement of medical equipment			V
Procurement of consumables			V
Patient and staff travel	V		V

Data source and quality

The carbon footprinting part of this TBL study is based on data collected from estates and patient and staff questionnaires to create a comprehensive picture of the environmental impact of paediatric and adult eye motility services. Concerning the estates data: data from 2015/16 was collected as this was the most recent data available.

Table 2 Environmental variables and their sources

Variable	Data source
Energy use, water use, waste disposal, procurement	Estates questionnaire
Child patient travel	Questionnaire for accompanying adult
Adult patient travel	Questionnaire for adult patients
Staff travel	Staff questionnaire

Data quality

Energy data: There was limited availability of energy data from across the satellite sites. Only two satellites, St. Georges and Croydon, plus Moorfields Eye Hospital supplied data on the total energy use. The energy data provided by Moorfields covers the whole hospital, not only outpatient eye motility services. As the resource use for inpatients is usually greater than for outpatients it is likely that the current data overestimates energy use per outpatient.

Moorfields energy data was split into gas and electricity. The same proportion of gas to electricity as at Moorfields was applied to the two satellite sites which provided total energy data. The energy data reported by satellites, is the energy used by paediatric and adult eye motility services.

Waste disposal and water use: As in the case of energy, only St. Georges and Croydon of the satellite sites and MEH reported on total tonnes of waste disposed and cubic metres of water used. Moorfields provided figures of the amounts of their different waste streams – landfill, recycling, clinical waste. It was assumed that the proportion between the different waste streams is the same in the satellite clinics as in the hub. Whereas the two satellites reported on waste disposal and water use associated with paediatric and adult eye motility services, Moorfields hospital's record was for the whole hospital. As in the case of energy this might have overestimated the GHGs associated with waste disposal and water use.

Procurement: Some of the satellites get their consumables for paediatric and adult eye motility services directly supplied by MEH. When calculating the amount spent and the GHGs associated with the procurement per patient visit this was taken into account. For the rest of the satellites, only procurement data from St. Georges and Croydon was used as they were also the only ones to provide energy, water and waste data. All three sites only provided procurement directly related to the provision of eye motility services. Other procurement, e.g. for administration was not taken into account.

Adult and child travel: The data quality for adult and child travel is good as it was based on the distance travelled from home postcode to hospital site postcode. The home postcode and data on the mode of transport were collected during the completion of the questionnaires. It was assumed that everyone travelled with one mode of transport for the whole distance. This might have introduced a small bias. For example, if people travel to London by train they are likely to use another mode of transport from home to the train station (walk, bus, taxi, car), and from the train station to the site of their appointment. They are either walking, taking the underground, a bus or a taxi. This was not taken into consideration.

Carbon conversion factors

Once resources had been identified and their utilization measured, carbon conversion factors could be applied. Carbon conversion factors measure the carbon intensity of a resource or service per unit. There are various published lists of carbon conversion factors. The one used for this study is one of the most commonly used lists in the UK, the table of carbon conversion factors published by the Department of Environment, Food and Rural Affairs (DEFRA)[10]. The carbon conversion factors applied in the Sustainable Development Unit's (SDU) sustainability reporting template for healthcare organisations were also utilized[11].

Table 3 Carbon conversion factors used

Resource [carbon conversion variable] (unit)	Carbon conversion factors (kgCO2e)	Source of information
Building energy use		
Electricity use (kwh)	0.44048	Defra
Gas use (kwh)	0.212014	Defra
Water use (m3)		
Supply (m3)	0.344	Defra
Treatment (m3)	0.708	Defra
Waste disposal (tonne)		
Municipal waste (tonne)	310	SDU
Recycling waste (tonne)	21	SDU
Combustion without energy recovery [clinical waste] (tonne)	220	SDU
Travel		
Walk (km)	0	Defra

Bus [local London bus] (passenger.km)	0.09007	Defra
Resource [carbon conversion variable] (unit)	Carbon conversion factors (kgCO2e)	Source of information
London underground (passenger.km)	0.05419	Defra
Train [National Rail] (passenger.km)	0.05599	Defra
Car [average car unknown fuel] (km)	0.22911	Defra
Intercity coach (km)	0.14533	Defra
Taxi (km)	0.23030	Defra
Ophthalmology procurement		
Medical equipment [optical equipment] (£)	0.3	SDU
Other procurement [dressings] (£)	1.54	SDU
Prisms and bangerter foil [medical instruments] (£)	0.23	SDU

Measuring the social impact

To measure the social impact of paediatric and adult eye motility services the study looked at patient and staff satisfaction and patient and staff travel time. Other indicators considered were the time paediatric patients took off school and the time the patients' guardians and the adult eye motility patients had to take off work to attend their appointment. The metrics for measuring the social impact were covered by questions included in the patient and staff questionnaire.

The question used in the patient questionnaire to measure the patient satisfaction levels was the 'family and friends' question:

How likely are you to recommend our service to friends and family if they needed similar care or treatment?

This question is the most common way to measure patient satisfaction. It is often used during routine patient surveys as a good indicator for a patient's experience.

Tab 4: Social variables and their sources

Variable	Data source
Patient satisfaction, patient travel time, time off work, time off school	Paediatric questionnaire, adult questionnaire
Staff satisfaction and staff travel time	Staff questionnaire

Measuring the financial impact

The financial impact of a health service can be threefold. The provision of paediatric and adult eye motility services is a cost to the health system. However, accessing hospital appointments, despite being free of actual monetary cost to the patient, is likely to incur a cost both to the patient and the economy.

Cost to the health service

The cost of a hospital appointment is usually measured in tariffs set by NHS England and NHS Improvement[12]. However, tariffs are not granular enough to differentiate between the provision of a paediatric and adult eye motility service at MEH and providing the same service at its satellite clinics.

As it was difficult to collect estates data at the granular level of outpatient eye motility services, the proportion of consultant-led clinics versus orthoptist-led clinics at MEH and satellite sites was considered as a proxy for the cost of the service. According to the BMA, consultants, depending on their level of work experience, earn between £76k and £103k[13]. Whereas the salary range for an orthoptist is between £18k and £44k[14]. At the lowest end, a consultant ophthalmologist earns four times more than an orthoptist. Providing a higher proportion of consultant-led clinics, which is mandatory for adult and paediatric clinics with the exception of the well-defined Child Vision Clinic Protocol, is likely to lead to a higher cost of the service.

Cost to the patient

For most patients, specialist services are not local. It is likely that patients need to travel to their specialist appointment either by active, public transport or by car. The question of patients' travel costs was covered in the patient questionnaire.

Cost to the economy

The measurement of the cost to the economy was based on the time patients and accompanying guardians had to take off work for the appointment at the eye motility clinic.

The Confederation of Business Industries(CBI) has calculated that employees' absences cost the economy £975[15] per employee per year, with employees being absent on average 4.4 days[16]. This translates into a cost of £222 per day of absence.

Table 5 Financial variables and their sources

Variable	Data source
Number of consultant- and orthoptist-led clinics	Patient questionnaire
Travel costs	Patient questionnaire
Time taken off work for appointments	Patient questionnaire
Cost of a day off work to UK businesses	Confederation of Business Industries

Measuring the health impact

It was outside the scope of this study to follow-up patients after they completed the initial questionnaire. Consequently, there is limited data on the long-term health outcomes of the treatments the patients have undergone.

However, for paediatric eye motility patients who have amblyopia and came to the clinic for a post-treatment visit, whether the visual acuity had improved by at least 0.1 logMAR was recorded.

For paediatric patients with amblyopia who have been treated with atropine blurring it was also noted if their better eye had temporarily lost 0.1 logMAR or more in visual acuity due to the blur.

As a measure of the health outcomes of adult patients, the eye sight of adult patients, who have undergone surgery, was examined to see if it was orthotropic, within 10 prism diopters of aimed correction or over 10 prism diopters of aimed correction. Adult patients who have been treated with botulinum toxin instead of surgery were excluded from the results as treatment with botulinum toxin is not offered at all satellite sites.

To get an indication of the safety of treatment, the complaints and incidence rates in one month were recorded.

