

BACKGROUND

PURPOSE

- Hazardous drugs (HDs) pose risks not only to patients receiving them therapeutically, but also to the health care personnel who compound, administer, transport, dispose, and/or otherwise handle them.^{1,2}
- Closed system transfer devices (CSTDs) allow HD manipulations to occur within a closed system, protecting health care workers from undue exposure and harm.
- Studies have shown that when CSTDs are used with standard open barrel syringes, cyclophosphamide, a commonly used HD, is detected on the syringe plunger during compounding or administration processes.³⁻⁵
- This contamination can then be transferred to the work environment, endangering workers.

- Measure the extent of hazardous drug (HD) contamination of the inner surface of standard open barrel syringes when used with closed system transfer devices (CSTDs).
- Establish evidence for HD contamination of the inner walls of regular syringes exposed to the environment.
- Compare the level of contamination between three commonly used HDs: 5-fluorouracil (5-FU), cyclophosphamide (CP), and ifosfamide (IF).

METHODS

RESULTS

- All testing was conducted in a hospital pharmacy setting for handling and preparation of hazardous drugs (e.g., cleanroom, BSC, PPE).
- Testing procedures are described in **Table 1**.
- BD PhaSeal™ CSTDs and BD 50 mL Luer-lock tip syringes were used during each of the preparations.
- ChemoGLO™ wipe kits were used for sampling the tested syringes.

- The average amount of **5-FU** detected by the ChemoGLO™ wipe kit for the 15 syringes tested was 1327.70 ng (SD = 873.63 ng).
- The average amount of **cyclophosphamide (CP)** detected was 1074.75 ng (SD = 481.6 ng).
- The average concentration of **ifosfamide (IF)** detected was 1700.04 ng (SD = 1098 ng).
- The positive controls for each drug resulted in measurements of > 4000 ng each.
- A Kruskal-Wallis Test performed on the data revealed that there was no statistically significant difference between the different drugs' level of contamination (P=0.144).

Figure 1: Average Amount of Drug Detected, with 95% CI

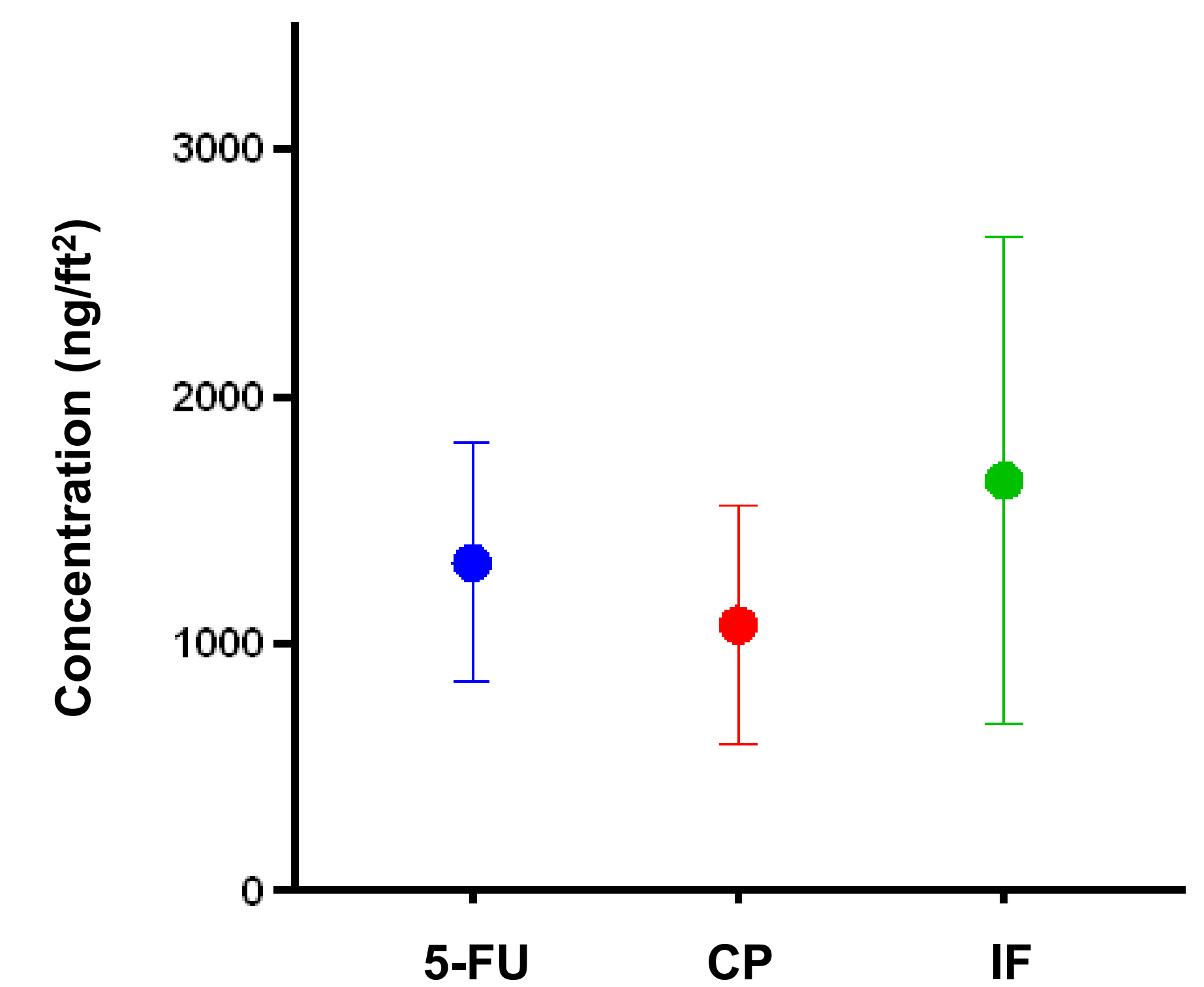


Table 1: Testing Procedures

Each of the following steps were performed in accordance with the CSTD manufacturer's instructions for use (IFU).

