**The UK Cancer nurses safe handling practice of cytotoxic drugs: a survey study.**

**Abstract**

**Background:** Cytotoxic drugs (CDs) potentially pose significant risks to cancer nurses. This study aimed to determine UK cancer nurses' perceptions and experiences regarding potential exposure to CDs,  knowledge of hazard, use of personal protective equipment (PPE) including closed systems transfer devices( CSTDs) and perceived  health issues.

**Methods:** A cross-sectional survey was conducted across the UK, facilitated through the UK Oncology Nursing Society. Descriptive analyses were employed.

**Results:** The survey revealed that PPE predominantly plastic aprons (97% n=723) and either glove, vinyl (53% n=393), and gloves labelled for chemotherapy (62% n=466). Additionally, knowledge of safe handling precautions across the UK, ranged from 86% to 96%. Closed systems were implemented in some always to sometimes (70%), and never used (30%). Perceived health issues were reported by 161 participants, both female (93%) and male (6%).

**Conclusions:** This study shows, an overall high level of knowledge of the hazards of CDs and plastic aprons and gloves are the primary protection against occupational exposure. There is a variation in use of CSTDs. Cancer nurses perceive their health is compromised as staff  self-report health issues attributed to the administration of CDs. Recommendation should be that all cancer treatment settings should implement CSTDs across the UK.

**Introduction:**

Control of Substances Hazardous to Health UK regulations (Control of substances hazardous to health [COSHH], 2002) have defined chemotherapy as dangerous cytotoxic drug (CD), and the law requires adequate control and safety in the workplace (Health Safety Executive [HSE] 2020).

The Hierarchy of Controls is deemed a systematic approach to managing and mitigating risks associated with hazardous substances, including CDs (Centres for Disease Control and Prevention [CDC], 2022). This model prioritises control strategies based on their effectiveness in reducing or eliminating exposure to hazards, structured in descending order of reliability and protective value. The application of the ‘Hierarchy of Controls’ in the context of CDs is essential to safeguard healthcare workers from potential health risks such as carcinogenicity, reproductive toxicity, and organ damage (National Institute for Occupational Safety and Health [NIOSH], 2016; European Biosafety Network [EBN] 2024).

Although elimination and substitution are the gold standard, the next level of protection and risk reduction is the implementation of engineering controls, such as biological safety cabinets and closed system transfer devices (CSTDs) (Eisenberg & Klein, 2021). These controls are designed to contain or limit the release of CDs into the workplace. These controls are vital in creating a barrier between the hazard and the healthcare worker, significantly reducing the likelihood of exposure (Mead et al., 2017; Eisenberg & Klein, 2021). Recent advancements in engineering controls have further enhanced their efficiency, ensuring better protection for healthcare personnel (CDC, 2022). Currently, the use of CSTD in the UK is optional (Yu et al., 2020); however, the recent White Paper by EBN (2024) advocates that all countries should implement CSTDs.

Most cancer nurses who handle and administrate CDs rely on workplace policies and procedures to reduce the risk. The protection includes implementing standard operating procedures (SOPs) for handling CDs, comprehensive training programs for healthcare workers, and enforcing proper work practices ( Crickman, 2017; Coyne et al., 2019; Lin et al., 2019; Toland and Simons, 2020; Sharp et al. 2024). Administrative measures are crucial in promoting a safety culture and ensuring consistent adherence to safe handling practices (Mead et al., 2017; Coyne et al., 2019; Yu et al., 2020; Eisenberg & Klein, 2021).

Personal protective equipment (PPE) forms the last line of defence in the hierarchy. It includes gloves, gowns, respiratory protection, and eye protection specifically designed to provide a barrier against hazardous drug exposure. While PPE is less protective than other controls, it is an essential component of a comprehensive safety strategy, particularly when other controls do not eliminate the risk.