Table 6 Health outcome and safety variables and their sources

Variable	Data source
Improvement of visual acuity of amblyopia patients of at least 0.1 logMAR	Patient questionnaire, answered by health professional
Decrease of visual acuity of 0.1 logMAR or more in the good eye of amblyopia patients treated with atropine blurring	Patient questionnaire, answered by health professional
Improvement of adult patient eye sight after surgery	Patient questionnaire, answered by health professional
Rate of incidence in a given month	Estates questionnaire

Data collection and management

The data collection protocol was co-developed by Moorfields Eye Hospital and The Centre for Sustainable Healthcare. Estates and energy data was collected across sites. A questionnaire for staff and patients was developed to assess travel habits, distance travelled, patient satisfaction, staff satisfaction and patient outcomes. Patient questionnaires were completed with the help of the National Patient Toolkit during patient consultations across the course of six months and were collated and sent to the Centre for Sustainable Healthcare for analysis. At the satellite sites, we approached patients and families attending children's eye clinics and adult eye movement/neuro-ophthalmology clinics. At Moorfields at City Road, we approached patients/families in the children's eye clinics (three types: consultant-led clinics, orthoptist/optometrist child-vision-clinics and orthoptic-only clinics, but excluding subspecialty other children's clinics such as cornea/oculoplastics/glaucoma) and in the adult strabismus clinics (excluding botulinum toxin treatment and neuro-ophthalmology clinics). A total of 933 patients (713 children and 220 adults) and 116 staff were surveyed. Data was collated, cleaned and reorganized in Excel for analysis.

Results

933 patients and/ or their guardians completed the patient questionnaire for this study - 713 paediatric patients and 220 adult eye motility patients.

42% of participants at Moorfields and 43% at the satellites were guardians of paediatric patients under five years of age. The second biggest age group was the 6 to 12 year olds who made up 25% at Moorfields and 32% at the satellite clinics. Among the adults the 40 to 65 years old and 66 to 79 years old age groups were equally represented (12% at Moorfields and 6% at the satellite clinics each).

Table 7: Age distribution of patient participants

	Number of patients		Percentage of patients	
Age groups	Moorfields	Satellite	Moorfields %	Satellite %
0-5 years	67	326	42%	43%
6-12 years	39	245	25%	32%
13-15years	1	23	1%	3%
16-18 years	0	11	0%	1%
19-39 years	12	37	8%	5%
40-65 years	19	49	12%	6%
66-79 years	19	46	12%	6%
Over 80 years	2	29	1%	4%
Total	159	766	100%	100%

Health status and health impact

Paediatric patients

89% of the paediatric visits at Moorfields Eye Hospital and 68% of the visits at the satellite clinics were post-treatment visits[ii]. The majority of paediatric patients who had an appointment at either Moorfields Eye Hospital or its satellites were more than 6 months post treatment.

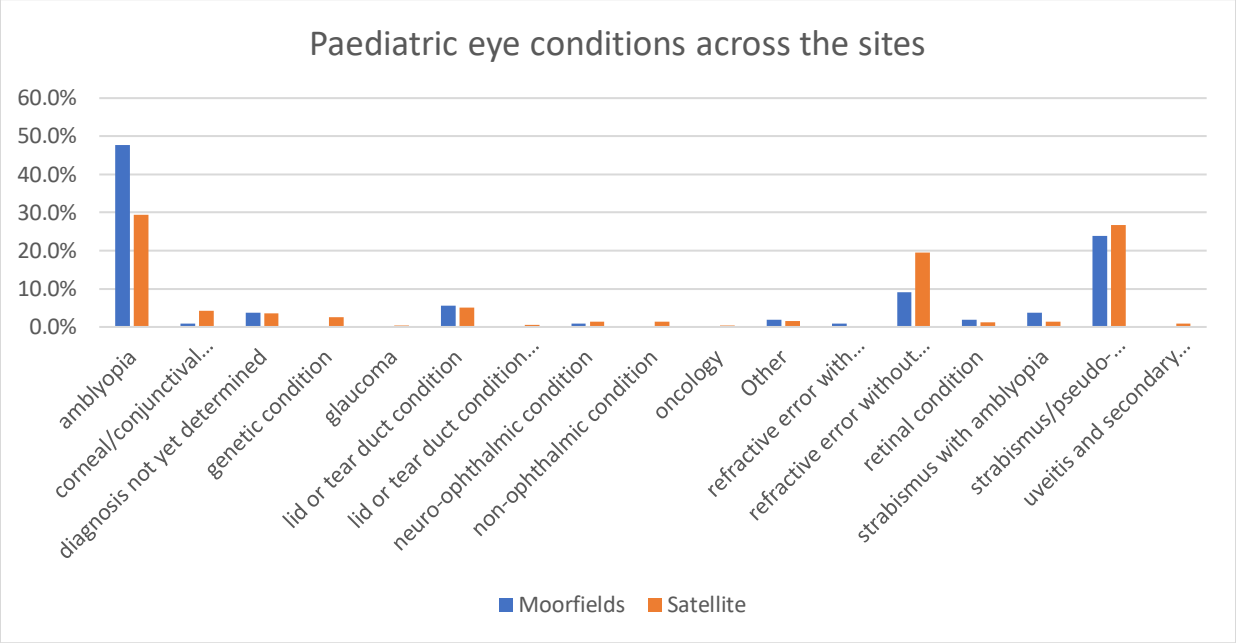
Table 8: Months post-treatment

Post-treatment	MEH	Satellites
2 months	19%	21%
4 months	15%	18%
6 months	4%	9%
Over 6 months	61%	52%

[ii] Post-treatment visits are follow-up visits. During these visits health outcomes are monitored to assess the treatment's progress.

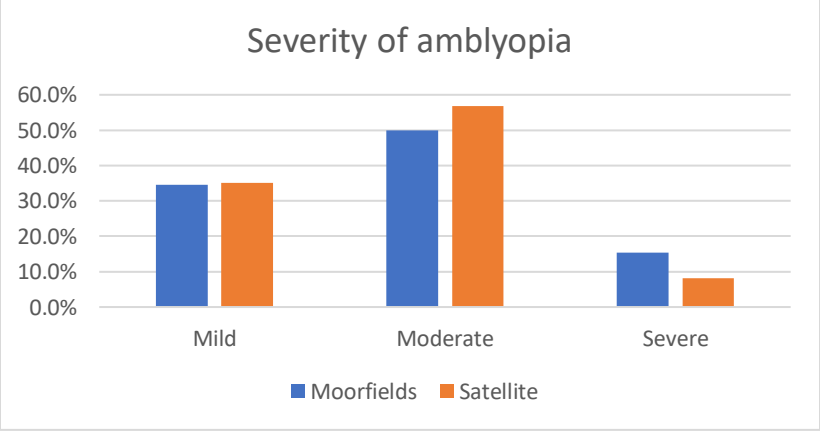
48% of paediatric patients who visited Moorfields hospital and 30% paediatric patients attending the satellites had the eye condition amblyopia. The other 51% and 70% respectively showed other children's eye conditions.

Graph 1: Comparison of paediatric eye conditions at MEH and its satellites



The Moorfields Eye Hospital was seeing a higher percentage of severe amblyopia cases (15%) – patients whose visual acuity is worse than 0.6 logMAR - than the satellites (8%). However, an equal percentage of mild cases – patients whose visual acuity is between 0 and 0.2 logMAR or equal 0.2 logMAR - attended Moorfields and its satellites and 50% of paediatric patients at Moorfields and 56% at the satellites had moderate amblyopia with a visual acuity between less than 0.2 and 0.6 logMAR.

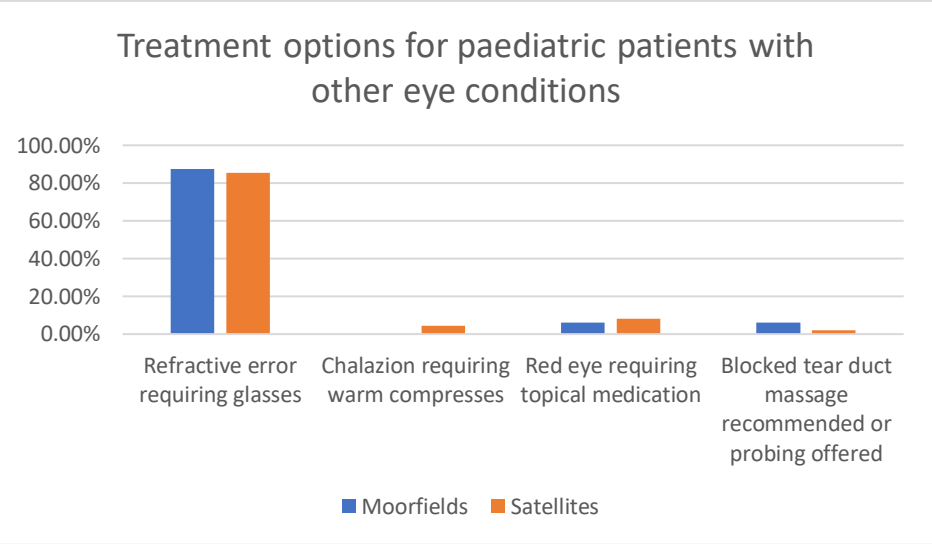
Graph 2: Severity of amblyopia of patients at MEH and its satellites



37% of paediatric patients with amblyopia who attended MEH for a diagnostic visit were treated with patching, 7% with atropine drops and 56% received none of the two. At the satellite clinics, 43% were treated with patching, 9% with atropine drops and 48% received none of the two.