- The flip-cap was removed from the drug vial and a CSTD vial adapter was attached to the vial.
- A CSTD bag adapter was attached to an IV bag.
- 50 mL of air was drawn into a 50 mL syringe and a CSTD syringe adapter was attached to the syringe.
- The drugs requiring reconstitution (i.e., cyclophosphamide and ifosfamide), were reconstituted according to the instructions in the drug's package insert.
- The syringe containing 50 mL of drug was connected to the vial via the CSTD adapters. (**Image 1**)
- Air was injected into vial then the vial was inverted, and 50 mL of drug was withdrawn into the syringe.
- The syringe adapter was disconnected from the vial adapter and then connected to the IV bag adapter.
- The entire drug dose was injected into the IV bag and the syringe adapter disconnected from the IV bag adapter.
- A quarter of the plunger barrel knob was cut out to enable controlled and easy access to the syringe barrel and to allow for wiping the exposed inner wall of the syringe.
- A ChemoGLO™ wipe was pre-wetted in accordance with its IFU and inserted into the space between the plunger and the barrel.
- Using a wooden rod, the wipe was inserted deep into the rear opening of the syringe and wiped up and down the barrel of the exposed syringe barrel (one quarter of the entire barrel).
- The wipe was pushed all the way down to the bottom of the syringe in 1 of the 4 spaces, wiping the exposed inner wall of the syringe.
- The syringe plunger rod was rotated 90 degrees and the process repeated for a total of 4 times to ensure that the entire syringe barrel is wiped.
- The wipe was packed and labeled in accordance with instructions provided in the sampling kit. A second ChemoGLO™ wipe was repeated on the inner wall of the syringe.
- The testing procedure was repeated a total of 15 times with the same drug (15 x 1 = 15 replicates).
- The previous process was repeated for each of the 3 drugs.

Table 2: Contamination With 5-Fluorouracil, Cyclophosphamide, and Ifosfamide on Tested Syringe Barrels (ng/ft²)

Wipe Location	5-Fluorouracil Concentration (ng/ft ²)	Cyclophosphamide Concentration (ng/ft ²)	Ifosfamide Concentration (ng/ft ²)
Syringe 1	1,662.29	877.30	1,637.10
Syringe 2	2,411.89	1,108.02	1,062.15
Syringe 3	720.23	620.85	1,943.34
Syringe 4	1,257.67	744.70	926.88
Syringe 5	887.52	708.81	845.88
Syringe 6	199.59	1,386.07	1,285.05
Syringe 7	801.97	791.11	1,188.50
Syringe 8	3,731.95	2,039.90	1,591.12
Syringe 9	1,249.09	484.42	1,041.16
Syringe 10	1,789.35	973.05	709.21
Syringe 11	1,111.71	655.76	1,647.08
Syringe 12	1,095.19	2,012.71	1,881.12
Syringe 13	594.00	1,421.08	>4,000.00 (4631.92)
Syringe 14	649.02	1,377.40	3,805.78
Syringe 15	1,753.97	920.00	1,304.33
Average (±SD)	1327.70 (873.63)	1074.75 (481.63)	1700.04 (1098.09)
Positive Control	>4,000.00	>4,000.00	>4,000.00



Image 1 (left): A 50 mL open barrel syringe connected to a CSTD syringe adapter, which is attached to a CSTD vial adapter connected to a vial.



Image 2 (right): The open end of an open barrel 50 mL syringe, pictured with a set of ChemoGLO™ HDclean wipes.

CONCLUSION

DISCLOSURES, REFERENCES, & ABBREVIATIONS

- The detected amounts of each the three drugs (5-FU, cyclophosphamide, and ifosfamide) on the inner surface of standard open barrel syringes were high.
- Such levels of drug contamination are of concern since they could be transferred to the working environment and expose health care workers to harm.
- The results of this study provide evidence for contamination of the inner surfaces of standard syringes by multiple HDs after a single transfer of drug from vial to syringe to IV bag.

Project funding was provided by Equashield® SFE is a co-founder of ChemoGLO™

References:

- Whittaker C, Ovesen JL, MacKenzie BA, et al. *Procedures for developing the NIOSH list of hazardous drugs in healthcare settings*. Publication No. 2023-129, 2023. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH).
- Connor TH and McDiarmid MA. *CA Cancer J Clin* 2006;56(6):354-365.
- Favier B, Gilles L, Latour J-F, et al. *J Oncol Pharm Pract*. 2005;11(1):1-5.
- Smith ST and Szlachky MC. *J Oncol Pharm Pract*. 2014;20(5):381-385.
- Simon N, Vasseur M, Pinturaud M, et al. *PLoS One*. 2016;11(7):e0159052.

Select Abbreviations:

5-FU	5-fluorouracil
BD	Becton, Dickinson and Company
BSC	biosafety cabinet
CP	cyclophosphamide
CSTD	closed system transfer device
HD	hazardous drug
IF	ifosfamide
IFU	instructions for use
NIOSH	National Institute for Occupational Safety and Health
PPE	personal protective equipment