

Article

A Pilot Study into the Use of Qualitative Methods to Improve the Awareness of Barriers to Sustainable Medical Waste Segregation within the United Kingdom's National Health Service

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Abstract: Within the United Kingdom, most medical waste is incorrectly classified as hazardous and disposed of via incineration or alternative treatment. Currently, no research has been conducted on why such a large quantity of medical waste is erroneously segregated. This pilot study explores the barriers to correct segregation with the aim to decrease the volume of incinerated waste by investigating why medical waste is wrongly identified as hazardous. No previous data are available to compare results, and so this study demonstrates the significance of using qualitative methods (questionnaires and focus groups) to bring awareness to issues faced within medical facilities when segregating waste. The low availability of different bins as well as lack of space and the healthcare workers' busy schedules were identified as main reasons for poor segregation. Bins were sparsely placed, and staff lacked time to find the appropriate one leading to incorrect segregation of non-hazardous waste. Lack of information around whether a material was recyclable or not led to less recycled waste. When ways to engage with this issue were discussed, most medical staff favoured quick forms of information provision, such as posters, whereas a participant proclaimed longer hands-on style sessions as more effective. The findings of this study provide evidence that governmental strategies focused on sustainable medical waste management should direct their attention to the placement and availability of bins, whilst including 'on-the-ground' personnel in their decision making. This pilot study showed the value in using qualitative methods when current data are lacking and can be repeated by other healthcare facilities to collectively grow a greater awareness of the sustainability issues faced by the UK healthcare waste management system.

Keywords: sustainable healthcare; waste management; incinerated waste; medical waste; focus group



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1. Introduction

It has been shown that around 85% of waste generated in hospitals globally is non-hazardous and does not need to be incinerated [1]. Studies across Europe show that over 70% of the contaminated waste stream contains waste which was uncontaminated prior to being discarded [2–5]. The issue lies where non-hazardous waste is incorrectly placed in waste streams designed for hazardous waste [6], resulting in it being incinerated or disposed via alternative treatment as dictated, in this case, by United Kingdom (UK) regulatory guidelines [7]. Over half of the non-hazardous medical waste being incinerated globally is made of recyclable materials such as paper and plastic [5].

Currently it is unknown why medical waste is incorrectly segregated across the UK because no studies have been conducted. The NHS has shown that the treatment of hazardous waste causes significant environmental and economic impact and is growing

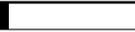
at a rate of 3% per year [8]. The UK's NHS contributes around 4% of the country's total carbon dioxide emissions with the government setting the target of the NHS being net zero by 2040 [8]. The sustainable management of clinical waste has been deemed "vital" in the recent NHS 'Clinical waste strategy 2023' for the continual operation of healthcare facilities, and yet, there has been no identification on what is causing incorrect segregation, and no data to validate studies [8]. Current approaches within the NHS focus on reducing device procurement and hiring more waste managers but fail to address why waste is being incorrectly segregated when disposed [8].

Outside of the UK, previous studies have used qualitative methods to explore healthcare workers' views on sustainability and key issues regarding sustainable waste management. Refs. [9,10] used questionnaires and focus groups to interview nurses and found that they are aware of the need for sustainability and want to contribute but face many challenges. A key problem was the lack of clear instructions, training, and feedback [11,12] with 86% of nurses within one study expressing the need for refresher training [9]. Other studies also used questionnaires and focus groups to test the knowledge of healthcare workers and found them to have poor understanding around the correct disposal of waste [13,14]. Less is understood about the most effective way to provide and help nurses retain this knowledge.

When waste segregation interventions and educational trainings were introduced on the correct placing of non-hazardous waste within European and American hospitals, the volume of the hazardous waste stream reduced from half [15,16] up to three quarters [17–19] found correct identification of infected devices to be the greatest obstacle to establishing recycling within hospitals [19]. It was found that easy access to the correct waste stream bin required was crucial for effective waste segregation [20,21]. A study from six operating suites in Australia discovered that 60% of the general waste was actually recyclable [22]. Less than 10% of the waste generated by the UK National Health Service (NHS) is currently recycled and the main barriers to recycling include a lack of staff training on what is recyclable, logistical accessibility to recycling bins, and clear guidelines to identify when waste is infectious [3].

Within the UK, once medical waste is placed into a specific-coloured bag, it will be closed using security seals or ties and never reopened [7]. It is, therefore, key that waste is segregated to the appropriate container before it is sealed [23]. As seen in Table 1, yellow and orange-coloured bins are used for hazardous waste; yellow for infectious and contaminated, orange for just infectious. Infectious waste is defined as waste that can transmit infection whereas contaminated waste is waste containing a pharmaceutically active agent [24]. The yellow waste stream must be disposed of via incineration which is the most environmentally impactful and most expensive end-of-life method [25,26]. The orange waste stream may also be incinerated but could instead be rendered safe by alternative treatment (i.e., heated to disinfect the waste) as a less environmentally impactful alternative to incineration [24].

Table 1. Colour codes for waste segregation within the United Kingdom's National Health Service retrieved from the UK Health Technical Memorandum 07-01 [24].

Colour of Waste Stream					
	Yellow	Orange	Tiger-Striped	Black	Clear
Description	Contaminated and infectious waste	Infectious waste	Offensive and hygiene waste	Domestic	Recycling
Disposal method	Incinerated	Alternative treatment or incinerated	Landfill	Landfill	Recycled

Black and yellow (tiger)-striped bins are for non-hazardous and non-infectious waste. Black bins for domestic, and clear bins for recycling. The tiger-striped, domestic, and recycling waste streams contain waste that cannot cause harm or infection and, therefore, can be landfilled or recycled (see descriptions in Table 1). These are environmentally

favourable options to the hazardous (yellow and orange) waste streams [25]. Table 1 demonstrates the different coloured bins currently available within UK NHS hospitals, as well as their description and end-of-life treatment as defined by the regulatory Health Technical Memorandum 07-01 [24].

Understanding the reasons behind poor segregation is crucial in order to identify steps to address it. This study aims to provide evidence to support the NHS' efforts to improve the clinical waste strategy by providing qualitative results of the reasons for inaccurate medical waste segregation by staff, as well as to identify the best way to communicate knowledge and guidelines on the matter. Finally, this pilot study will also provide recommendations for the NHS's intended course of action and suggestions for future research.

2. Methodology

For this study, a focus group and semi-structured interviews were conducted with healthcare workers within the United Kingdom during June and July 2023. These qualitative approaches were chosen as they have been found effective in determining attitudes and experiences within medical and social settings within previous studies [9–12]. The goal of the study was 'to explore barriers to correct medical waste segregation within the UK National Health Services (NHS) and investigate why medical waste is incorrectly identified as 'hazardous''.

The criteria for participation selection were that the participants currently worked within a United Kingdom-based NHS medical facility and that they handled and segregated hazardous and non-hazardous waste as part of their daily job duties. All participants were over the age of 18. Two participants were between the ages of 18 and 40 and four were between the ages of 40 and 60.

