**Pharmaceutical Waste Disposal – A Survey of Hospital Patients To Determine How Patient Behaviour Changes with Formulation and Source of Medication.**

**Abstract**

**Objectives** – Patients generate a significant amount of household pharmaceutical waste. Improper management has a significant and detrimental effect on patient care, healthcare finances and the environment, through greenhouse gas emissions and environmental pollution. In England, proper disposal is via a Community Pharmacy. Previous studies have suggested that patient behaviours regarding appropriate disposal is influenced by both the formulation of the medicine and its origin. This work set out to determine if these factors are still relevant to English patients.

Methods –English hospital inpatients at 10 NHS Hospital Trusts were surveyed on how they would preferentially dispose of different drug formulations (Tablets/Capsules, Liquids, Inhalers, Injections, Patches, Drops & Topical products) sourced from a hospital, general practitioner (GP), community pharmacy or ‘alternative’ location, such as supermarket.

**Key findings**

* Both the source of medication and its formulation affected patient waste disposal behaviours.
* Tablets/Capsules, Liquids, Inhalers, and Injections were primarily returned to a Community Pharmacy, but nearly a third of patients reported that they would pour liquid medicines down the sink or toilet.
* Patches, Drops, and Topical formulations were primarily disposed of via household rubbish.
* For all formulations, there appeared to be a positive relationship between proper community pharmacy disposal and acuity of the source of medication.

**Introduction & Objectives**

Household pharmaceutical waste associated with patients managing personal health needs in their own home, is produced when elements of care or patient circumstances change, such as altered pharmacokinetics, symptom resolution, adjustment of therapy, or even death. However, regardless of cause, household pharmaceutical waste is a globally ubiquitous problem in addition to presenting a significant risk to human and environmental health, and prosperity.

Chemical pollution is considered one of the nine planetary boundaries, and present evidence suggests that we are already operating outside of this, risking irreversible environmental change. (1) The impacts of medication in natural ecosystems have been demonstrated to influence animal behaviour, in relation to food seeking, mating, defence (2) and ultimately, survival. (3) The presence of anti-infective drug contamination of water-systems is irrefutably linked to antimicrobial resistance. (4)

 In 2015 NHS England estimated medication worth approximately £300million is wasted annually, with the impact likely to be greater due to underreporting. (5) However, using this figure as a reference point, and the Greener NHS carbon emission factor for pharmaceuticals, leads to a suggested annual greenhouse gas emission burden of approximately 187,000 tonnes of CO2e (equal to approximately 187,000 return flights, Paris to New York) (6) on medication that derives zero patient benefit whilst draining healthcare resources.

England’s Chief Pharmaceutical Officer estimated that 10% of prescriptions in primary care are issued unnecessarily. (7) Other international research projects suggest that personal medicines waste is a universal concern, with wasted medicines calculated at between 3 and 50% of that prescribed. (8) (9) (10) (11)

In England over 12 months (Nov 23 – Oct 24) approximately 1.2 billion prescriptions items were issued. (12) If just 10% of these were unnecessary, and if each item consumes 1minute of healthcare professional time, this equates to a sacrifice of over 20 million hours which could have otherwise been allocated to patient care.

It is essential that patients are aware of the correct procedures for appropriate disposal. This would provide access to healthcare professionals, both to intervene on improving healthcare, and to limit environmental harm.

In England, proper disposal is high temperature incineration via Community Pharmacies, who have been contractually obliged to accept patient-level pharmaceutical waste as part of the Community Pharmacy ‘essential services’ contract since 2004. (13) Despite this, a large international study by the Organisation of Economic Cooperation and Development (OECD) in 2022 on management of household pharmaceutical waste, cited a 2006 UK study which reported that 63% of drug items are inappropriately disposed of by English patients. (14)

Intriguingly, the OECD study presented findings that behaviour was influenced by both the source of medication, and the formulation of the medication in question: “Liquids tend to be more often discharged in sinks or toilets, whereas solids (e.g. tablets and capsules) and semi-solid pharmaceuticals (e.g. creams and ointments) tend to be more often disposed of in solid household waste. Additionally, medicines considered to be more harmful, such as antibiotics, were more often returned to a pharmacy than over-the-counter products”

As healthcare professionals, we were intrigued to determine whether these behaviors remain applicable to the UK population at this time and when multiple geographical communities were surveyed.