Out of 487 paediatric patients who did not have the eye condition amblyopia, 265 received one or more of the following treatments – see graph 3.

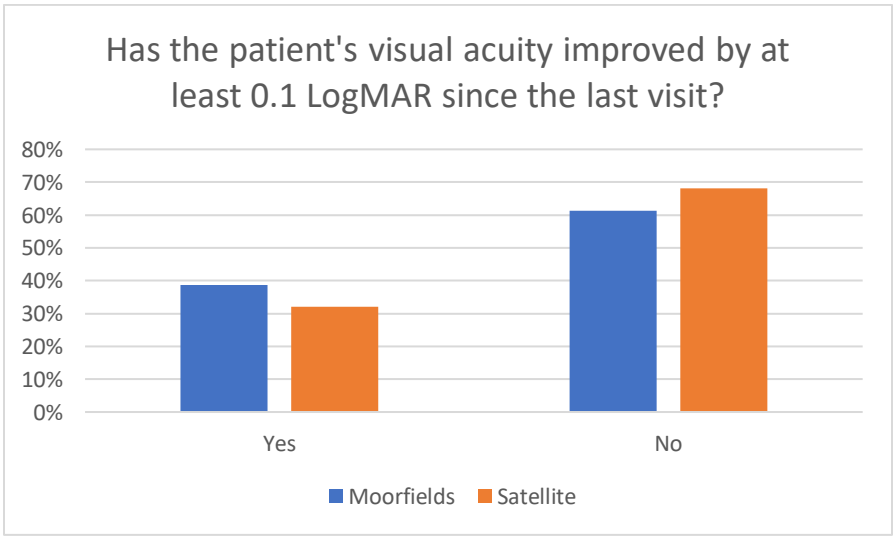
Graph 3: Treatment options for paediatric patients with other eye conditions



Health impact

To assess if the treatment for amblyopia is working the paediatric patients' visual acuity is monitored. For 39% paediatric patients attending MEH and 32% attending the satellite clinics, visual acuity improved by 0.1 logMAR since their last visit.

Graph 4: Improvement of visual acuity in patients with amblyopia



For 25% of Moorfields and 12% paediatric patients, who received atropine occlusion treatment, the better eye temporarily lost acuity of 0.1 logMAR or more, due to the blur. No patient lost vision permanently.

As it was outside the scope of the study to follow up patients after the end of their treatment no statement can be made about the health outcomes of paediatric patients with other eye conditions.

2% of paediatric patients attending Moorfields and only 0.2% attending satellite clinics reported side-effects.

Adult eye motility patient

In the adult group, 51% of the visits to Moorfields Eye Hospital and 58% to the satellites were post-treatment visits with the highest percentage of patients being over 6 months post-treatment.

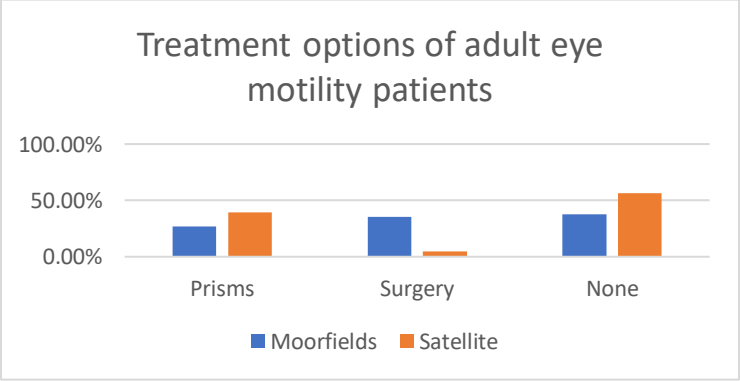
Table 9: Months post-treatment

Post-treatment	MEH	Satellites
2 months	32%	19%
4 months	11%	18%
6 months	7%	16%
Over 6 months	50%	47%

98% of the adults were suffering from eye motility problems (excluding neuro-ophthalmic problems). 57% adult patients at Moorfields and 53% patients at the satellites suffered from double vision. 34% at Moorfields and 21% at the satellites suffered from strabismus greater than 20 prism diopters or greater in primary position.

There are different treatment options for adult patients with eye motility conditions. 27% at Moorfields and 39% at the satellite clinics were treated with prisms and 35% at MEH received surgery. At the satellite clinics only 5% had surgery. Altogether more patients received treatment at Moorfields (63%) than at the satellite clinics (44%).

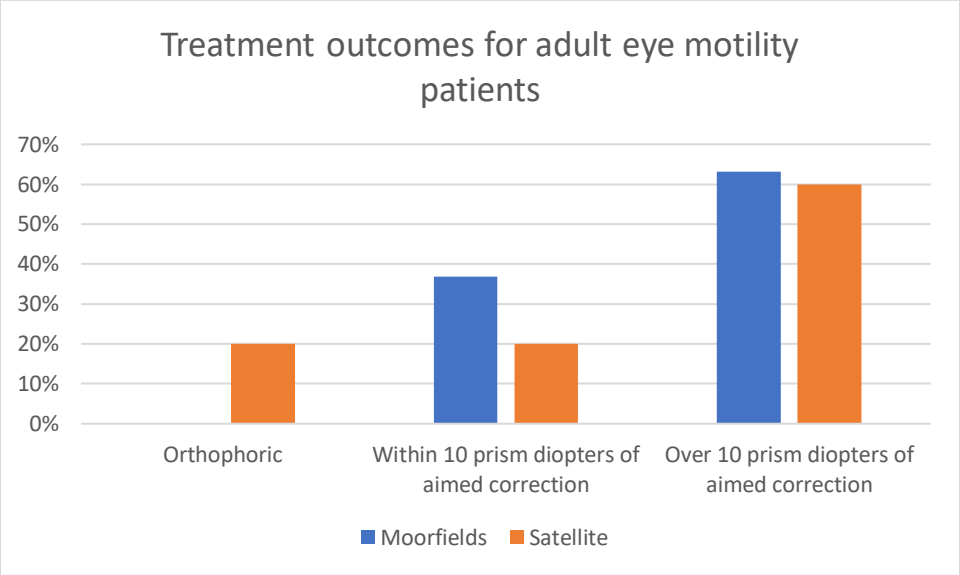
Graph 5: Treatment options for adult patients with eye motility conditions



Health impact

Of the patients who received treatment none at Moorfields and 20% at the satellite were orthotropic, 37% at Moorfields and 20% at the satellites were within 10 prism diopters of aimed correction and 63% at Moorfields and 60% at satellites were over 10 prism diopters of aimed correction.

Graph 6: Treatment outcomes for adult eye motility patients



Four adult eye motility patients at MEH suffered side effects, 12% of the group which completed the questionnaire. Only one patient, 1%, at the satellite clinics experienced side effects.

Quality and Safety

For the study, the complaints and incidents occurring in one month were collected. There were no complaints concerning the diagnostics and treatment of amblyopia patients, children with other eye conditions and adult eye motility patients.

The percentage of incidents reported concerning the diagnostics and treatment of children with other eye conditions was 0.99% at Moorfields Eye Hospital and 0.92% at the satellite clinics.

For adult eye motility patients, the reported incident rate was 2% at Moorfields Eye Hospital and 2.6% at the satellite clinics.

Environmental impact

Total carbon footprint per patient

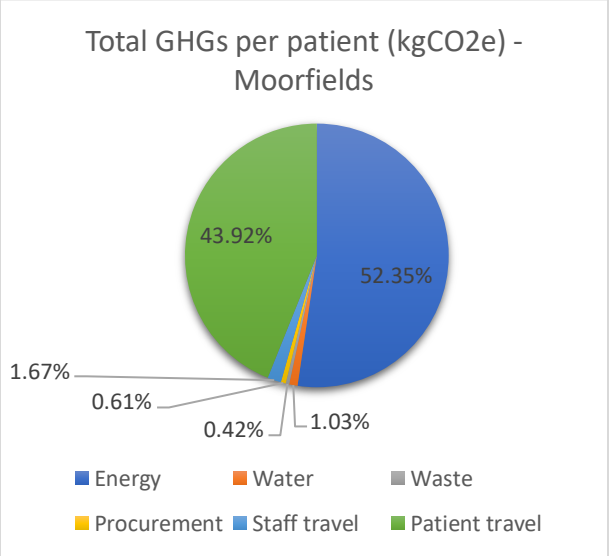
The total carbon footprint of eye motility outpatient services per patient visit is 5.26 kgCO2e for patients attending the satellite clinics and 15.43 kgCO2e for patients attending Moorfields Eye Hospital – see table 10. The carbon footprint per patient visit is around 3 times higher at Moorfields Eye Hospital than at its satellite clinics.