There has been one dominant survey by Polovich and Clarke (2012) implemented globally (Callahan et al., 2016; Graeve et al., 2017a & b; Mahdy et al., 2017; He et al., 2017; Menonna-Quinn et al., 2019; Abu-Sharour et al., 2021; Srisintorn et al., 2021) exploring the Theoretical Factors Predicting Use of Hazardous Drug Safe-Handling Precautions to understand the attitudes, knowledge, and usage of protection among the cancer nurses involved in handling and administrating CDs people living with cancer. In the UK, two studies in the last ten years have explored the safe handling of chemotherapy (Simons and Toland, 2017, 2019). However, it appears that there is a lack of evidence of how this forms a picture across the whole of the UK, understand if and how nurses' health is affected when handling the CDs (Simons and Toland, 2017, 2019).

This study aimed to determine UK cancer nurses' perceptions and experiences regarding potential exposure to CDs, including hazard knowledge, use of PPE and closed systems and self-reported health issues.

**Methodology:**

A cross-sectional survey study was conducted from October 2022 – July 2023. A validated survey (Polovich and Clarke 2012) was reviewed by a UK-represented stakeholder group for content consistency and applicability. The online survey was administered using a university-subscribed Novi survey tool through a link for the participants. Informed consent was obtained after the participants had reviewed the privacy statement and participation information sheet.

The survey included 14 sections; however, only descriptive statistics will be presented, including knowledge of hazards, usage of personal protective equipment (PPE), (cytotoxic preparation, administration, disposal), CSTDs and health Issues effects

**Population and sampling:**

The survey was open to any cancer nurses practising in the UK who were willing to participate and consent to the study. Nurses who had yet to gain experience handling CDs or administration to patients or nurses practising in other countries or the EU were excluded from the study. Convenience sampling was applied with dissemination routes that allow maximum recruitment capacity. Recruitment for the survey was sought through advertisements and reminders on the social media pages of the UK Oncology Nursing Society. The distribution created a snowball effect amongst the participants, who encouraged other cancer non-UKONS members to participate in the survey.

**Ethical considerations**

Ethical approval was granted by Edinburgh Napier University (SHSC2895752).

**Data Analysis:**

The data collected were analysed using SPSS (version 26.0). Descriptive data was calculated using the survey responses' percentages, frequencies, mean, and standard deviations.

**Results:**

**Nursing and setting characteristics:**

Six hundred and seventy-five nurses answered all the sections, including the demography, and the other participants (n=183) answered the sections partially and thought only relevant to them (Table 2). Education levels were reported as having the highest bachelor's degrees (24.2% diploma, 60.6% bachelor's degree, and 15.1% master's degree). The mean age of the participants was 41.3 years; the average nursing experience was 14.3 Years; the mean oncology nursing experience was 10.9 years; the mean chemotherapy handling experience was 10.3 years. Ninety-eight per cent (n=661) had training in oncology nursing, and 2% (n=14)) did not have a training history. Just under seventy-six per cent (n=509) were members of the UK Oncology Nursing Society. The mean number of patients handled by nurses each day was 8.17± 10.043, and the mean number of patients treated in the unit per day was 44.05± 42.133 The highest number of participants were from the England southeast region (n=149), followed by Scotland (n=86), England southwest (n=84), England Northwest (n=82), England Midlands (n=79), England Northeast (n=78), England London (n=52), Northern Ireland (n=42), Wales (n=23).

The highest number of participants worked ( n = 675) in the Cancer centres ( n = 357), followed by District General Hospitals ( n = 238), Private Hospitals ( n = 40), others ( n= 25), and community and home care settings ( n= 15).

Ninety-eight per cent (n=794) of participants agree that there are written policies for safe handling within their workplace. 76% (n=620) participants workplace prepare CDs in the aseptic pharmacy; 17% (n=138) prepared CDs are brought from off-site locations; followed by 2% (n=16) in designated preparation room, 2%(n=13) in treatment area and 3% (n=24) in other areas. Spill kits to manage the spills of CDs are available in 99% (n=724) of workplaces, and 1% (n=5) of workplaces are reported not to have spill kits.

The participants' training experience ( n = 675) was varied. The highest reported training was workplace training ( n = 291), followed by university accredited training ( n= 211) and UKONS chemotherapy training ( n= 149), with others ( n = 15) and not applying ( n= 9). The results are presented proportionally for the different regions of the UK (figure 4).