The objectives of this piece of work were therefore to determine:

1. Hospital patients’ beliefs on the most appropriate way to dispose of medication
2. If medication disposal beliefs were influenced by the medication formulation
3. If medication disposal beliefs were influenced by the source of medication

**Methods**

1. A patient survey was conducted in 10 English hospital trusts (13 sites) to ascertain how patients or their parents/guardians (henceforth referred to as ‘patients’) would theoretically dispose of different medications.
2. Survey wording was developed with the support of an NHS communications expert to ensure clear and neutral wording of questions, using language targeted to patients with lower literacy standards.
3. Respondents were eligible for survey inclusion if they or their child were hospitalized for at least one day during the period from January to March 2024 and were deemed cognitively competent for participation by medical staff. There was no restriction on clinical specialty of patients included.
4. Eligible patients were invited to take part, and surveyors were on hand to introduce the survey topic, seek permission to proceed and provide clarity where needed.
5. Each site surveyor was asked to survey a minimum of 50 patients over the months February, March & April 2024, and submit data for collation by the end of April 2024.
6. The survey asked patients what their preferred disposal method would be, should they be given medication on discharge, in each of the following formulations:
* Tablets/Capsules
* Liquids
* Inhalers
* Injections
* Patches
* Drops
* Topical products
1. Patients were further asked how they would dispose of these formulations when obtained from a variety of settings, namely:
* Hospital
* General Practitioner (GP)
* Community Pharmacy
* ‘Other’ sources. such as supermarkets or petrol stations.
1. Patients were provided with the following disposal options:
* Return to pharmacy
* Dispose of in household waste/rubbish
* Recycle the medicine
* Pour down a toilet or sink
* Donate to family or friends
* Alternative process
* Unsure
1. Patients were given the option to provide commentary on their chosen action.
2. The survey also collected geographical data (Hospital Trust) and demographic data (patient age, gender, ethnicity). No patient-identifiable data were collected.
3. The survey was submitted to each Trust’s research group for approval as a quality improvement project aimed at informing patient education regarding management of discharge medication.
4. Anonymised results were collated and analyzed (using Google Sheets) to determine average patient beliefs across the study population.

**Results**

Responses were received from 765 patients, over 13 individual hospital sites, representing 10 English NHS Foundation Trusts. Demographic data is shown below and followed national trends with regards increasing numbers of patients with age, female patients representing just over half of all hospital inpatients and ranking in terms of patient numbers by ethnicity classification.(15)

**Demographic information**

|  |  |
| --- | --- |
| **Age** (years) | PatientsSurveyed |
| 0-18 | 4 (1%) |
| 18-24 | 28 (4%) |
| 25-34 | 73 (10%) |
| 35-44 | 91 (12%) |
| 45-54 | 104 (14%) |
| 55-64 | 133 (17%) |
| 65+ | 332 (43%) |

|  |  |
| --- | --- |
| **Gender** | PatientsSurveyed |
| Female | 408 (53%) |
| Male | 350 (46%) |
| Other / Preferred Not To Say | 7 (1%) |

|  |  |
| --- | --- |
| **Ethnicity** | PatientsSurveyed |
| White | 603 (79%) |
| Asian / Asian British | 86 (11%) |
| Black / African / Caribbean / Black British | 32 (4%) |
| Mixed/Multiple ethnic groups | 22 (3%) |
| Other Ethnic Group | 22 (3%) |

**Disposal of Tablet/Capsule Formulations**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Disposal Route | Pharmacy | Rubbish | Recycling | Toilet/ Sink | Donate | Alternative | Unsure |
| Source of Tabs/Caps |  |  |  |  |  |  |  |
| Hospital | 58%  | 31%  | 3% | 5% | 1% | 2% | 0% |
| GP  | 56%  | 32%  | 3%  | 6%  | 1%  | 2%  | 0% |
| Pharmacy  | 45%  | 37% | 2% | 5% | 6% | 3% | 2% |
| Other | 34%  | 45% | 3% | 5% | 7% | 4% | 1% |
| Ave Result | **48%** | **36%** | **3%** | **5%** | **4%** | **3%** | **1%** |

**Disposal of Liquid Formulations**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Disposal Route | Pharmacy | Rubbish | Recycling | Toilet/ Sink | Donate | Alternative | Unsure |
| Source ofLiquids |  |  |  |  |  |  |  |
| Hospital | 46% | 18% | 3% | 26% | 0% | 2% | 4% |
| GP | 44% | 18% | 4% | 28% | 0% | 1% | 4% |
| Pharmacy | 36% | 23% | 5% | 24% | 3% | 3% | 6% |
| Other  | 28% | 29% | 5% | 25% | 4% | 3% | 6% |
| Ave Result | **39%** | **22%** | **4%** | **26%** | **2%** | **2%** | **5%** |