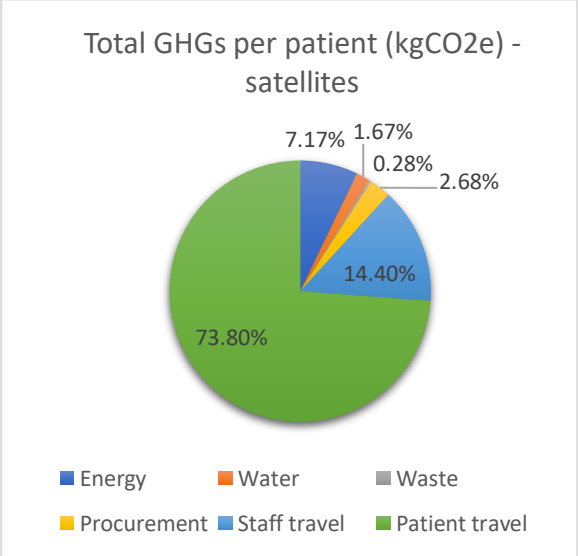
Table 10: Carbon footprint per eye motility outpatient visit at Moorfields Eye Hospital and its satellite clinics

Categories	GHGs (kgCO2e/patient) MEH	GHGs (kgCO2e/patient) satellites
Energy	8.08	0.38
Water	0.16	0.09
Waste	0.07	0.01
Procurement	0.09	0.14
Staff travel	0.26	0.76
Patient travel	6.78	3.88
Total	**15.43**	**5.26**

At Moorfields Eye Hospital energy use contributes the most to the carbon footprint per patient at 52%, followed by GHG emissions associated with patient travel (44%) and then staff travel (2%). At the satellites, GHG emissions associated with patient travel contribute 74%, followed by staff travel at 14% and energy use at 7%

Graph 7: Carbon footprint per patient visit (kgCO2e) at Moorfields and its satellites





Procurement

Procurement contributes only a very small amount to the average total carbon footprint per patient visit (0.14 kgCO2e for the satellite patient visit and 0.09 kgCO2e for the MEH patient visit) and the GHGs associated with procurement are very similar at the satellites and MEH.

Table 11: Comparison of carbon footprint of procurement per patient

	GHGs (kgCO2e/patient visit) MEH	GHGs (kgCO2e/patient visit) satellites
Medical equipment	0.0032	0.0067
Transport, freight and carriage	0.0008	0.0015
Other procurement: dressings/ patches/ wipes/ disposable items	0.0812	0.1250
Prisms and bangerter foils	0.0095	0.0077
Total	**0.0947**	**0.1410**

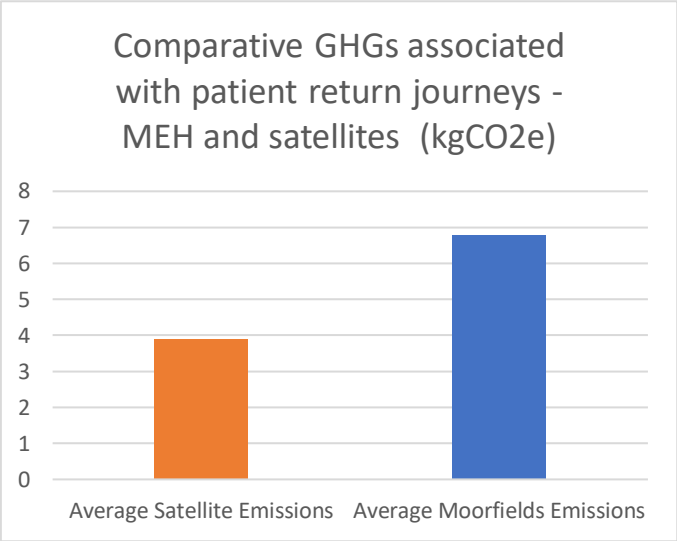
For MEH and for the satellite sites the highest contributor to the procurement GHGs is the 'other procurement' consisting of dressings, patches, wipes and disposable items (0.125 kgCO2e at the satellite sites and 0.081kgCO2e at MEH). Prisms and bangerter foil contribute 0.008 kgCO2e at the satellites and 0.01 Moorfields.

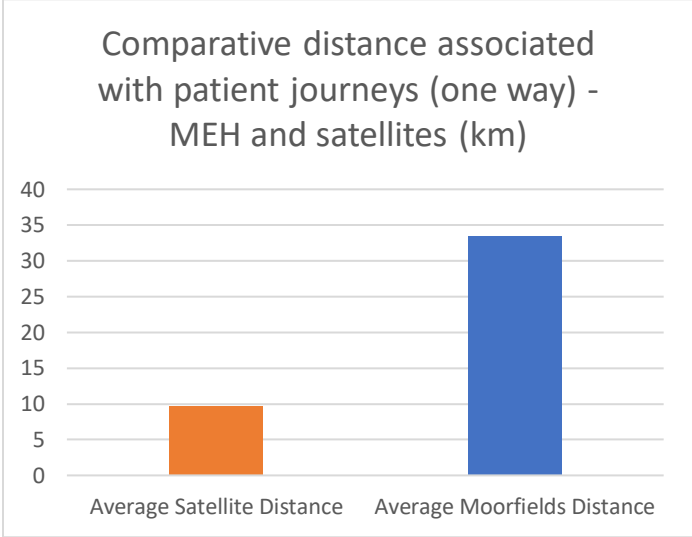
Patient Travel

GHG emissions caused by patient return journeys totaled an average of 3.88 kgCO2e/patient visit and 6.78 kgCO2e/patient visit for satellite clinics and Moorfields Eye Hospital respectively. Return journeys to paediatric appointments were more carbon intensive (4.27 kgCO2e for satellite clinics and 7.65 kgCO2e for MEH) than adult patients' return journeys (2.48 kgCO2e for satellite clinics and 4.93 kgCO2e for MEH). This is because children under the age of 16 were assumed to travel with an adult, which doubled the carbon footprint for public transport travellers.

The average travel distance for all patients was 9.73 km and 33.36 km (one way) for satellite clinics and MEH respectively. The child travel distances were 10.47 km for satellite clinics and 33.78 km for MEH while adult travel was on average shorter with 7.09 km for satellite clinics and 32.51 km for MEH – see graph 8.

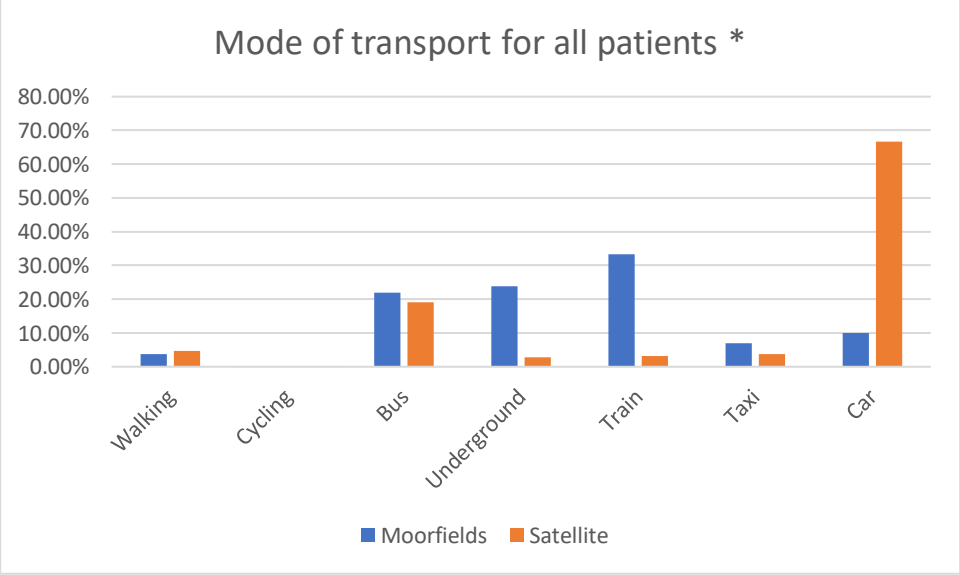
Graph 8: Carbon footprint associated with patient return journeys





Though travel emissions and distance of return journeys were highest for MEH patients, public transport usage was also highest amongst them. No patient cycled to their appointment and only 4% walked in both groups. 67% of satellite clinic patients took the car compared to 10% MEH patients. Levels of bus use were similar, with 19% of satellite clinic patients using the bus compared to 22% of Moorfields patients. The difference between transport method is greatest in terms of train and underground, with train usage for MEH patients at 33% and underground usage at 24% compared to 3% train usage and 3% underground usage for satellite clinics.