**Nurses' knowledge of hazard of CDs:**

Nurses were tested by asking twelve questions to assess their knowledge of hazards which were true or false answer at the start of the survey. The survey results indicate high knowledge among the participants, with a mean of 10.4 ± 1.41; 89.5% of the nurses scored higher knowledge (9-12); 10.5% scored moderate knowledge (5-8). The frequency and percentages of correct and incorrect responses to the 12 knowledge questions of the survey are presented (Table 1).

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| **Question** | **Correct Answer****( N = 858)** | **Incorrect Answer****( N=858)** |
| 1. Chemotherapy can enter the body through breathing it in  | 759 (88%) | 99 (12%) |
| 2. Chemotherapy can enter the body through ingesting it | 848 (99%) | 10 (1%) |
| 3. Chemotherapy cannot enter the body through contact with contaminated surfaces | 682 (79%) | 176 (21%) |
| 4. Chemotherapy can enter the body through contact with spills and splashes | 852 (99%) | 6 (1%) |
| 5. Chemotherapy gas and vapour in air can enter the body through the skin and mucous membranes | 750 (87%) | 108 (13%) |
| 6. Oral forms of chemotherapy do not have the potential to be absorbed | 809 (94%) | 49 (6%) |
| 7. Chemotherapy in liquid form can be absorbed through the skin | 805 (94%) | 53 (6%) |
| 8. A surgical mask protects from chemotherapy aerosols | 382 (45%) | 476 (55%) |
| 9. All types of gloves provide the same level of protection | 728 (85%) | 130 (15%) |
| 10. Chemotherapy can more easily enter the body through damaged skin | 809 (94%) | 49 (6%) |
| 11. Alcohol hand sanitiser is as effective as soap and water in removing chemotherapy residue | 797 (93%) | 61 (7%) |
| 12. Chemotherapy can enter the body through contaminated foods, beverages, or cosmetics | 710 (83%) | 148 (17%) |

**Table 1: Nurses Knowledge about Chemotherapy occupational exposure in the UK**

**Safe Handling Precautions:**

The usage of chemotherapy-labelled gloves was practised by 62% (n=466) during administration, 63% (n=430) during disposal, and 59% (n=298) during handling of excreta. Usage of other non-chemo gloves is reported by 53% (n=393) during administration, 53% (n=359) during the disposal, and 60% (n=299) during the handling of excreta. Double gloves are used by 15% (n=110) during administration, 14% (n=93) during disposal, and 15% (n=77) during the handling of excreta.

Plastic aprons were used by 97% (n=723) during administration, 96% (n=655) during disposal, and 98% (n=492) during the handling of excreta. A few participants practised the re-use of plastic aprons during disposal (7% n=50) and the handling of excreta (3% n=17). Eye protection was used by 42% (n=279) of participants during administration, 37% (n=229) during disposal, and 32% (n=147) during the handling of excreta. Respirator/mask was used by 50% (n=334) during the administration, 47% (n=292) during the disposal, and 47% (n=216) during the handling of excreta.

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| --- | --- |
| **Safe Handling Precautions** | **% and mean figures within administration, disposal and handling of excreta** |
| **Administration N=747** | **Disposal N=682** | **Handling excreta N=502** |
| **n (%)** | **Mean** | **n (%)** | **Mean** | **n (%)** | **Mean** |
| **Closed system** | 521 (70%) | 2.98 | N/A | N/A | N/A | N/A |
| **Gloves labelled for use with chemotherapy** | 466 (62%) | 3.02 | 430 (63%) | 3.02 | 298 (59%) | 2.69 |
| **other gloves (e.g.: vinyl)** | 393 (53%) | 2.39 | 359 (53%) | 2.39 | 299 (60%) | 2.65 |
| **Double gloves** | 110 (15%) | 0.34 | 93(14%) | 0.33 | 77 (15%) | 0.50 |
| **Gowns labelled for use with chemotherapy** | 111 (15%) | 0.55 | 102 (15%) | 0.54 | 56 (11%) | 0.42 |
| **other gowns** | 83 (11%) | 0.28 | 65 (10%) | 0.25 | 55 (11%) | 0.30 |
| **Plastic aprons** | 723 (97%) | 4.72 | 655 (96%) | 4.66 | 492 (98%) | 4.77 |
| **Re-use Plastic aprons** | N/A | N/A | 50 (7%) | 0.21 | 17 (3%) | 0.11 |
| **reuse disposable gloves** | N/A | N/A | N/A | N/A | N/A | N/A |
| **eye protection** | 320 (43%) | 1.41 | 256 (38%) | 1.29 | 159 (32%) | 1.16 |
| **Respirator/mask** | 380 (51%) | 2.16 | 320 (47%) | 2.06 | 234 (47%) | 2.12 |