Participants were identified as potential candidates to partake in the study as well as initially contacted through communication leads within various NHS trusts across England. A total of six healthcare workers participated in the study: three as individual interviews and three within the focus group. Participants of varying job responsibilities were encouraged to contribute in order to provide a wide breadth of ideas and perspectives to the questions asked. Of the healthcare workers who contributed, one was a medical doctor, three were nurses, and two were previously nurses who then switched their primary job responsibilities to become head providers of nurse training. Four of the participants were female and two were male. Four of the participants had medical careers which exceeded 10 years, whereas the remaining two had been employed for between 5 and 10 years.

It was decided to conduct interviews and a focus group to allow a mixture of in-depth responses from participants as well as facilitate discussions, which could be checked for validity by a variety of sources [27]. This mixed approach then provided not only a variety of responses but also allowed elaboration on specific aspects if required whilst staying within a reasonable timeframe [28]. The focus group and interviews took place virtually via Microsoft Teams.

2.1. Focus Group

The focus group took place for over 90 min in July 2023. The focus groups began with an introductory warm-up exercise, to be followed by four questions. Each question was allocated roughly 15 min to allow for discussion. At the end, 15 min were allocated for closing statements. A brief PowerPoint was used during the focus group for visual aid. The PowerPoint used allowed for each question to be visually displayed in writing on screen to provide reminders and convenience for the participants. Some images were also shown where appropriate (the PowerPoint slides used for each question are provided in Figure S1 within the Supplementary Materials (SM)). The warm-up exercise consisted of a description of what each coloured waste stream is used for followed by three images of a blue face mask, plastic packaging, and a used bandage. The participants were then asked which coloured waste stream they would place these items into followed by a reveal of

the correct response. This allowed for an ice-breaker style introduction to the topic as well as engagement from the participants prior to questioning. The images used during the icebreaker are provided in Figure S2 of the Supplementary Materials.

2.2. Semi-Structured Interviews

The interviews were conducted individually with three of the participants. The same questions asked during the focus group were also asked during the interviews, but no time limits were placed. Each interview did not last longer than one hour by request of the participants and were conducted over Microsoft Teams. No visual aid such as PowerPoint was used and, instead, were solely one-to-one conversations. A warm-up exercise was not conducted but the topic of discussion was briefly explained to the participants at the start of the interviews. The participants were also given time at the end of the interview to expand on any previous points discussed or to provide their own insight into the topic of sustainable healthcare.

2.3. Questionnaire

Four open-ended questions were provided to each participant for the interviews and focus group. These specific questions were chosen because they address the key aspects of waste segregation whilst also being open-ended and allowing fruitful discussion. Question 1 (Q1) opens the conversation by identifying the initial thought process the healthcare workers have without prompting or encouraging any specific response. Q2 and Q3 then go on to further explore barriers to this segregation process, specifically focusing on the incorrect segregation of non-hazardous waste and recyclable waste which are key problems as shown within current the literature. Finally, Q4 directly addresses which method of communication is most preferred, giving the participants some examples as a guide. During the interviews/focus group, participants were permitted to branch into other related topics if they so desired. The questions provided to the participants are as follows:

- Q1 What questions do you consider when deciding whether a device is hazardous or not and, therefore, which coloured waste bin it will enter?
- Q2 Are there situations where you are unsure whether waste is hazardous or not and so erred on the side of caution and placed it in the hazardous waste stream?
- Q3 What barriers do you face when identifying if something is recyclable?
- Q4 What method is best to communicate information and training on correct waste segregation (e.g., types of plastics that are recyclable, situations which make a device hazardous, etc.), which requires minimal distraction to your primary job role?

2.4. Ethical Considerations

Written consent (via consent forms) was received from all participants prior to the commencement of the study. The participants were provided with written details about the nature of the study as well as any information about what the study would entail and how the results would be used. Participation was completely voluntary, and the participants were allowed to withdraw from the study at any point with no need for explanation. Participants provided informed consent for the publication of this paper. Ethical approval was received prior to any contact with the participants from the Brunel University London research ethics committee. The aim of the study, how it was to be conducted, prepared participant information sheets, and risk assessment of any potential issues regarding the questions to be asked and how they were to be asked were all submitted to the committee for thorough review. Changes required were made prior to any recruitment of participants and were ensured to be designed to minimise any potential harm or issues that could arise due to this study. The assigned ethical approval reference number as set by the committee is 41309 and the ethics approval was given June 2023.

Information about the participants such as their names, job description, and location of employment were collected but only made available to the principal researcher. After the analysis was conducted, all participant data were anonymised so that no identifiable

information was provided. Participants were labelled with general titles in order to aid the analysis within this paper without alluding to any specific descriptions of the participant. These titles are as follows: Doctor, Nurse 1, Nurse 2, Nurse 3, Head nurse, and Training lead. The appropriate title will be provided alongside any associated quotes provided within Section 3.

2.5. Analysis

To analyse the responses, the focus group and interviews were recorded and transcribed using Microsoft Teams, which were then manually checked by the primary researcher to ensure accuracy. These transcriptions were transferred to the qualitative analysis software NVivo 12 plus [29]. NVivo is a type of Computer-Assisted Qualitative Data Analysis Software (CAQDAS) which allows qualitative research to be coded and examined for occurring themes. The use of NVivo helps aid the systemic evaluation of qualitative research to provide additional structure and ensure scientific validity. The themes identified within the research are then ensured not to be arbitrarily decided by the researcher, but instead recognized as significant by the software due to the number of occurrences within the coded responses. The full steps of a thematic analysis performed using NVivo (as outlined within [30]) are as follows:

1. Familiarisation with the data (i.e., transcription, comprehension of the data, and general noting of initial identifiable themes).
2. Identify common themes whilst systematically reading through the data.
3. Collate all data associated with each theme and identify repetition.
4. Review themes.
5. Define the features of the themes and the research outcome they suggest.
6. Analyse the themes including the use of relevant quotes to produce meaningful findings.

From the data, eight themes were identified. Table 2 helps demonstrate how these themes have been generated using examples of quotes from the transcript.

Table 2. Themes identified within the transcripts generated from the interviews and the focus group.

Question	Sample Quote from Participant	Theme Identified
Q1—Identifying when something is hazardous	“In your mind, yeah, you know, but it’s not even a checklist. It’s automatic because you’ve done it so many times”	High competence with hazardous waste segregation
	“I normally go off, whether it’s had contact with, any bodily fluids or anything like that”	Contamination with bodily fluids
	“The tiger bags are the ones where I work that usually aren’t available”	Poor availability of bins
Q2—Incorrect segregation of waste	“I think being a busy clinician it is about what’s available to you”	Lack of time
	“Our clinics bases are usually not fit for purpose a lot of the time in terms of space”	Lack of space
Q3—Barriers to recycling waste	“I find plastic items the most difficult to decide on as some can be recycled and some can’t and it’s not always easy to work out”	Lack of information

Table 2. Cont.