Graph 9: Mode of transport for all patients

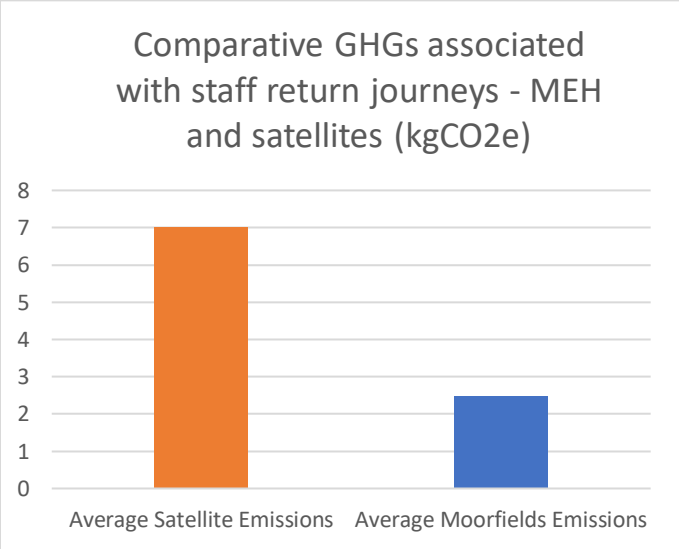


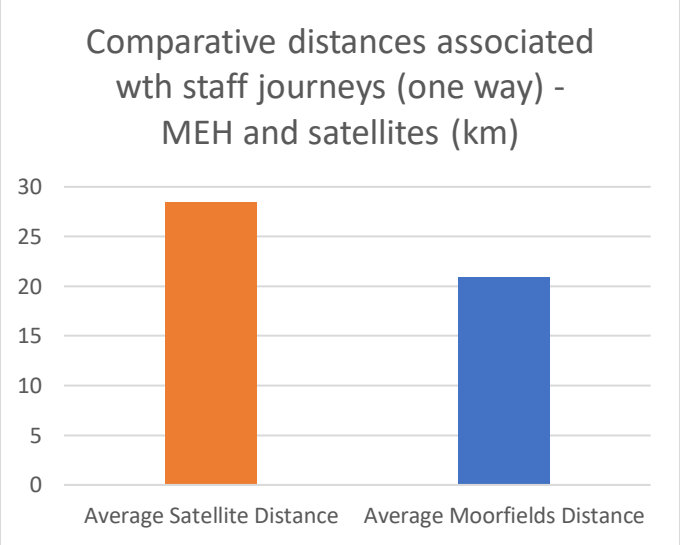
* All patients = paediatric and adult eye motility patients

Staff Travel

Staff travel showed a reverse trend compared to patient travel. Journeys to satellite clinics were on average 28.41 km long and the return journeys caused emissions of 7 kgCO2e per staff member. Staff travelled on average 20.88 km to MEH, which caused emissions of 2.48 kgCO2e per staff member for their return journey.

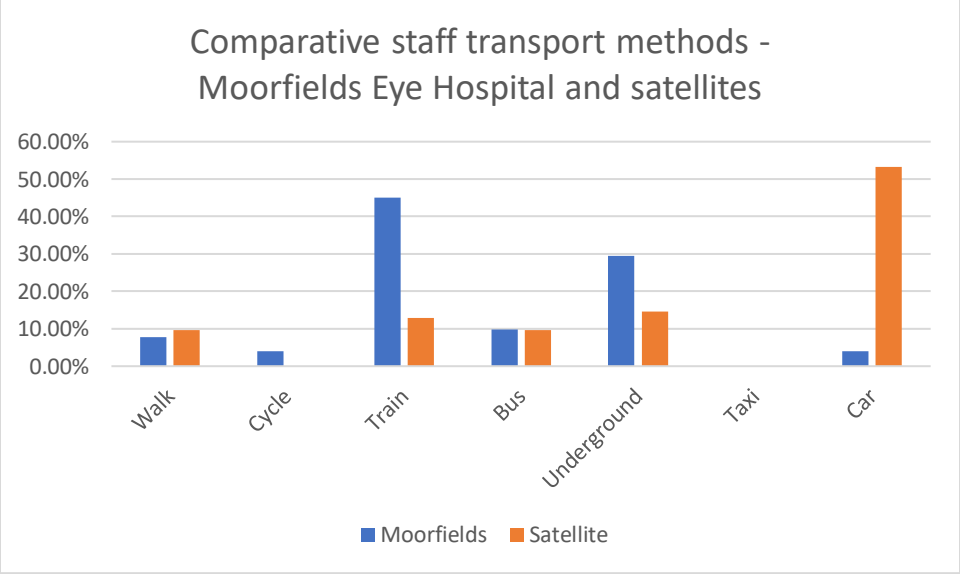
Graph 10: Comparison of GHG emissions and distances travelled





As with patient travel methods, the majority of staff travel by car (53.23%) to the satellite clinics whereas the majority of staff travel by public transport (45.10% by train and 29.41% by underground) to MEH. As with patient travel, levels of walking and cycling are low.

Graph 11: Comparison of staff modes of transport



Social Impact

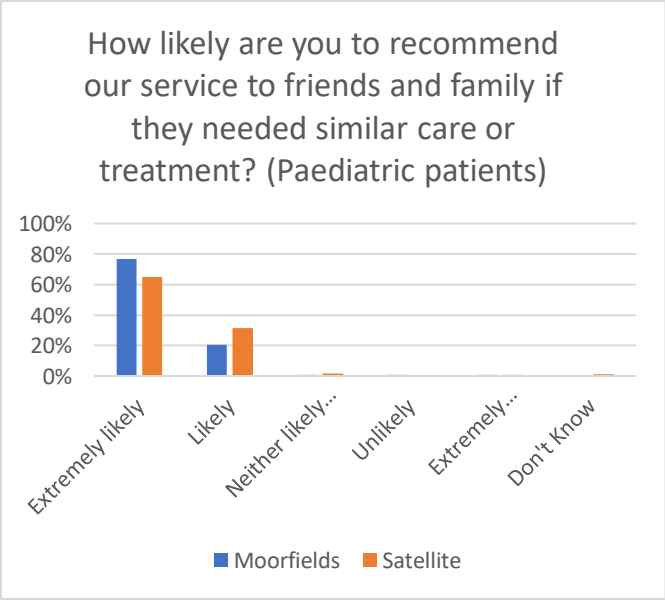
To measure the social impact of paediatric and adult eye motility services, four different metrics were taken into consideration: patient travel time, time taken out of work and school, patient and staff satisfaction.

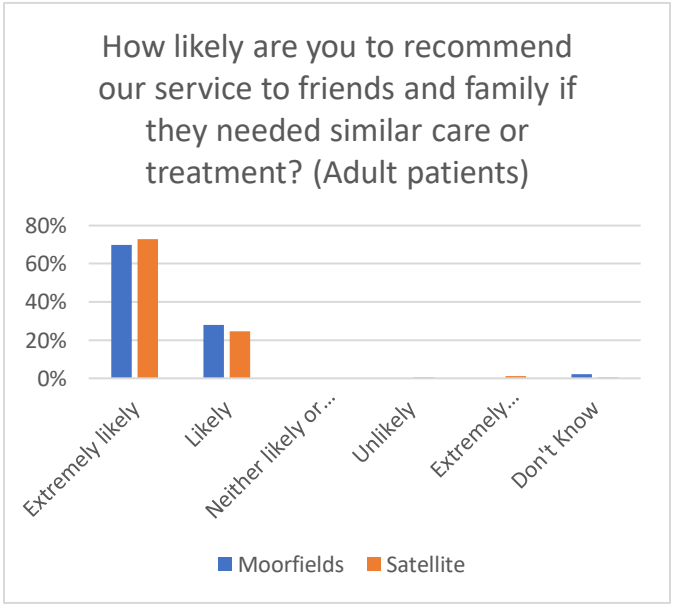
Patient and staff satisfaction

Satisfaction levels, measured by the likeliness of patients to recommend the service to friends and family, were highest for paediatric patients at Moorfields Eye Hospital compared to the satellite clinics. 77% paediatric patients/paediatric patient guardians at Moorfields Eye Hospital are 'extremely likely' to recommend the service to family and friends if they needed similar treatment compared to 65% at the satellite clinics. 21% of paediatric patients/paediatric patient guardians responded that they would be 'likely' to recommend the Moorfield service compared to 31% at satellite services. This means that overall 98% of paediatric patients at Moorfields had positive satisfaction levels compared to 96% at satellite clinics.

Satisfaction levels of adult eye motility patients were similar with 70% of adult patients 'extremely likely' to recommend Moorfields services compared to 73% 'extremely likely' to recommend satellite services. 28% of adult patients were 'likely' to recommend the MEH service compared to 25% at satellite services. Again, overall positive satisfaction was similar to paediatric patients with 98% positive satisfaction for both MEH and satellite clinics.