**Table 2: Frequency ( %) of safe handling precautions for administration, disposal and handling of excreta**

Seventy percent (n=521/747) have had experience using a closed system during the administration of the CDs (Table 3). This result includes the regular and occasional usage of the CTSD. Table 3 displays the frequency of usage for the always, very frequently, occasionally, rarely, very rarely, and never-used closed systems. The use of closed systems is represented proportionally by workplace (Figure 1 ) and regionally (Figure 2).

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Frequency of usage of Closed System** **N = 747** | **Always**  | **Very Frequently** | **Occasionally**  | **Rarely**  | **Very Rarely**  | **Never** | **Used**  | **Never used** |
| **During Preparation** | 54 (56%) | 6 (6%) | 5 (5%) | 1 (1%) | 5 (5%) | 26 (27%) | 71 (73%) | 26 (27%) |
| **During Administration** | 325(44%) | 95 (13%) | 49 (7%) | 19 (3%) | 33 (4%) | 226 (30%) | 521 (70%) | 226 (30%) |
| Used—Had experience using the closed system (includes frequency from always, very frequently, occasionally, rarely, very rarely).Never used- No experience using the closed system (includes only the Never category) |

**Table 3: Frequency ( % ) of Usage of Closed System**

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**Figure 1: Use of closed systems in workplace settings**



**Figure 2: Proportional Usage of Closed System per region**

**Perceived health issues:**

The survey participants reported perceived health issues experienced through an unbiased open-ended optional question. Eighteen per cent (n=161) of the survey participants reported perceived health Issues effects; ten male participants, 150 female participants, and one participant who remained anonymous. Sixty-four participants self-reported one health Issues effect; 66 participants self-reported more than one health Issues effect (2 health issues ), and 31 participants self-reported more than two health Issues (3 health issues). The reported perceived health Issues-effects by male participants were hair loss, headaches, skin rash, skin irritation, anxiety, and nasal congestion. In Figure three the perceived self-reported health issues are rated in frequency of reporting.



**Figure 3 Perceived self-reported health issues rated in frequency of reporting.**

The survey did not find a statistically significant difference in the perceived health issues reported using a closed system transfer device during administration. Perceived health issues were reported in the 35% never-used CSTD category (n=56), the 36% always-used CSTD category (n=58), and the 23% partially used CSTD category (n=36).

**Discussion:**

The results from this study contribute to the body of knowledge of practice in a sample of cancer nurses and their knowledge of hazards, safe handling precautions of CDs and perceived health issues from occupational exposure within the UK.

**Knowledge of hazard:** Participants in this study demonstrated a high level of knowledge, consistent with global findings (Borges et al., 2014; Hon et al., 2015; Callahan et al., 2016; Nwagbo et al., 2017; Srisintorn et al., 2021). However, Table 1 reveals some misunderstandings about the hazards of cytotoxic drugs (CDs) across the UK. Even a small gap in knowledge among a minority could lead to unsafe handling practices and potential occupational exposure—one case of exposure is one too many.

Notably, 98% of participants reported prior training, spanning accredited education and in-house programs, including UK Oncology Nursing Society (UKONS) training. This aligns with patterns seen in both UK and global studies (Polovich & Clark, 2012; Callahan et al., 2016; Silver et al., 2016; Deroy et al., 2017; Mahdy et al., 2017; Alehashem & Baniasadi, 2018; Simons & Toland, 2019; Srisintorn et al., 2021). In-house training practices reflect trends identified in global research (Shahrasbi et al., 2014; Hanafi et al., 2015; Tuna & Baykal, 2017; Alehashem & Baniasadi, 2018).