Question	Sample Quote from Participant	Theme Identified
Q4—Preferred training and information provision	“A poster on the wall saying what things can go in, what bins and what can be recycled would be really, really helpful”	Bin labels and posters
	“Hands-on is real life and any training real life is better than just giving them something to read”	Longer training sessions

3. Results and Discussion

The results will be discussed following question order (Q1–4), identifying recurring themes within the answers provided by participants. Question 1 is discussed in Section 3.1, then question 2 in Section 3.2, and question 3 in Section 3.3, whilst question 4 is in Section 3.4. They are followed by suggestions for change in Section 3.5.

3.1. Question 1: Identifying When Something Is Hazardous

Two key themes were identified when the first question (Q1) was answered. The first theme was that the medical staff are confident in their ability to identify when waste is hazardous and have enough knowledge around each patient in order to make informed decisions. The second theme was that even though the healthcare workers knew how to determine when medical waste is hazardous, waste which came in contact with bodily fluids was automatically placed in one of the hazardous waste streams (yellow or orange) despite the fact that this is not necessary if the waste is not infectious or contaminated with pharmaceutically active agents [24]. These two themes are explored further in Sections 3.1.1 and 3.1.2.

3.1.1. Theme: High Competence with Hazardous Waste Segregation

The responses received from all of the participants indicated that ample training was provided on identifying when waste is hazardous and that healthcare workers are attentive when segregating hazardous from non-hazardous waste. Interestingly, this finding contradicts two previous studies [13,14] which identified a lack of knowledge when discerning what waste is infectious or not. It is important to note that these studies were not conducted within the UK and that their participants also expressed disinterest with the importance of waste segregation. Correct segregation of hazardous medical waste is highly regulated within the United Kingdom, which may explain why participants of this study stated that they receive extensive training and are confident identifying when waste is infectious.

When Q1 was asked (see Section 2.2), each participant provided a thorough breakdown of all the considerations they have when deciding if waste is hazardous. These considerations included the previous diagnosis of the patient, the contact the waste had had with the patient, the level of potential cross contamination with other surfaces and staff, and if it had come in contact with bodily fluids [24]. Multiple participants described their thought process as automatic. The head nurse mentioned the importance of experience when it comes to waste segregation.

“It’s not even a checklist, it’s automatic because you’ve done it so many times”, “Experience plays a huge part in what we do” —Head nurse

Even for situations where the healthcare worker was unsure deciphering between different types of non-hazardous waste, it was clearly stated that hazardous waste would never enter the non-hazardous waste stream. For situations where the worker was not certain, it would most likely end up in a hazardous waste bin (yellow or orange coloured). This was done to reduce the likelihood that hazardous waste would enter the non-hazardous waste stream due to the severity for harm to the general public.

“I do not think that there’s ever been a time where I thought that something might be infectious and put it in a black bin or I would definitely always go for orange or yellow if I was not sure.” —Training lead

This shows the significance of ensuring hazardous waste is correctly disposed of when considering the potential consequences improper segregation could have on the public’s health. Minimising any doubt when deciding which waste is hazardous would help alleviate uncertainty and direct some of that waste from the hazardous waste stream into offensive, general, or recycling bins (refer to Table 1 for descriptions). If all waste that is unknown to be hazardous is placed into hazardous waste bins, then reducing uncertainty would help divert some of that waste. One way to lessen doubt would be to provide workers with any extra information required to make an informed decision. The head nurse described the stages at which patient details would be provided to staff:

“We have two main handovers. Start of shift and finish of shift, but in between we have what we call a catch up. So when we are handed over, we do get given history and if someone has got something infectious, we will be told so. If it was something that we know is infectious then we definitely would be putting it in the in the coloured bag.” —Head nurse

As no change-over of patients would occur without a thorough debrief, this must then indicate that healthcare workers are informed when a patient is non-infectious as well as infectious. Waste produced by a non-infectious person has a much lower likelihood of needing to be placed in the yellow or orange waste streams. There must, therefore, be a disconnect between staff knowing a patient is non-infectious but still being unsure if the waste produced is hazardous. This may suggest that healthcare workers lack confidence in placing waste into non-hazardous waste streams even when they know a patient is non-infectious. Training could help emphasise that non-hazardous waste should be segregated correctly just as much as hazardous waste is. For example, a study found that within developed nations, education for healthcare workers is one of the key aspects required to ensure non-hazardous waste is not incorrectly identified as hazardous [26]. So far, importance has clearly been placed on ensuring hazardous waste is never incorrectly segregated; however, with the issue of sustainability becoming an increasingly greater global crisis, an equal amount of importance should also be placed on confidently identifying when waste is non-hazardous and segregating that correctly as well. Studies have shown that hospital facilities where staff received increased training on the correct disposal of waste have decreased the volume of waste entering the hazardous waste stream to be incinerated and increased the quantity of waste undergoing alternative treatment or being landfilled [15–18]. These routes are less environmentally impactful and cheaper than incineration and, therefore, would result in environmental and economic savings for the NHS [25,26].

3.1.2. Theme: Contaminated with Bodily Fluids

All participants mentioned that when medical waste had been contaminated with bodily fluids, it would be higher risk and placed in waste bins for hazardous waste (yellow or orange).

“I normally go off whether it has had contact with any bodily fluids or anything like that. They always go in the infectious bags.” —Nurse 2

“I ask myself could this be contaminated with blood or body fluid and is it offensive? If yes it goes in the orange clinical waste bin.” —Nurse 1

“Within my ward, there’s always going to be bodily fluids involved and with the bins available, I have no choice; they’ve always got to go in the orange.” —Nurse 3

This shows that it is common practice for medical waste contaminated with bodily fluids to be placed in the infectious waste streams. This raises the issue of why all medical waste contaminated with bodily fluids is placed in the infectious waste streams even if the patient themselves was not infectious. Current UK governmental guidelines [24]

specify that medical waste that is not infectious but could be deemed offensive (such as dressings contaminated with non-infectious fluids) should be placed in the tiger-striped bags. Only the yellow-coloured waste stream is required to be incinerated (orange can be incinerated but it is not always necessary; shown in Table 1). Therefore, directing waste from the yellow or orange bins into the tiger bins by correctly recognising when bodily fluids are non-infectious would reduce the volume of waste that is incinerated. If healthcare professionals are automatically placing medical waste contaminated with bodily fluids into the hazardous waste streams without first checking if the patient is infectious, then they are unnecessarily increasing the quantity of waste being incinerated.

This instinctual nature that healthcare workers appear to have when segregating waste contaminated with bodily fluids indicates that behavioural change may be necessary when dealing with non-infectious bodily fluids. A good example of the unnecessary incineration of non-infectious waste was provided by the head nurse. The head nurse described an issue they faced during training where the incontinence pads that they had used, that had not been in contact with any patients, were required to be placed in the infectious waste stream due to preconceptions from cleaning staff that any appearance of bodily fluids meant it had to be infectious.

