

# The Effectiveness of Washing Clothing Contaminated With Cyclophosphamide: A Pilot Study

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**BACKGROUND:** Measures to prevent exposure to anticancer drugs mitigate health hazards for caregivers, family members, and healthcare workers caring for patients with cancer. Previous studies have reported that anticancer drugs were detected on the linens of patients receiving chemotherapy.

**OBJECTIVES:** This pilot study investigated the effectiveness of the washing methods recommended by Japanese guidelines for linens contaminated with cyclophosphamide (CTX).

**METHODS:** This study used 15 shirts contaminated with 10 mg of CTX divided into three study groups washed with or without detergent, with or without an additional clean shirt. The CTX level on each shirt was measured after washing. Residual CTX levels on the shirts were compared to the measurable level of 1 ng/cm<sup>2</sup> as a criterion for evaluating efficacy.

**FINDINGS:** Washing a garment twice, as recommended in the Japanese guidelines, is effective in removing CTX contamination from clothing with or without detergent. However, contaminated garments should be washed separately from uncontaminated clothing.

## KEYWORDS

antineoplastic agents; body secretions; contaminated linens; washing methods

## DIGITAL OBJECT IDENTIFIER

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**ANTICANCER DRUGS HAVE BEEN ASSOCIATED** with various toxic effects (e.g., carcinogenesis, chromosomal aberrations, fetal malformations, infertility, miscarriage) in healthcare workers who prepare and administer the drugs (National Institute for Occupational Safety and Health, 2018). Because healthcare workers can be indirectly exposed to health hazards in the environment, the U.S. Pharmacopeial Convention (USP, 2020) has established procedures for occupational exposure prevention. Böhlandt et al. (2017) reported that platinum was detected in the urine of family members living with patients receiving chemotherapy. Accordingly, anticancer drug exposure is a critical problem for healthcare workers and family members of patients with cancer.

Fransman et al. (2007) investigated the contamination level of anticancer drugs on bedsheets used by patients receiving anticancer drugs. They found that 0.015–3.06 mcg/100 cm<sup>2</sup> of cyclophosphamide (CTX) was detected on 4 of 15 bedsheets. In addition, irinotecan and its active metabolite, SN-38, were detected in the sweat of patients treated with irinotecan (Irie et al., 2019). These findings suggest that anticancer drugs are excreted in sweat. The Oncology Nursing Society recommends washing linens that may have been contaminated with anticancer drugs twice using warm water, detergent, and bleach (Polovich & Olsen, 2018). In Japan, the *Guidelines for Preventing Occupational Exposure in Cancer Chemotherapy Drugs, 2019 Edition* (hereafter “the Japanese guidelines”) (Japanese Society of Cancer Nursing, Japanese Society of Medical Oncology, & Japanese Society of Pharmaceutical Oncology, 2019) recommend that evidently contaminated linens be separated from other laundry and washed twice by the patients themselves using detergent (see Table 1). In addition, the Japanese guidelines and the U.S. Occupational Safety and Health Administration (n.d.) suggest that contaminated laundry should be prewashed separately and then included with other laundry for a second wash.

Few studies have investigated effective washing methods for linens contaminated by anticancer drugs; therefore, there is insufficient evidence to support the established guidelines. In a previous study (Tanigawa et al., 2022), as much as 10 mg of CTX was detected on the sweat-contaminated shirts of patients who received high-dose CTX therapy as a conditioning regimen for hematopoietic stem cell transplantation (HSCT). However, whether