**Disposal of Inhaler Formulations**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Disposal Route | Pharmacy | Rubbish | Recycling | Toilet / Sink | Donate | Alternative | Unsure |
| Source ofInhalers |  |  |  |  |  |  |  |
| Hospital | 50% | 31% | 11% | 0% | 1% | 2% | 5% |
| GP | 49% | 33% | 12% | 0% | 1% | 2% | 4% |
| Ave Results | **50%** | **32%** | **11%** | **0%** | **1%** | **1%** | **5%** |

**Disposal of Injection Formulations**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Disposal Route | Pharmacy | Rubbish | Recycling | Toilet / Sink | Donate | Alternative | Unsure |
| Source of Injections |  |  |  |  |  |  |  |
| Hospital | 61% | 19% | 2% | 0% | 0% | 10% | 8% |
| GP  | 61% | 19% | 2% | 1% | 0% | 10% | 7% |
| Ave Results | **61%** | 19% | **2%** | **0%** | **0%** | **10%** | **8%** |

**Disposal of Patches Formulations**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Disposal Route | Pharmacy | Rubbish | Recycling | Toilet / Sink | Donate | Alternative | Unsure |
| Source of Patches |  |  |  |  |  |  |  |
| Hospital | 39% | 48% | 2% | 0% | 0% | 2% | 9% |
| GP  | 39% | 48% | 2% | 0% | 0% | 2% | 9% |
| Pharmacy  | 34% | 51% | 2% | 0% | 1% | 3% | 9% |
| Other  | 26% | 59% | 3% | 0% | 2% | 3% | 8% |
| Ave Results | **35%** | **51%** | **2%** | **0%** | **1%** | **3%** | **9%** |

**Disposal of Drops Formulations**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Disposal Route | Pharmacy | Rubbish | Recycling | Toilet / Sink | Donate | Alternative | Unsure |
| Source ofDrops |  |  |  |  |  |  |  |
| Hospital | 38% | 44% | 4% | 4% | 0% | 2% | 8% |
| GP  | 37% | 46% | 4% | 4% | 0% | 2% | 7% |
| Pharmacy | 32% | 48% | 4% | 4% | 1% | 3% | 8% |
| Other  | 24% | 53% | 5% | 4% | 2% | 3% | 9% |
| Ave Results | **33%** | **48%** | **4%** | **4%** | **1%** | **3%** | **8%** |

**Disposal of Topical Formulations**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Disposal Route | Pharmacy | Rubbish | Recycling | Toilet / Sink | Donate | Alternative | Unsure |
| Source ofTopicals |  |  |  |  |  |  |  |
| Hospital | 38% | 48% | 4% | 1% | 1% | 3% | 6% |
| GP | 36% | 51% | 4% | 1% | 1% | 2% | 6% |
| Pharmacy | 33% | 50% | 4% | 1% | 2% | 3% | 6% |
| Other | 25% | 56% | 4% | 1% | 3% | 3% | 8% |
| Ave Results | **33%** | **51%** | **4%** | **1%** | **2%** | **2%** | **7%** |

**Discussion**

This work indicates that English hospital patients dispose of medication in a range of different ways, and change their behaviours according to both formulation and medication source.

The limitations of this work includes a relatively small patient cohort, which restricted the ability to further analyze patient behavior by ethnicity, age or gender. A larger study population would enable robust statistical analysis to determine if these factors influence outcomes and whether patient education needs to be tailored according to these demographic characteristics.

Results indicate that the formulations primarily and correctly, returned to a Community Pharmacy, included Tablets/Capsules, Liquids, Inhalers, and Injections. An additional 11% of patients indicated that they would recycle their inhalers, which may be correct or not. The survey was not designed to address this question, however, inhaler recycling facilities in England vary significantly by geography and overtime. Although several pilot inhaler recycling programs have been implemented in England, there is currently no national program accessible to patients. (An incorrect response would be to recycle inhalers via household recycling.) We propose the establishment of a clearly identified national program to foster this emerging awareness of the potential to recycle medical inhalers.

Injections were the formulation most likely to be returned to a pharmacy for proper disposal, at 61%. An additional 10% of patients reported they would use an ‘Alternative’ disposal practice. The survey was not designed to further assess these responses, but anecdotally, patients mentioned practices that may be suitable, such as a designated council collection or hospital return service. However, these services are not uniformly available across the country, and patients would need to be specially educated about local variations in practice. Alarmingly, 19% of patients indicated that they would dispose of injectable medications, presumably containing medical sharps, in household rubbish streams.

Nearly one-third of patients (26%) intending to dispose of liquid medications stated that they would pour them down a toilet or sink, reflecting the findings of the earlier OECD study, and possibly indicating a population perception of what constitutes a ‘real medicine’. Similarly, the primary disposal route for Patches, Drops, and Topical formulations was via household rubbish, possibly suggesting that patients are not as concerned about the medication element within these formulations.