“For our training for when we take blood, we use red dye. The red dye goes on the inco pad which is not infectious; it’s not even bodily fluids. I asked our waste management guy, what bag should we put this in, because we were putting it in an infectious waste. He said it shouldn’t go in infectious, it should go in your normal black bag. However, in the same meeting, there was a supervisor of our housekeepers that said, ‘if any of my housekeepers saw an inco pad with red on it in a non-bodily fluid or infectious bag waste, they will not take that bag’.” —Head nurse

This provides a clear opportunity for staff to be encouraged to consider whether the bodily fluid they are disposing of requires treatment as if it is infectious, and also identifies issues around communication between staff and the cleaning teams. A similar disconnect appears to also occur when disposing of PPE used by the healthcare worker versus PPE used on patients.

“Waste generated by others is more likely to go into orange for safety, waste generated by myself I will usually make an extra effort to get it into a tiger bin if I think it is safe to do so. PPE used on patients is more likely to go in orange.” —Doctor

“I would be more cautious with PPE etc. produced by others and would lean towards contamination, the orange bag.” —Nurse 1

If the patient is non-infectious, then the waste they generate is also non-infectious and can be placed in the tiger, domestic, or recycling bins. However, when there is a lack of certainty or confidence around determining what waste is generated by a non-infectious person, it will increase the quantity of waste which is needlessly incinerated. Perhaps training focused on identifying when waste is non-infectious would help foster a culture where waste contaminated with bodily waste is not primarily treated as infectious and grow confidence in staff when placing non-infectious waste in tiger bins.

3.2. Question 2: Incorrect Segregation of Waste

When answering Q2, three main obstacles were brought up: the poor availability of bins, the lack of time available to the healthcare workers, and the lack of space within the medical facilities. These themes are discussed further in Sections 3.2.1–3.2.3.

3.2.1. Theme: Poor Availability of Bins

The poor availability of bins within healthcare facilities was by far the most brought up issue by the participants. Previous studies also identified access to bins as crucial to correct waste segregation [20,21]. Each participant mentioned how most coloured bins were not present within their workspace with mainly only two bins (orange and black) available.

“I only have a choice of two bins. Orange for clinical waste and black for all other waste. A recycling bag has been placed in the kitchen, but only because an individual person instigated it; it is not the norm. What would be better is having the different coloured bins more available in each area.” —Nurse 1

“Most clinical waste bins are orange in most places so more often than not if I have any suspicion of it being infectious, it will go in orange, partly for convenience.” —Doctor

“The tiger bags are the ones where I work that usually are not available. We have recyclable, we have a black bin, and we have the orange bin.” —Nurse 3

“Things that have come into contact with specimens like samples and stuff, not all of that necessarily needs to go in orange bags. We don’t even have a black bin in the labs, so everything goes in the clinical waste, which I don’t think it really needs to.” —Nurse 2

If the appropriate bins are not available, regardless of whether the staff knows the waste is non-infectious, it may still end up in the infectious waste stream. In these cases, the first approach to limit the quantity of waste that is incinerated would be to allow the healthcare workers access to the bins they are missing; specifically, tiger-striped bins for non-infectious clinical waste and recycling bins for non-infectious non-clinical waste. No amount of waste segregation training would help if the lower environmentally impactful and non-incineration route waste streams are not provided. The participants emphasised that they and their colleagues can only work with what they are given and having the right bin available was very important.

“If all you have available is an orange or black bin, your hand is forced. If you feel like it should not be going into domestic you have got nowhere else to put it other than in that high incineration location. I think there are a lot of people that know some waste does not need to be in an orange, but what else have I got. . . nothing. So that’s kind of it, that’s choice made.” —Training lead

Lacking the equipment required to adequately fulfil their job role responsibilities is a significant obstacle and one which was expressed by every participant. This signposts that this issue may be widespread across large parts of the UK’s healthcare system. Repeating this study to various other facilities would help indicate the size of this problem and the urgency in which it should be addressed.

The responses have shown that the bins commonly not available are the tiger-striped and recycling bins. These are the bins that contain waste which would be landfilled or recycled [24]. These are also the bins which have the lowest environmental impact when treated compared to the alternative clinical and non-clinical waste route streams [25]. Without a tiger-striped bin, all clinical waste, whether infectious or not, will be required to be placed in the yellow or orange bins for incineration or alternative treatment. Any non-clinical waste will be required to enter the general waste for landfill without the option of being recycled. Both these scenarios are less environmentally favourable and indicate that having these disposal routes available will introduce the possibility for waste to be treated in a less environmentally impactful way [8].

3.2.2. Theme: Lack of Time

A second issue that was discussed is the lack of time that the participants had to make decisions about waste placement. Having clearly labelled bins close to where they are working was highlighted as key when segregating waste in order to minimise time thinking about where the appropriate bins are located as well as the time it would take to walk to it.

“As a busy clinician it is about what is available to you and the right bin being in the right location. If you have got to traipse halfway across the ward to go and throw something away, you are going to go for the one that is nearest to you.”, “If the only bin available in front of you is a tiger bin, but you have not actually touched anything that is needed to go in and it could have gone in a domestic, you are going to use the one that is there because you are probably already five minutes late for your next patient.” —Training lead

“Sometimes you are so busy and the closest bin to you is a bin that is not suitable, but you are so busy that you cannot even walk ten steps and I do not condone it, but I understand.”
—Head nurse

Dealing with highly time-constrained and fast-paced environments such as within medical facilities, it is essential that any chance to reduce wasted time and mental energy during decision making is taken advantage of. Ideally, the layout of the facilities should be optimised to identify which bins are required and where in order to allow access to the appropriate waste stream in the most convenient way possible.

3.2.3. Theme: Lack of Space

Connected to the previous issue of lack of time, a primary reason that the right bin is not available close to the healthcare worker was found to be that there is simply not enough space to fit the number of potentially required bins.

“Ideally, we should have a tiger-striped bag as well, the black and yellow, for offensive waste. We do not have one and I feel that is mainly down to not having enough room for lots of bags.” —Nurse 1

“I think the biggest thing with us is always space. We work in a hospital where when they move our patients and us to different wards, the space is never ever considered in terms of working space both in clinics and nursing offices. We end up having to adjust to space that is usually not working area friendly. So in terms of having the right bins available, that is why half the time they never are.”, “Our clinics bases are usually not fit for purpose a lot of the time in terms of space. The ward I work on, the clinic is small, so the bins that you can fit in that space are limited, which is why we have not got all the choices.” —Nurse 3

“Right bin and right places I think are really, really key. I think that it comes down to that space issue.” —Training lead

Not having the space to fit the bins required could cause big issues when it comes to not only the types of bins available to the staff but also the extra time required to find where the required bin is. This is a particularly difficult issue for established medical facilities as expanding the space in which the staff are required to work might require extensive expansion projects or relocation, which may not be feasible.

Identifying the type of bins that are required most for each section of a facility would help in providing the most appropriate bins in the limited space available. Less used bins could be removed from an area to make space for a more appropriate bin. Assessing the needs of each area of the medical facility and the kind of waste they are producing (particularly if it is likely to be hazardous or not) could help the waste management team determine the requirements of each section/ward. For example, a study in America tracked how quickly certain bins inside of a hospital required emptying in order to decide which bins were required more in each area. They found this reduced cost and increased the efficiency of waste management [31]. Another study by Ishaq et al. found that placing sensors within medical waste bins to notify the waste management team how quickly various bins became full helps with optimising placement of bins where they are most needed [32].