Training in this study is predominantly workplace-based rather than academically accredited. While this doesn’t imply workplace training is substandard, it highlights variation in organizational approaches—some rely on in-house programs, while others invest in higher academic qualifications for handling CDs. This variability underscores the need for further research to address standardization in safe handling practices across the UK.

**Safe handling Precautions:** The cancer nurses reported a high use of safe handling precautions. It is noted that the ‘plastic apron’ is the primary body protection with differing interpretations attached to the 'gloves for chemotherapy use’ versus ‘vinyl gloves’. The survey results for this study indicate that only 62% wore chemotherapy gloves during administration and 63% during the disposal of the CDs. These results suggest that the UK has a lower-than-average chemotherapy glove use, similar to Asefa et al. (2021), who stated that, in one hospital, 72.7% of nurses wear gloves when handling CDs. However, other studies highlight a higher use of gloves; Dejoy et al. (2017), with 87% of participants using chemotherapy gloves; He et al. (2017), 90% of participants used chemotherapy gloves. For this study, it may be worth stating that 'gloves for use with chemotherapy' may have yet to be universally understood or that people use ordinary gloves for chemotherapy administration. Further investigation is required to determine the detail of use. *Gowns for chemotherapy* are also noted as a standard by the USA Oncology Nursing Society (ONS 2024) whereas the ‘apron’ is the dominant PPE wear in the UK.

Respirators/masks were used by 50% (n=334) during the administration and 47% (n=292) during the disposal, which is different from other global studies, with only 7% wearing masks (Asefa et al.,2021; Benoist et al.,2022). The mask-wearing question in *knowledge of hazards* also showed diversity in the knowledge scores; this may have been confused with the recent use of wearing masks during the pandemic. It is worth stating that surgical masks do not provide respiratory protection from chemotherapy aerosol exposure. Air purifying respirators must be fit tested to ensure minimal exposure ( USP General chapter >800 2017).

**Closed System Transfer Devices**: This study highlights variable implementation of CSTDs across the UK, with some cancer nurses consistently using CSTDs while others never do. The reported percentages of consistent use (44%) and any use (70%) align closely with an American study by Menonna-Quinn et al. (2019), which reported 69% frequent use. However, these findings surpass the usage levels reported in Simons and Toland's (2017) UK study, which indicated a 44% usage rate overall.

While this study did not identify statistically significant correlations between perceived health issues and the use of CSTDs, the findings provide insight into current practices across the UK. According to the UK Health and Safety Executive (HSE), the directive is to "use totally enclosed systems where reasonably practicable" (HSE, 2020). This raises a critical question: if some health care settings and regions of the UK have implemented CSTDs, does this not demonstrate their reasonable practicability to implement across the UK to reduce occupational exposure risks for cancer nurses?

Although elimination and substitution are the gold standards in the Hierarchy of Controls, the next level of protection and risk reduction is the implementation of engineering controls, such CSTDs (Eisenberg & Klein, 2021). These controls are designed to contain or limit the release of cytotoxic drugs (CDs) into the workplace. Engineering controls are vital for creating a barrier between the hazard and the healthcare worker, significantly reducing the likelihood of exposure (Mead et al., 2017; Eisenberg & Klein, 2021).

In the ‘Hierarchy of Controls’, the use of CSTDs aligns with both engineering controls (creating barriers between workers and hazards) and, when integrated into pharmacy workflows, supports elimination by reducing exposure risks at the source. This is essential for protecting healthcare workers from potential health risks, including carcinogenicity, reproductive toxicity, and organ damage (Centres for Disease Control and Prevention [CDC], 2022).

Despite the variance in CSTD use across practice settings, the most recent guidance from EBN (2024) strongly advocates for CSTDs to be used universally from pharmacy preparation to administration, ensuring a consistent reduction in occupational exposure. This recommendation is further substantiated by Bernabeu-Martinez et al. (2021), who found that nurses using CSTDs still engaged in "spiking" infusion bags and attaching CSTDs to syringes just before administration—an identified exposure risk.