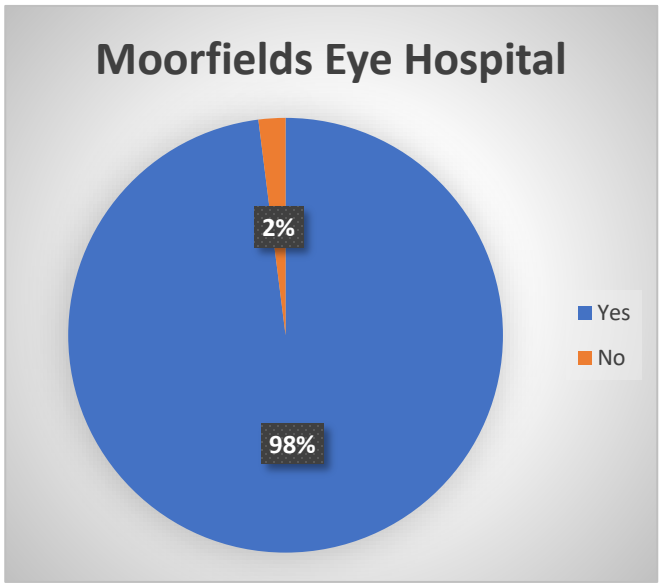
Graph 12: Comparison of patient satisfaction

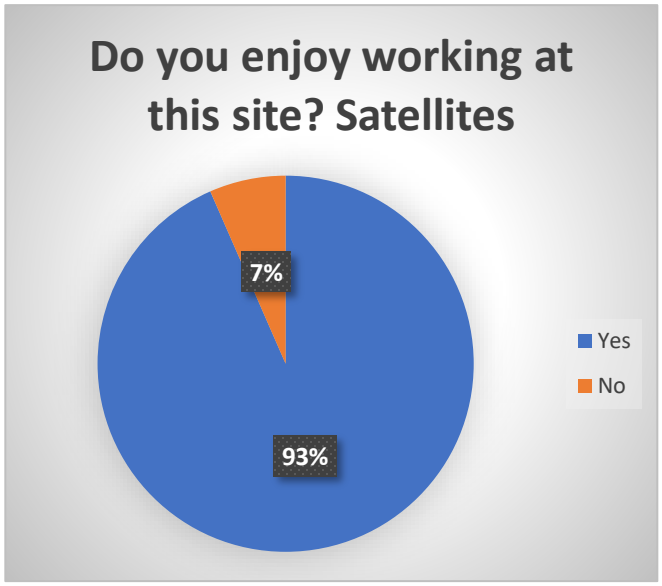




Staff satisfaction showed a similar trend to patients' satisfaction. 98% of staff reported they enjoyed working at MEH compared to 93% of staff enjoyed working at the satellite clinics.

Graph 13: Comparison of staff satisfaction

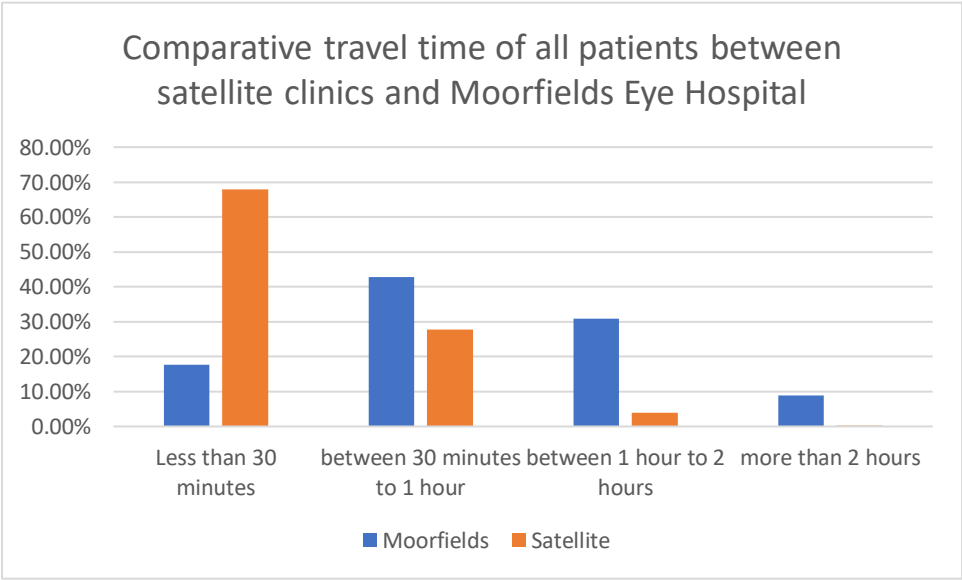




Patient and Staff Travel Time

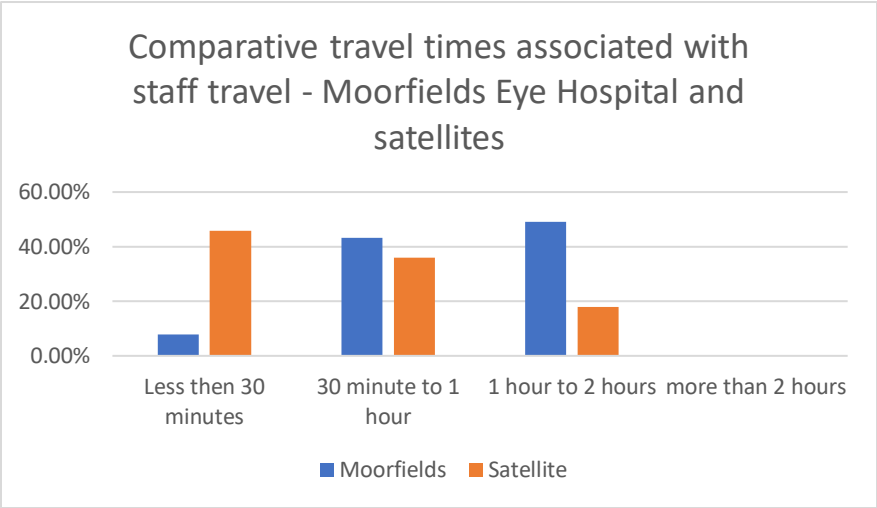
Travel time for MEH patients tended to be longer, with over 80% of patients taking more than 30 minutes to get to their appointments, over 39% taking more than 1 hour and 8% taking more than 2 hours. Meanwhile, 68% of satellite clinic patients took less than 30 minutes, 28% took between 30 minutes and 1 hour and only 4% took over 1 hour.

Graph 14: Comparison of patient's travel time



Travel times for staff at Moorfields are inversely proportional to the travel times for staff at the satellites with the majority of staff taking less than an hour to travel to work at satellite sites (82%) compared to 49% of staff taking over one hour to travel to work at MEH. Despite staff travelling greater distances to satellite sites, staff take less time to get to work.

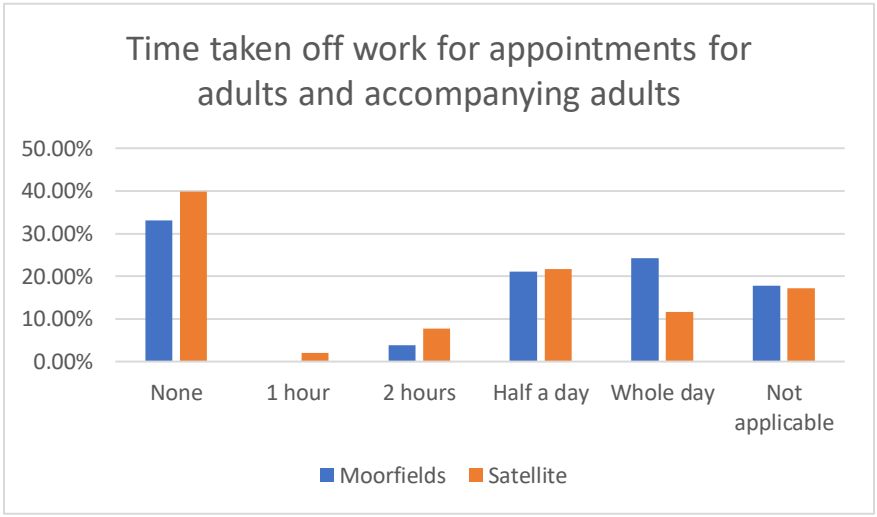
Graph 15: Comparison of staff travel time