Furthermore, no studies have been conducted yet on how the bin type and size influences waste management within hospitals by affecting where the bins can fit within the hospitals. Non-clinical studies have shown that varying the shape of bins can optimise space and workload [33]. This could be a potential solution to be employed within the UK NHS facilities in order to save space and time.

3.3. Question 3: Barriers to Recycling Waste

Before waste can be considered for the recycling waste stream, it must first be classified as non-infectious, which a previous study found to be the biggest hindrance to a successful recycling initiative [19]. Once this classification has been made, and assuming

a recycling bin is present for the healthcare worker to use (again another key issue [3]), further problems are still present to segregate recyclable waste. The participants stated that easily recognisable recyclable items (similar to those recycled at home) are the easiest to be placed in the recycling bins, e.g., clear plastics cups or food containers. For other recyclable items, a lack of information was a big issue.

“If patients are drinking out of general stuff, then they get recycled, anything domestic we are pretty good at sorting through.” —Nurse 3

“The only thing I can think of for recycling would be if I was clearing a patient table, in which case it would probably be foodstuffs or plastic bottles or things like that.”
—Training lead

Theme: Lack of Information

The participants mentioned some issues they faced when trying to recycle non-infectious waste, all of which revolved around the lack of information provided about the type of material the waste is made of. This appears to be a common theme within the current literature as the lack of labelling and not knowing what materials the products are made of makes it difficult to recycle [34,35].

“I find plastic items the most difficult to decide on as some can be recycled and some cannot and it is not always easy to work out.” —Nurse 1

“Labelling is confusing with recycling, especially soft plastic as opposed to hard plastic.”
—Nurse 3

“Lack of labelling on medical packaging to indicate recyclability. Being unsure if something is made of composites or not. As well as thin films and thin wrappings of varying thicknesses; I know very thin films are usually not recyclable but I do not know about the thicker ones.” —Doctor

“When things are made of multiple different components so that you’ve got a harder plastic bottom and then a softer plastic top and knowing which bit of things can be recycled is sometimes challenging.”, “If you have got to stand there for even ten or fifteen seconds and try and muddle through whether you think something is recyclable or not when you are already really busy, that might be a challenge too far.” —Training lead

Having clear labels on the different materials of the products and packaging will help the healthcare workers identify what can and cannot be recycled. Even simple symbols such as an ‘R’ on recyclable materials could go a long way in providing valuable information to healthcare workers. Currently in the UK, on-pack recycling labels, the Mobius loop, and Resin identification codes are the most recognisable symbols to indicate that something is recyclable or what recyclable material it is made of [36]. A similar approach could be applied to medical packaging as is now commonplace on commercial products.

In addition to labelling, increasing the number of products and packaging that are recyclable would help decrease the volume of waste entering the general waste stream. An issue discussed was the problems caused when trying to recycle waste made of multiple materials, i.e., composite materials. One issue is when identifying whether each component is recyclable or whether they need to be separated prior to disposal. The training lead had worked previously on this issue within their hospital and offered the following advice:

“My team are finding that it is really, really difficult when different products are made out of such different materials and it would be a lot more useful if actually what was coming in, the base material, was something that meant that everything could be recycled together. So rather than having to think oh actually this glove is made of a nitrile base and this mask has got a polypropylene base, therefore they need to go in two separate bins which we do not have the space for.” —Training lead

This again puts the onus on the manufacturers to design their products and packaging to be recyclable as well as simplified in the type of materials being used. More enforced unified standards on the type of materials being used for medical products and their

packaging would help healthcare workers immensely when sustainably disposing of medical waste.

Separate from labelling and increasing the recyclability of waste, the participants also suggested that further training on identifying the types of recyclable materials could help during segregation. Specifically, there appeared to be some confusion around the different terms that are used for certain types of sustainable materials.

“I think specific training would be really good cause we’ve all got heaps of mandatory training anyway, so it would be really useful to have. We are told what colour bins are used for what, but they do not go into specifics about what can be recycled and what cannot, which would be really helpful.” —Nurse 2

“I’ve come across a lot of people who do not necessarily fully understand the difference between if something’s recyclable or compostable and the fact that the bins on the in the hospital site are recycling bins and you cannot put things that are compostable into a recycling bin”, “I think there is a lot of confusion about the terms which make it a little bit difficult for people and then it sort of comes back to that sort of cognitive effort of trying to work out whether something can be recycled or not.” —Training lead

Clarifying to staff the differences between recyclable and compostable as well as explaining the different types of materials which are recyclable could help aid their decision to recycle even when labels are not present on the material. Having the information provided to the staff would be most ideal as there is then no room for error, but if manufacturers do not provide this, the workers having their own specialised training could help fill these gaps in information. As recycling is the most environmentally and economically beneficial option out of all the disposal routes, any initiative which increases the quantity of waste diverted from the general waste stream to recycling will result in an overall reduction in environmental impacts for the organisation [25].

3.4. Question 4: Preferred Training and Information Provision

When asked how the participants would prefer to receive extra training or information regarding the segregation of waste in the future, a clear favourite was discovered. The majority of participants expressed their interest in having quick-to-digest forms of information such as clear labels or posters on or above the bins they are working with. Only one participant recommended longer-style trainings. These themes are discussed in Sections 3.4.1 and 3.4.2.

3.4.1. Theme: Bin Labels and Posters

Most of the participants favoured shorter forms of information provision over the longer training sessions or courses. The reasons for this included the limited time healthcare workers have to undertake longer sessions as well as the already overwhelming number of courses they are required to take. Posters or labels that can be read quickly were mentioned to be the most effective in communicating the information needed.

“In my clinical role I have very little time for non-clinical education—so I would say brief targeted interventions such as posters, face to face verbal advice from a knowledgeable colleague or screensavers are likely best.” —Doctor

“I think labelling is probably the most effective, more than the training online because unfortunately I’ve just finished a run of fourteen mandatory courses in the past two weeks. So I can tell you I don’t want to look at another course.” —Nurse 3

Even more specifically, having posters or labels on or above bins that indicated the types of waste that should be entering that waste stream was agreed by everyone to be beneficial. Some suggestions for these labels/posters include pictures of what types of waste should go where, reminders about what types of waste are recyclable, and a pouch for the label/poster to be kept in to allow for the information to be changed if necessary and for the pouch to be wipeable in the case of contamination.

“So just a poster on the wall saying what things can go in, what bins and what can be recycled would be really, really helpful, especially of things that I use regularly. So just a poster on the wall to remind people would be really helpful. Maybe even just above the bins so that you can see would be really, really helpful.” —Nurse 2

“Stickers on the top of each lid indicating with pictures what goes where.” —Nurse 1

“Yeah, it is too much information. Whereas the thing sliding on top of the bin there that go inside wipeable and plastic is definitely a great idea. So, things like concertinas and those then stuck above the bin and on the bin is perfect actually; and wipeable, so it’s all good.” —Nurse 3

Two participants mentioned how their medical facilities are already trialling these bin labels and posters which have so far been received well by staff.