To truly integrate CSTDs within the Hierarchy of Controls, organizations must aim for elimination of exposure risks through comprehensive workflow integration, starting at the pharmacy level and continuing through to administration units. This approach minimizes risk at its earliest stage, safeguarding healthcare staff.

Additional research is necessary to evaluate closed system use, and the specific risks associated with "spiking" infusion bags in the UK. Furthermore, local risk assessments must be conducted to ensure consistency and alignment with safety standards nationwide. Implementing CSTDs universally is not merely a recommendation but a critical step toward prioritizing health and safety within the chemotherapy workflow system.

**Health Issues in CD Handling and Administration:** Perceived health issues reported by participants in this study align closely with findings from multiple global studies (Shahrasbi et al., 2014; Borges et al., 2015; Orujlu et al., 2016; Hanafi et al., 2017; He et al., 2017; Mahdy et al., 2017; Topcu et al., 2017; Tuna & Baykal, 2017; Batista et al., 2021; Soheili et al., 2021) and one UK-specific study (Simons & Toland, 2017). The predominant health issues observed were subcutaneous reactions and hair loss or thinning. Additionally, participants frequently reported concerns related to reproductive health, including pregnancy complications, fertility problems, foetal abnormalities, and hormonal imbalances. These reproductive and hormonal concerns mirror findings from other studies (Borges et al., 2015; Orujlu et al., 2016; Mahdy et al., 2017; Simons & Toland, 2017).

Notably, most individuals administering cytotoxic drugs (CDs) are women, who often navigate critical hormonal life stages such as menstruation, reproduction, and menopause. The majority of health issues were reported by participants aged 31 to 50. While women form the primary group affected, this study also highlights that men perceive health risks associated with handling CDs. Overall, 24% of participants reported health concerns related to their work.

Understanding the degree and scope of these perceived health issues requires further investigation to explore their complexity. Retrospective and prospective epidemiological studies are necessary to quantify the acute and long-term impacts of CD handling on the UK workforce. Additionally, research into potential workflow contamination, spanning from pharmacy to administration units, is critical.

The United States is proactively addressing similar issues by establishing a cancer nurse registry to collect cohort data (Clark, 2024). In the UK, the introduction of the UKONS digital passport (UKONS, 2024) presents an opportunity to gather anonymized, large-scale data. This initiative could help quantify the number of units and healthcare professionals involved in administering systemic anti-cancer treatments across the country. Such data could enhance understanding of clinical practices, ensure equitable access to personal protective equipment (PPE), and promote the consistent use of closed-system transfer devices (CSTDs) to mitigate exposure risks.

This study is part of a wider programme of research which will include a systematic review (Campbell et al 2024); an article of predicative factors associated with CD safe handling precautions and a qualitative article on the perceptions and experience of potential occupational exposure to CDs.

**Conclusion and Recommendations:**

This UK study reveals that variation exists providing somewhat adequate control and safety in the workplace; there is a high reported availability of guidance for practice but variation in practice for training. There is a commonality in using plastic aprons and gloves for the main PPE across the UK, but inconsistency of use CSTDs. The PPE use is not as robust, and under the requirements, against the global PPE or the European Biosafety Network CSTD guidance.

As there is a perception of staffs’ health being compromised, and in line with a number of global studies, with the reporting perceived health Issues-effects, there needs to be a focus on observing practice, risk assessment and environmental monitoring. Practice across the UK should be equitable for PPE and CSTDs. Standardised education pathways need to be explored to provide a consistent knowledge base for safe staff and patient care.

**Limitations:**

This study has a several limitations; the first limitation is that this is a small sample population in comparison to all the cancer nurses administering and disposing CDs across the UK. It does give us a picture of the practice that exist across the UK, and this is a platform for further research. The survey is a self-reported perception of knowledge of hazards, PPE and closed system use and health Issues-effects. To understand the complexity of administering and disposal of CDs future research must include exploration through observation of PPE use and risk assessment behaviours. Although the survey asked an open-ended question about perceived health issue this again was a self-reported activity and does not result in providing proof, as health Issues-effects can be associated with other environmental or workplace stressor.

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UK Oncology Nursing Society 2024

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