Time taken out of work and school

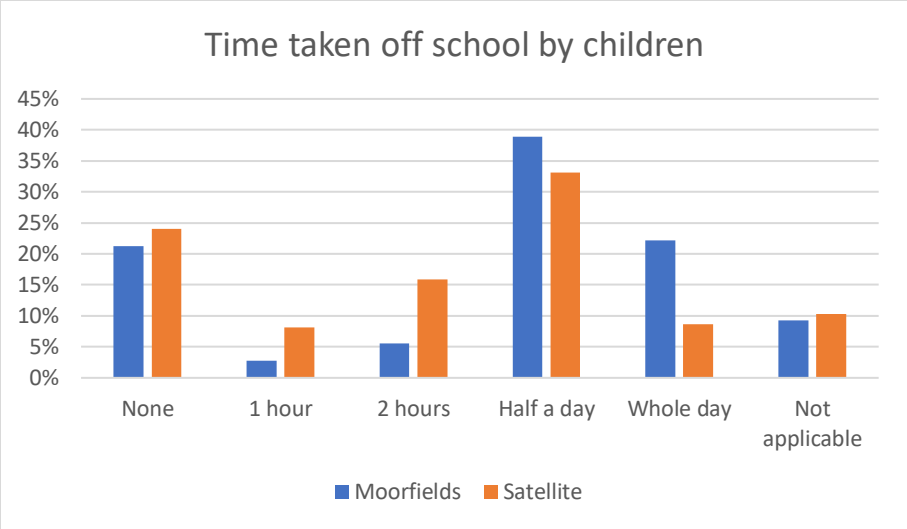
The greatest difference in time taken out of work and school occurred in the percentage of adults and accompanying adults who required taking a whole day off work with 24% of Moorfields adults compared to 12% of satellite clinic adults missing a day of work to attend an appointment or accompany a child for their appointment.

Graph 16: Comparison of time taken off work



There is more disparity between MEH and satellite clinics for school day disruptions in child patients. Over 65% of children in both groups are having to take at least one hour off school. However, the proportion of MEH children taking time off school was greater with 39% taking half a day and 22% taking a whole day compared to 33% and 9% for satellite clinics respectively. This means that 61% of MEH children took at least half a day off school compared to 42% of satellite clinic paediatric patients.

Graph 17: Comparison of time taken off school by children

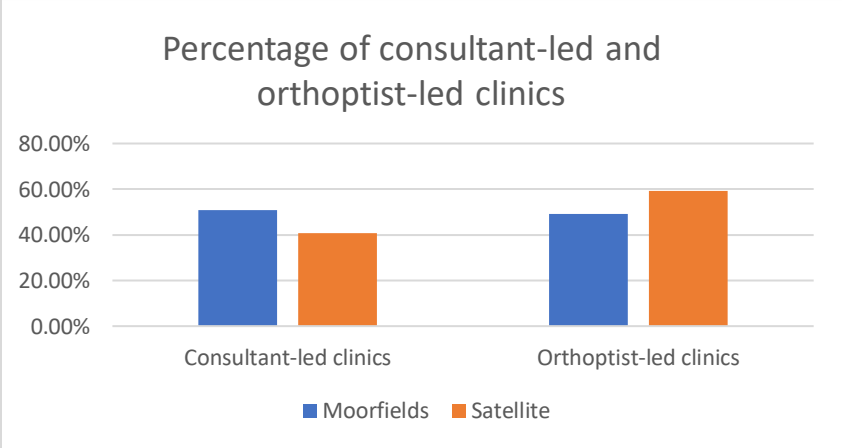


Financial Impact

Cost of services

If we base the cost of an eye motility outpatient appointment solely on the percentage of consultant-led versus orthoptist-led clinics, the hospital appointments at Moorfields Eye Hospital would be costlier, as their clinics are more likely to be consultant-led. 51% of MEH's paediatric and adult eye motility appointments were consultant-led whereas 49% were orthoptist-led. At the satellite clinics 41% were consultant-led and 59% were orthoptist-led.

Graph 18: Comparison of percentage of consultant-led and orthoptist-led clinics



Looking at appointments for paediatric and adult eye motility services separately, it becomes clear that a higher percentage of adult eye motility clinics were consultant-led (83% at Moorfields Eye Hospital and 72% at satellite clinics) compared to the paediatric ones (36% at Moorfields Eye Hospital and 32% at the satellite clinics).

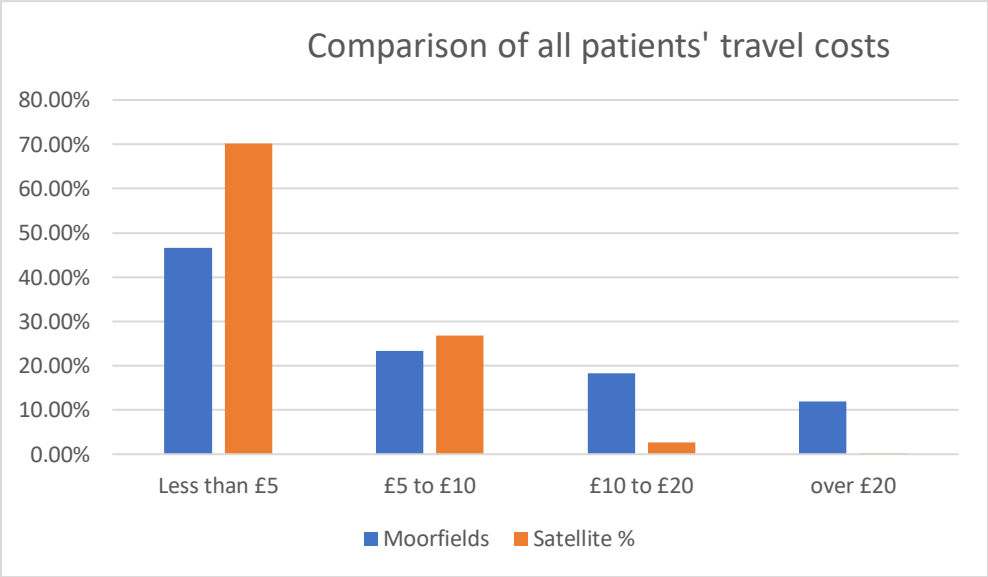
Table 12: Percentage of consultant-led and orthoptist-led clinics

	Adults		Children	
	MEH	Satellite	MEH	Satellite
Consultant-led clinics	83%	72%	36%	32%
Orthoptist-led clinics	17%	28%	64%	68%

Cost to patients

Overall, the cost of travel for patients was cheaper for satellite clinic patients with only 3% of patients spending more than £10 compared to 30% of MEH patients. 70% of patients attending satellite clinics spent less than £5 whereas 47% of Moorfields patients spent less than £5. When attending their appointments at a satellite clinic, 27% of patients paid between £5 and £10. 23% of the Moorfields patients spent £5 to £10.

Graph 19: Comparison of travel costs



Cost to the economy

The total cost to the economy of work missed for clinic appointments by adults and accompanying adult participants was £54,142 for all participant visits at both sites. With 157 study participants, MEH's total cost to the economy was £12,431 and with 760 participants, the satellite clinics' total cost was £41,711.

Although the difference of missed work days appears relatively similar between Moorfields and its satellites (refer back to time taken out of work in section on social impact), the difference in full work days missed creates a significant difference in the average cost to the economy of a patient visit. This means the cost to the economy of the average patient visit to Moorfields is £79. The average patient visit to satellite clinics costs the economy £54.

Table 12: Comparison of cost of a patient visit to economy

Cost of time	No. adults Moorfield	No. adults Satellite	Cost - Moorfields	Cost - Satellite
No time missed/not applicable	80	433	£0	£0
£29.54 (1 hour missed)	0	15	£0.00	£443.18
£59.09 (2 hours missed)	6	59	£354.54	£3,486.35
£110.80 (half day missed)	33	165	£3,656.24	£18,281.18
£221.59 (full day missed)	38	88	£8,420.42	£19,499.92
Total per site	**157**	**760**	**£12,431.20**	**£41,710.62**
Average cost of 1 visit	-	-	**£79.18**	**£53.88**
Total for both sites		**917**		**£54,141.82**

Discussion

Triple bottom line overview

Overall, the triple bottom line analysis shows that satellite clinics have a lower environmental impact, are less costly and their health and social impact is similar. While there are some areas where satellite clinics have a larger environmental impact, such as higher emissions for staff travel, these emissions are less significant in total as there are fewer staff commuting than number of patients attending clinics. Rates of patient and staff satisfaction are slightly lower at satellite clinics. However, travel time, cost to the patient and time taken of work is lower for patient visits at satellites which might compensate for the slightly lower patient satisfaction. Overall, in the case of eye motility services, expanding services to satellite clinics closer to patients' homes is a sustainable way to increase capacity and lower the environmental and financial impact without jeopardizing health outcomes and increasing the social burden on the patient.

Environmental Impact

According to the results, GHG emissions associated with the average patient visit are lower for satellite clinics than Moorfields Eye Hospital.