“What you will see in our bins now on the lid it says what are what sort of things you can put in. Every bin has been done in such a way that on top it says what can go in these bins. It’s not exhaustive, but it helps.” —Head nurse

“So at my trust, we’ve received a grant to print out massive full size bin lid labels which have got on it a little bit more information. There’s posters that go with it, they’re going to go up behind the bins.” —Training lead

Other studies in America, Spain, and Australia, agreed with these findings and when they conducted similar styles of interventions (specifically short presentations and the use of posters) on the correct placing of non-infectious waste, they found these successfully lowered the volume of waste classified as infectious [15–17]. These types of labels and posters appear to have many benefits with few downsides. It was discussed that having a quick reminder to staff of what waste should go where would be helpful in cases of indecision.

At times when healthcare workers are unsure of whether the best place for their medical waste (for example, could it potentially be placed in the tiger bin instead of orange, is it recyclable or not, etc.), a simple label or poster could be the deciding factor in whether the most sustainable choice is made. With the incineration disposal route (yellow bins) having the greatest environmental and economic impact of all the bins, any reduction in the quantity of waste placed within these bins into alternative routes would result in an overall decrease in environmental impact and economic cost to the medical facility [25,26]. Therefore, if placing labels and posters on or above the bins help staff redirect clinical waste into the orange or tiger-striped bins and redirect non-clinical waste into recycling, this would result in environmental and economic savings for the organisation.

An additional benefit of labels/posters is that if they are placed in pouches (also called plastic pockets) then they would be able to be removed or updated when necessary. If the type of coloured bin were to be changed at any point, the label could be replaced as well, allowing for each switch-over of available waste streams.

No studies have yet been conducted specifically to assess the effectiveness of bin labels versus posters on waste segregation within medical facilities, but studies have found that visual aids of any form lead to improved waste segregation [37]. Regardless of whether posters or labels are used, for the chosen method to be effective, they should be clear, brief, and concise [38]. One study found that the effectiveness of visual information methods can be reinforced by providing auditory aids explaining the posters or labels in the form of training demonstrations or instructional videos [39]. This, therefore, indicates that providing posters or labels alongside auditory explanations would be optimal in improving waste segregation within medical facilities. To provide scientific validation of these methods, a study would be required comparing the volume of hazardous waste pre- and post-implementation. A suggestion for future research is that a pilot study is conducted to determine whether there is significant change in waste segregation optimisation when the various visual information methods are employed.

3.4.2. Theme: Longer Training Sessions

One participant partially disagreed with the other healthcare workers in that they did not think quick-to-read forms of information provision were the most effective. The head nurse, whose current primary role was to train future nurses, strongly favoured hands-on simulation-style training as opposed to labels or posters.

“Nurses do not have time to read because we are so short of staff and we are so busy. Now, I’m not condoning that they do not read, however, there is a reason why simulation is preferred by every university and it’s becoming bigger and bigger because it is close to real life. So hands on and any training real life is better than just giving someone a leaflet to read.” —Head nurse

It is understandable that being provided a more in-depth hands-on style of training could be more effective as these types of trainings require full engagement by the staff. However, also taking into consideration previous comments made by the other participants, these sessions also require a lot more time and energy from the healthcare workers. With the number of mandatory courses already partaken by staff, the decision to add more would require individualised consideration from each medical facility to decide whether this extra time and energy is an acceptable demand on their staff. In some situations, a combination of hands-on training as well as the quicker to read labels and posters may be the best approach.

3.5. Suggestions for Change

At the end of the interviews and focus group, the participants were asked if they had any final remarks about the topic of sustainable waste disposal or whether they had any suggestions for changes that they would recommend. The following were mentioned:

Using co-creative approaches

One key aspect that was mentioned was how any future changes are only best if made to fit the unique requirements of the facility they are intended for. The participants stated any changes would need to be addressed with the staff before implementation to ensure they are suitable and pragmatic. Specific wards may have unique methods of operating that new procedures should take into consideration in order to not cause any disruption or unease among staff.

“If you try and go in as a manager and try and impose and say oh you do not need this, you just need one of those, it is different in every single place. So I think co-creation of location of bins and what is actually needed in terms of the different types is really important. Working with the people who work on that ward, they know how they behave and they know what they need where.” —Training lead

“We have slightly different issues sometimes with what we can put out on the ward is limited by what behaviours are going on the ward at the time. Which means when you are again limited as to what we can use where. So it is the nature of the wards that often dictate.” —Nurse 3

This demonstrates the importance of co-creation approaches and communication throughout every level when attempting to implement sustainable changes. For example, a systematic review of the literature addressing interventions within healthcare facilities found that changes that were collaborative and encouraged involvement from the staff had the most effective outcomes [40]. Studies have found that the primary way to include ‘on-the-ground’ personnel in future policy change is by using questionnaires and focus groups, as were used during this study [41–43].

In order to implement effective data gathering of the views of staff, there are three main steps [44]. Step one is establishing a clear purpose for the questionnaire/focus group; it is essential that the intended goal is clearly addressed via the questions asked. Step two is to ensure senior management are supportive of the project and that their endorsement is communicated to the employees. Finally, a knowledgeable individual or group should be assigned to plan and implement the study with the employees. This individual/group

will be responsible for recruiting participants (the most effective approach being via email or direct contacts provided by their superiors [45]) as well as communicating the findings to upper management. Once these steps are followed, the possibility for policy change aligned with staff insight is achievable. It is important for the changes introduced to be clearly communicated to the staff and waste volume metrics to be measured before and after implementation to track the effectiveness of the initiatives put in place [46]. The expected outcome of organising questionnaires/focus groups via these steps is that recommendations from the hospital staff will lead to barriers in waste segregation being removed and, therefore, less waste being incorrectly identified as hazardous. This, in turn, would reduce the high environmental and economic cost associated with the incineration of hazardous waste [25,26].

The Role of Manufacturers

Another suggestion made was to focus on the changes the manufacturers could make to allow their products and packaging to become more easily segregated.

“If everything was made out of something that meant that things could be lumped together to be recycled together, that would kind of help to solve with the space issue.” —Training lead

“If plastic goes into the incinerator, then one of the byproducts of that is the chlorine that comes from burning the plastic. If things were made of a biodegradable material or a recyclable material, even if they did not make it into the recycling stream, the waste that is left at the end of the incineration process would be less harmful. If there is something we can put back onto the manufacturers to make it so that what we are getting is less wasteful or can be reused and if we can get those materials back out and get it into a circular economy, great. But if they do have to be incinerated, how can we do that in a way that is less harmful.” —Training lead

When healthcare facilities receive medical products, they no longer have any say over what material the product is made of. Pressure should be placed on the manufacturers to make their products and packaging from more sustainable materials. This may be by making them from non-composite materials or materials that together can be recycled, so that the staff are able to place the entire waste into the recyclable waste stream [47]. For products that are likely to encounter infectious substances, regardless of if it is made of recyclable material, the waste will end up in the infectious waste stream [24]. For these materials, manufacturers should explore whether different materials could be used that, when incinerated, produces less environmentally impactful fumes; for example, biopolymers that have been shown to have a low pollutant potential from incineration [48]. Putting the emphasis on how manufacturers can change their practices would reduce the pressure placed on medical staff that are already experiencing high demands for their time and energy.