Across the formulations studied, medication was more likely to be returned to a community pharmacy when it originated in acute healthcare settings, particularly a hospital, with ‘appropriate disposal’ rates declining as the medication was sourced further from a hospital. This may indicate an unconscious bias to treat medication more seriously when it originates from an acute healthcare setting. Alternatively, the patients in this work were hospitalized, presumably with serious medical conditions, and therefore may have allocated greater value to medication received there. They may also have been more focused on health advice from hospital professionals and acted accordingly.

Very few patients opted to donate or share medication, which is a positive outcome. However, individual patient responses for ‘Alternative’ methods of disposal highlight a clear need for education, as these included administering medications to pets and burning them in regular garden bonfires.

With the exception of solid oral formulations from a hospital or GP setting, a certain number of patients expressed a lack of clarity with how to manage their waste medication in every section of the survey, peaking at 9% for patients managing unwanted patches and drops.

Further research is warranted to explore the relationship between patients’ understanding of correct process and previous exposure to medication or medication-related campaigns. Anecdotally, several patients indicated that they would return anti-infective medications to a Community Pharmacy, influenced by antibiotic amnesty/champion campaigns that highlighted the importance of these medications.

Interestingly, there was a range of responses from different sites for individual survey questions, for example, with regards to disposal of hospital supplied tablets/capsules to a Community Pharmacy, average responses varied from 34% to 86%. This may have been as a result of patient education given on dispensing labels, hospital posters, or patient information on discharge notices.

A study of healthcare professionals’ knowledge might also be a crucial next step. Several patients reported that their medical professionals were unsure of proper disposal practices, even when asked. This raises concerns about how patients can be expected to follow correct procedures if specialist authorities cannot provide accurate guidance.

In summary, despite the limitations of this study, it has highlighted that the patterns of behavior described in the OECD study remain present in inpatient populations throughout England. There is a clear need for national-level education on the proper disposal of patients’ own medications. Specifically, educational efforts should emphasize that liquids must not be poured down sinks or toilets and that all medications, regardless of formulation or origin, should be returned to Community Pharmacies for proper disposal.

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References

 1. Outside the Safe Operating Space of the Planetary Boundaries for Novel Entities. al, Persson et. 56(3), 2022, Environmental Science Technology, Vol. 1, pp. 1510-1521.

 2. Long-term effects of widespread pharmaceutical pollution on trade-offs between behavioural, life-history and reproductive traits in fish. al, Aich et. 1-16, s.l. : Journal of Animal Ecology, 2024, Vol. 00.

 3. Toxicity of non-steroidal anti-inflammatory drugs to Gyps vultures: a new threat from ketoprofen. al, Naidoo et. 3, s.l. : Biology Letters, 2010, Vol. 6.

 4. Antibiotic pollution and associated antimicrobial resistance in the environment. al, Barathe et. s.l. : Journal of Hazardous Materials Letters, 2024, Vol. 5.

 5. BSA), Bertie Hazell and Ross Robson (NHS. Pharmaceutical Waste Reduction in the NHS. s.l. : NHS England, 2015.

 6. <https://calculator.carbonfootprint.com/calculator.aspx>.

 7. Ridge, Dr Keith. National Overprescribing Review Report. s.l. : Department of Health and Social Care, UK Government, 2021.

 8. Pharmaceutical research has steadily brought new drugsto the market, aimed at cure or palliation of numerousdiseases. Their wide accessibility provides important bene-fits in reducing morbidity and mortality and alleviatingpain and suffering. As a consequ. al, Wasserfallen et. 5, s.l. : Annals of Pharmacotherapy, Vol. 37.

 9. Practices of pharmaceutical waste generation and discarding in households across Portugal. Dias-Ferreria C, Valente S et Vaz J. 10, s.l. : Waste Manag Res, 2016, Vol. Oct.

 10. Taking stock of medication wastage: Unused medications in US households. al, Law et. Jul-Aug, s.l. : Res Social Adm Pharm, 2015, Vol. 11.

 11. Development, Organisation for Ecomonic Cooperation and. Management of Pharmaceutical Household Waste. 2021.

 12. <https://www.prescqipp.info/>. Prescription Data Analysis for England .

 13. <https://cpe.org.uk/national-pharmacy-services/essential-services/disposal-of-unwanted-medicines>.

 14. Household disposal of pharmaceuticals as a pathway for aquatic contamination in the United kingdom. Bound JP, Voulvoulis N. s.l. : Environ Health Perspect. , 2005, Vol. 12.

15. [Summary Report - Patient - NHS England Digital](https://digital.nhs.uk/data-and-information/publications/statistical/hospital-admitted-patient-care-activity/2019-20/summary-reports---apc---patient) [Accessed 18.04.25]