The carbon footprint analysis needs to be treated with caution. To calculate the carbon footprint, the GHGs associated with patient and staff travel, hospital energy and water use, hospital waste disposal and procurement were calculated. Whereas the travel data was collected directly via questionnaires, the estates data was based on routinely collected hospital data.

Currently, hospitals have not got the tools to collect data according to separate service lines. The two satellite clinics, which provided data for energy, water use and waste disposal, tried to allocate the hospital level data on resource use to eye motility services. The apportioning of hospital level data to the service might have introduced some bias, resulting in the carbon footprint being around a third of MEH's carbon footprint and less than a fourth of the GHG emissions estimated for an acute outpatient appointment by the Sustainable Development Unit (SDU) (23kgCO2e)[17].

For Moorfields Eye Hospital, the data on energy, water and waste was provided for the whole hospital, covering not only outpatients, but also inpatients. Collecting data for the whole hospital has the advantage that overheads like offices, storage, pharmacy etc. are accounted for. However, inpatients tend to have a much higher resource use than outpatients. As we were not able to separate the GHGs associated with energy, waste and water between inpatients and outpatients, the average carbon footprint per outpatient visit is almost certainly inflated. Nevertheless, as in the case of the satellites, the carbon footprint per patient visit for MEH is also lower than the GHG estimation for acute outpatient appointments provided by the SDU. This might be due to the fact, that in this study only procurement data directly relating to eye motility services were included. Moreover, staff travel was solely based on staff involved in the provision of eye motility services. The staff travel of, for example, admin staff is not included.

The results have shown that the distance travelled and the travel emissions per patient are lower for patients travelling to satellite sites than to an appointment at MEH. However, the rate of car use in

satellite patients was far greater than that of Moorfields patients. The disparity in travel methods between clinics is likely due to the central London location of Moorfields Eye Hospital making public transport travel more practical than car travel as well as the longer distances travelled by Moorfields patients, necessitating train travel.

In the case of staff travel, emissions were greater for staff commuting to satellite sites than Moorfields Eye Hospital. This is due to their longer commuting distances and their higher rate of car use.

Within the satellite patient group, taking into consideration their physical ability, there are opportunities to switch to sustainable travel alternatives as the proportion of journeys that are short and could therefore be swapped from car travel to walking is higher than among the Moorfields patients. 17% patients who attended one of the satellite clinics by car travelled equal or less than 2.5km (30 minutes walking distance for healthy individuals). Conversely, there are no Moorfields patients that use the car for journeys equal to or less than 2.5km.

Social impact

Patient satisfaction was overall very high across the satellites and Moorfield Eye Hospital. The sum of positive satisfaction levels was equal on both sites for adult patients (98%) and only 2% lower in satellite clinics (96% vs 98%) for paediatric patients. It is important to note that patient satisfaction could be influenced by the perceived importance and higher standards of the Moorfield Eye Hospital over its satellite clinics. This might explain the difference in the paediatric group.

Staff satisfaction was lower in satellite clinics by 5% (93% vs 98%). This could be explained by two factors. Firstly, only five staff responded negatively to enjoying working at the location, one at Moorfields and four other staff spread across three satellite clinics. This means that the results show a greater difference because our comparison was between satellites as a group compared to the Moorfields Eye Hospital. Secondly, the staff question only allowed for a binary “yes” or “no” response rather than the five point Likert scale used for patients. This means we cannot deduce the extent of satisfaction or dissatisfaction accurately.

While levels of satisfaction were very similar across sites, travel to the satellites is faster, on the surface cheaper and requires less time off work and school for adults and paediatric patients. Similarly, staff took less time to commute to satellites largely due to the higher levels of car usage despite longer distances.

Financial impact

Due to data availability, the cost of the service was only based on staff costs. Therefore, the cost of eye motility services at Moorfields Eye Hospital can be assumed to be higher as the percentage of clinics which are consultant-led are also higher. This is predominately due to the adult eye motility services as a higher percentage of adult clinics are consultant-led than orthoptist-led (83% vs 36% at Moorfields and 72% vs 32%). However, to get a complete picture of a service’s cost, all cost items need to be taken into account.

The cost to the patient of attending an appointment at the satellite clinics was less than attending an appointment at Moorfields Eye Hospital. We found costs to be higher especially for children, due to the cost of accompanying adults. It can be assumed that Moorfields travel was costlier because of the higher rates of public transport use. However, public transport is not necessarily more expensive than car travel overall. Looking at the travel costs provided by participants who used the car, it can be concluded that fuel consumption, car maintenance and insurance was not considered as part of the travel costs.

Travel costs for staff have not been covered by the staff questionnaire. However, the questionnaire asked staff if there is anything that would improve their experience of working at the site. The issue of travel expenses has been raised both by public transport users and car users (parking charge).

Health Impact

When considering and improving the triple bottom line of a service the quality and safety of the service needs to be guaranteed above all.

This study was a snapshot in time. Patients or their guardians who completed the patient questionnaire were not followed up at a later stage. Consequently, the health impact of the service could only be evaluated based on patients who attended post-treatment visits.

Though the percentage of amblyopia patients at MEH whose visual acuity improved by at least 0.1 logMAR was slightly higher than for satellite clinics (36% vs 32%), there was also a higher percentage (25%) of paediatric patients at MEH who had temporarily lost visual acuity by 0.1 logMAR or more in their good eye during atropine blurring than at the satellite sites (12%) and MEH had a slightly higher percentage of patients who suffered side effects. This might be due to the fact, that Moorfields in general saw a higher percentage of paediatric patients whose amblyopia was severe.

For adult patients, the health outcome of patients who had undergone surgery was evaluated. A higher rate of patients attending the satellite clinics compared to patients visiting MEH were orthotropic (20% vs 0%), but a higher rate at MEH was within 10 prism diopters of aimed correction. However, at MEH the percentage of patients who received surgery was seven times higher than at the satellites. It can be assumed that the more complex eye motility conditions get referred to MEH and therefore the outcome is likely to be affected by the original condition.

There is hardly any difference in the incident rates between Moorfields Eye Hospital and the satellites and the rates itself are less than 1% which reflects a good safety record.

Conclusion and Recommendations

Overall, in the case of eye motility services, the study has shown, that expanding services to satellite clinics closer to patients' homes is a sustainable way to increase capacity and lower the environmental and financial impact without jeopardizing health outcomes and increasing the social burden on the patient. It is a model which has potential to be rolled out to other services to bring services closer to the community.

Environment

The carbon footprint per patient visit shows that at least in the case of Moorfields Eye Hospital energy is the highest contributor of GHG emissions. There are various sustainable energy solutions available the hospital might like to consider, e.g changing the lighting to LED lighting, combined heat and power boilers, solar panels, better temperature controls.

Moorfields Eye Hospital is currently planning to build a 'new' Moorfields near St. Pancras. It is good practice to take energy efficiency measures into account while in the planning process as it will be easier to incorporate them right from the start.

Travel

The carbon footprint analysis of eye motility patients showed that, in the case of satellite clinics patient travel is the highest contributor and in case of MEH the second highest contributor to the GHG emissions. A large proportion of satellite patients use the car to attend their appointments and many of these journeys are short distances.

Recent public health campaigns, such as Active 10[18] and Walking for Health[19], have recommended walking as part of daily exercise. The NHS proposes that people should exercise moderately 5 times a week for 30 minutes[20]. Walking to and from hospital appointments could cover 2 of those walking sessions. Taking into consideration their physical abilities and the practicalities of attending appointments with children, patients and families could be encouraged to walk or cycle to their appointments for their health if possible, to save money and to reduce the impact on the environment.

Recently, the Clean Air Day campaign[21] has drawn attention to the impact of people's travel on air pollution and the SDU is encouraging Healthcare Trusts to estimate and reduce the impact of their organization's transport and travel on pollution and health with their Health Outcomes Travel Tool[22].

The highest rates of driving were found among staff commuting to satellite clinics. Staff could be encouraged to use more active transport like walking and cycling, public transport or consider car sharing. It might be useful to carry out a staff travel survey and some in-depth staff focus group discussions to better understand travel habits and how they could be changed. Some preliminary qualitative staff feedback suggested that they would welcome support with travel expenses. Financial incentives for using public transport may be a worthwhile consideration.

Perceptions

Perceptions of service quality and work environment are difficult to manage. As it is possible that patients and staff may perceive satellite clinics as less important and therefore of lower quality, managing perceptions of staff and patients could help increase patient and staff satisfaction. Making sure that patients understand that procedures and services are the same across locations and that decision-making processes are explained clearly to patients could increase patient satisfaction.

As well as better communication between staff and patients, open communication between managers and clinicians could increase staff satisfaction. Communication issues were raised in the qualitative feedback from staff.

A small number of in depth interviews and focus groups with staff and patients could reveal useful information about satisfaction and perceptions of service quality. This process could also be used to facilitate communication between management and clinical staff.

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