3.6. Discussions

- All bodily fluids are classified as hazardous waste.

It was found that all participants would dispose of waste contaminated with bodily fluids regardless of whether the fluids were from an infectious patient or not. The UK’s HTM regulations states that only a bodily fluid contaminated with a dangerous substance is deemed hazardous waste [24]; therefore, this study proposes that more efforts should be made to promote the understanding of when waste contaminated with bodily fluids should be classed as hazardous or non, for example if the patient is non-infectious. Previous studies disagree with this finding and have specifically said that all bodily fluid should be treated as hazardous regardless of the patient’s infection [49–53]. This clearly indicates that previous research favours treating fluids as hazardous despite the legal need to do so. The proposal of this study is that in opposition to previous studies, staff should be retrained to carefully consider whether the waste contaminated with bodily fluids needs to be classed as hazardous.

- There is a lack of required bins available.

Despite this being the most brought up issue, the lack of appropriate bins within healthcare facilities has not been discussed as an issue in previous studies. This may be due to the lack of similar studies available or specifically the lack of enquiring about the availability of bins. In the same light, no studies mention that adequate bins are provided, so this appears to be a novel finding in an under-researched area with no studies which support or oppose.

- There is a lack of space to place the appropriate bins.

Lack of space for bins within UK NHS medical facilities has been identified in previous studies as a barrier to correct medical waste segregation [50,54]. These studies agree with the finding that there is not enough space within UK NHS healthcare facilities, which results in the required bins not being placed where they would be utilised, resulting in waste being incorrectly segregated. Utilising the limited space available within healthcare facilities should, therefore, be a key area for focus for future studies in cross-cutting fields and policy changes.

- There is a lack of information detailing what is recyclable.

One previous study conducted within the UK also found the lack of labelling on medical devices to be a key contributor to the low recycling rates within hospitals [35]. The researchers found that the lack of identification of the various materials present within, in this study, a plastic feeding bottle resulted in an inability to determine if the waste could be recycled or not. As was found within this study, they also concluded that indicating on the device using labelling would help assist in increasing recycling rates within hospitals.

- Labels and posters should be placed near bins to help remind staff what types of waste should be placed within them.

Bin labels are yet to be used within any large-scale initiative across UK NHS trusts but have been highlighted within this study to be a promising finding. No studies have tested the use of bin labelling and posters within the UK but they have shown to be successful in America, Spain, and Australia [15–17]. Trialling this idea within the UK could then also be beneficial to improving waste management within hospitals. Future researchers are advised to conduct a pilot study to compare the effectiveness of the various visual information methods on medical waste segregation.

4. Recommendations

This section summarises the policy recommendations for changes in Section 4.1 and for future research in Section 4.2.

4.1. Recommendations for Policy Change

The NHS clinical waste strategy 2023 [8] is currently the UK's most recent initiative to reduce the amount of incinerated clinical waste within NHS trusts. An additional desired aim is to reduce greenhouse gas emissions generated by the NHS to aid the delivery of the NHS' net zero goals by 2040. The strategy's primary objectives include increasing the recording of waste data, increasing training for staff, employing waste managers, and setting targets for the percentage of waste which is disposed of as infectious. Despite these objectives, no specifics are mentioned within the strategy guidance document of why waste is being incorrectly segregated and does not detail the type of training the healthcare workers are intended to receive.

The findings of this study can help guide the clinical waste strategy on how best to focus their efforts by addressing the barriers previously discussed.

The proposed solution for all bodily fluids being classified as hazardous.

1. It is recommended that staff should receive mandatory training to demonstrate when bodily fluids are non-infectious and detail the waste management option that should

be taken. Educational training should be provided to healthcare workers specifically focusing on identifying when medical waste is non-hazardous and emphasising how to classify and manage waste coming from a non-infectious person. NHS policy should require NHS trusts to provide their staff specific instructions that non-infectious waste should not be entering the hazardous waste streams and monitor when this takes place to track and address occurrences of erroneous waste segregation. This would require long-term change in how medical facilities train and monitor their staff's adherence to the correct disposal of bodily fluid-contacted waste. This may disturb the current operational environment within the medical facilities and, therefore, it can be expected for changes to happen gradually as the new procedures are reinforced and adopted. The importance of establishing performance metrics should be emphasised by ensuring the quantity of waste, which is classified as hazardous and incinerated prior to and post training, is measured. Targets should be set for reducing the amount of waste that is incinerated. This not only provides actionable data to determine the effectiveness of the training provided but can also be used to demonstrate to staff the beneficial consequences of their actions.

The proposed solution to the lack of required bins being available.

2. Finding solutions to the low availability of bins should take high priority in order to provide healthcare staff with the resources they need to correctly segregate waste. The NHS should update their guidelines for how much space is deemed acceptable to perform medical duties in regard to how many bins are made available compared to the amount of waste being generated. UK policy should regulate that trusts are providing staff with the adequate bin types to allow the correct placement of non-hazardous waste. This solution can be approached on both a short-term and long-term approach. If there are clear cases where introducing an additional required bin would reduce the quantity of waste being incinerated and that there is the space allowed, then the facility may find a quick change in quantity of incinerated waste once introduced. On a longer timescale, acquiring new bins and determining where they would best be placed would take foreplanning and careful evaluation of the types of waste generated throughout the medical facility. The quantity of various types of waste should be measured before and after new bins are introduced to determine the influence bin availability has on waste management, which can also be used to calculate any environmental or economic changes incurred.

The proposed solution to the lack of space to place the appropriate bins.

3. Waste management teams within medical facilities should assess whether the bins currently available to staff are being used to their full potential or whether it would be more favourable to have an alternative bin in their place. Hospital waste managers should be made responsible for optimising the utilisation of the space available. The NHS Clinical waste strategy 2023 should be used to enforce long-term data tracking of the quantity and types of waste generated within sections of each NHS facility. Having data available on the amount of various waste types being generated throughout a medical facility would become valuable especially when measuring the effect that different changes have. Targets can also then be set to reduce the amount of certain waste generated unique to each area and monitored to ensure these targets are met.

The proposed solution to the lack of information detailing what is recyclable.

4. Manufacturers should be required to identify which of their products is recyclable to provide staff with the knowledge of what can be placed in the recycling waste stream. Training should also be provided to staff specifying what types of materials are recyclable, as well as providing visual guides (e.g., on bin labels or posters) reminding staff what can be recycled. The quantity of recycled waste should be recorded to determine whether any changes are successful. Currently, the clinical waste strategy does not put any onus on the role of the manufacturers when considering how waste

can be sustainably disposed of. Legislation should encourage manufacturers to use recyclable materials as well as clearly label which materials they are using that are currently recyclable. Composite materials should be minimised or be able to be recycled together as one attached unit. The NHS procurement teams have the power to not purchase supplies which do not meet their requirements. If these requirements were set to include recyclability guidelines, manufacturers would be required to change. With how great of an economic loss the manufacturers may encounter if they were to lose their procurement frameworks with the NHS supply chain, any required changes to the products could be enacted quickly if deemed necessary. A longer waiting period may be experienced as the NHS supply chain decides what rules they wish to enforce with the manufacturers. The proposed solution of providing labels and posters near bins to help remind staff what types of waste should be placed within them.

5. Appropriate forms of information should be provided to staff with a clear favouritism shown towards easy-to-read forms such as labels and posters. If governmental guidance encouraged the use of bin labels and posters, healthcare workers may find it easier to classify waste without requiring more intensive forms of training such as mandatory courses. The design and utilisation of such labels/posters should become compulsory and standard practice as set by the NHS. Printing a poster and placing it above a bin can be achieved very quickly. The issue which may require long-term change is identifying the best way to design these posters/labels and in measuring the change in volume of various types of waste produced to determine whether the intervention has been successful in reducing the quantity of incinerated waste. Performance metrics should be set by setting goal targets for the quantity of waste types generated, particularly a reduction in the most environmentally and economically impactful waste disposal option, incineration. It is important to note that this study has been conducted with a limited number of participants and the findings should be used carefully, as they may not necessarily be consistent across all NHS medical facilities. Producing policy based only on a small sample may prove ineffective and capture a limited understanding of the barriers faced in other unstudied facilities. Now that some of the main barriers have been identified, NHS facilities could be surveyed to determine if they also face similar problems. This approach may prove quicker and more effective in determining whether changes in policy can be implemented with the solutions provided without requiring lengthy studies. Ideally, before any of these solutions are enacted within governmental policy, further research of a similar nature will be conducted across a variety of locations to provide an in-depth investigation of barriers other facilities face.

4.2. Recommendations for Future Research

- This pilot study should be scaled to involve more participants across numerous healthcare facilities. This will allow for a larger breadth of responses to be received that can be used to confirm or negate the key findings of this study.
- Once future studies involve more participants to contribute to this research, statistical analysis should be utilised to determine if certain barriers to sustainable waste management are more likely to occur within specific parts of the healthcare facility in order to support any future changes implemented across NHS trusts.
- Studies should conduct waste audits within NHS trusts before and after implementing trainings on medical waste segregation to measure the change in the volume of waste classified as hazardous.
- Trial versions of the bin labels and posters should be conducted, and waste audits performed to measure the change in classified waste.
- Trial studies should be conducted where the quantity of different types of generated medical waste within various wards are monitored in order to optimise the types of coloured bins provided. The quantity of waste classified as hazardous can then be

measured before and after the bins have been changed to determine if certain bin placements affect the types of waste generated.

- Studies should investigate whether labelling recyclable materials/devices as recyclable increases the quantity of medical waste that is recycled. Various types of labelling should be trailed to determine if the appearance of the label has any effect on the amount of recycled waste.

5. Limitations of the Study

Despite the significance of the findings found during this study, the scale of which it was conducted limited the representation of the results. This small scale of participant responses may mean that the findings of this study are not consistent on a nationwide basis. This has been attempted to be minimised during this research by involving participants from a range of job subcategories and from various NHS trusts to increase the breadth of responses. A key suggestion is that this study is emulated on a larger scale to test the validity of the findings across the UK. A consensus on the problems faced could then be generated and compared. It is also important to note that a study like this has not been conducted within the UK previously and one reason may be how challenging it was to recruit participants. Having a study that demonstrates, even on a smaller scale, that qualitative methods can be implemented and be used to uncover valuable findings will help spur future research to conduct wider-reaching studies.

Ideally, running a statistical analysis of the responses would provide numerically backed findings, but the small number of responses and lack of current data within this field together with the difficulty in recruiting participants limited this as an option. Qualitative methods are currently the most popular approach in similar studies due to the lack of numerical data, but it is hoped that as future research is conducted, this will become a possibility.

It is also important to consider that the participants of this study were more likely to become involved due to a personal bias towards improving sustainability within healthcare. They may be more aware of issues within their trust that other healthcare workers have no knowledge of. It is, therefore, possible that potential participants who were disinterested and, therefore, decided not to become involved would have provided different responses. This study attempted to avoid any biases by inviting a variety of participants using various communication leads and not simply those who had an interest in sustainability. The effect of having previous knowledge of sustainability within healthcare was also deemed to have an insignificant effect on the answers provided. Many of the findings (e.g., lack of bins, lack of labelling, etc.) were problems faced by anyone within the field and not just those who are environmentally conscious. Preferably, the NHS could implement sustainability questionnaires and training as a core module, which would then ensure all healthcare workers participate, but the size of such an operation was outside the scope of this study.

6. Conclusions

In conclusion, it has been shown that a variety of obstacles are present which impede UK healthcare workers' ability to correctly segregate clinical waste within NHS trusts.

- Medical staff are shown to be competent when it comes to identifying hazardous waste, but more work can be done to correctly segregate non-hazardous waste into more sustainable waste disposal streams.
- Currently, all clinical waste that comes into contact with bodily fluid is automatically classified as infectious where this does not necessarily need to be the case. Specific interventions should be introduced to encourage staff to consider whether a piece of medical waste is or is not infectious and subsequently place it in the corresponding bins.
- The availability of the required coloured bins was found to be a big hindrance to successful waste segregation. In most cases, it was found that only orange and domestic bins were available to the staff. Assessing whether different bins could

be provided would be key in facilitating the diversion of non-infectious waste from hazardous waste streams, thus reducing incineration.

- Having the right bin available would also help with the lack of time that healthcare workers have available to dispose of waste. Space within the medical facilities may present an issue to having the appropriate bins present.
- It was found that the lack of information about what materials are recyclable discouraged waste from being placed in the recycling bags. Manufacturers should be pressured to label their products and packaging with indications of which materials are recyclable.
- Most participants expressed that quicker-to-read forms of information provision, such as posters, were preferred. Specifically, labels stuck onto the lids of bins or posters placed above the bins were popular suggestions. These labels and posters can be used to help remind staff what types of waste should go in which bin as well as aid in what types of materials are recyclable.

Overall, this study has provided guidance on how waste can be more sustainably segregated with UK NHS trusts. The results of this research should prove invaluable and help guide future legislation and practical interventions in an informed direction, as well as provide a framework for future researchers to conduct their own similar studies.

Supplementary Materials: The following supporting information can be downloaded at <https://www.mdpi.com/article/10.3390/su16073027/s1>, Figure S1: PowerPoint slides used for the four questions asked during the focus group; Figure S2: Images used during the ice-breaker questions asked during the focus group.

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