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***Research paper***

# Beyond The Mask: Lived Experiences and Psychosocial Impacts of Chemotherapy Drug Dispensing Personnel in High-Risk Clinical Settings

**Bingmin Wu [1], Sheilla M. Trajera [2], Gregory S. Ching [3]***

*[1] Graduate School, University of St. La Salle, Bacolod City 6100, Philippines Nursing School, Binzhou Medical University Hospital, Binzhou City 256603, Shandong Province, China*
*[2] Chair, Nursing and Education Programs at University of St. La Salle Graduate School Faculty, BSN, MN, MAN, and PhD in Nursing, University of St. La Salle, Bacolod City 6100, Philippines*
*[3] Faculty, Graduate Institute of Educational Administration and Policy, National ChengChi University, Taipei City 11605, Taiwan*
**Corresponding author E-mail: gching@nccu.edu.tw*

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**Abstract**

Healthcare professionals involved in dispensing intravenous chemotherapy drugs face significant risks from cytotoxic exposure, which can lead to both physical harm and psychological distress. Despite existing safety protocols, limited research has explored the personal and emotional challenges encountered by personnel in high-risk clinical environments. This study investigated the lived experiences of chemotherapy drug dispensing personnel within the context of occupational exposure. Using a qualitative descriptive phenomenological approach, ten participants from a tertiary hospital in Shandong Province, China, were purposively selected. In-depth interviews were conducted, and data were analyzed using Colaizzi's seven-step method. Five major themes emerged: (1) challenges related to occupational exposure safety, including operational risks, environmental constraints, and equipment deficiencies; (2) difficulties in implementing protective measures; (3) mental health struggles; (4) career development obstacles; and (5) coping and adjustment strategies. The findings highlight that occupational exposure affects not only physical well-being but also emotional resilience and professional trajectories. Participants emphasized the need for improved protective infrastructure, mental health support, and institutional recognition of the psychological burden of their work. The study concludes that occupational safety programs must address the comprehensive needs of chemotherapy drug dispensing personnel.

***Keywords***: *Occupational Exposure; Chemotherapy Drug Dispensing; Psychosocial Impact; Phenomenological Research; Healthcare Worker Safety.*

## 1. Introduction

Intravenous chemotherapy remains one of the most critical life-saving treatments for patients with various types of cancer. (Clapp et al., 2007; Hellmann et al., 2016; Pacheco et al., 2023). At the heart of this complex medical intervention are healthcare professionals who prepare and dispense chemotherapy drugs (Antúnez-Blancat et al., 2024; Zakaria et al., 2022). In most cases, these personnel, who are typically nurses, are in charge of administering cytotoxic agents, which are therapeutic for patients, but may pose significant health risks to those who administer them. (Chen et al., 2016; Fadhil & Hassan, 2018). Despite strict handling protocols, the daily responsibilities of these healthcare professionals involve potential exposure to harmful drug particles through accidental spills, skin contact, or inhalation. (Boiano et al., 2014), posing both physical and psychological risks.

While nursing stress has intensified since the pandemic (Condes et al., 2025; Jimenez et al., 2022; Tamon et al., 2025). Recent studies in China have highlighted an alarming frequency of occupational exposure among nurses working in intravenous chemotherapy settings. (Huang et al., 2022; Lihui Zhang et al., 2022; Zhang et al., 2016). While much attention has been given to physical safety, psychological distress, including anxiety, fear, and mental fatigue, remains an underexplored consequence of working with hazardous drugs. (Soheili et al., 2021; van Huizen et al., 2025). In reality, these persistent threat of exposure, coupled with high workloads and limited systemic support, heightens stress levels and potentially undermine both individual well-being and patient care quality. (Lin et al., 2025; Olorunfemi et al., 2024).

Although there are guidelines that emphasize the use of personal protective equipment (PPE) and safe-handling procedures, the accounts of chemotherapy drug dispensing personnel vary. The emotional toll, coping strategies, and long-term effects of working in such environments remain inadequately addressed in both research and institutional practice. Hence, this study seeks to foreground these experiences

to inform more holistic safety and support measures for oncology healthcare workers. To capture the multifaceted nature of occupational exposure, this study draws upon three complementary nursing theories: the Health Promotion Model (Aqtam & Darawwad, 2018; Pender et al., 2011), the Stress Appraisal and Coping Theory (Folkman, 2013; Lazarus & Folkman, 1984), and the Self-Care Deficit Nursing Theory (Masters, 2015; Orem, 1995). Together, these frameworks guide the exploration of how individuals perceive risk, adopt coping behaviors, and respond to institutional support systems in high-risk clinical settings. The conceptual framework also considers demographic factors, such as age, gender, education, and years of service, which may also shape how personnel experience and manage occupational challenges.

### 1.1. Research Objective

This qualitative study primarily aims to explore the lived experiences of healthcare professionals involved in the preparation and dispensing of intravenous chemotherapy drugs, particularly in the context of occupational exposure. It seeks to examine how these professionals perceive physical risk, experience emotional strain, and adopt coping mechanisms. Specifically, the research investigates their challenges with safety protocols, psychological responses to exposure, barriers to professional development, and the institutional factors that either mitigate or exacerbate their stress. Through this exploration, the study intends to generate actionable insights for improving safety standards, psychological support systems, and training programs in oncology healthcare settings.

### 1.2. Significance of the Study

This research offers critical insights for various stakeholders in healthcare. For nursing administrators and occupational safety personnel, the findings provide evidence for strengthening safety infrastructure and mental health resources. For chemotherapy drug dispensers and frontline nurses, the study gives voice to their struggles and affirms the need for institutional empathy and support. Healthcare policymakers can use the findings to develop or revise protocols that better address both physical and emotional dimensions of occupational safety. Finally, future researchers may find in this study a valuable foundation for longitudinal or intervention-based research aimed at improving the work lives and well-being of oncology healthcare workers. Ultimately, the study underscores the need for a more comprehensive and human-centered approach to occupational health in high-risk clinical environments.

## 2. Literature Review

**Intravenous Chemotherapy Drug Dispensing Personnel** - Intravenous chemotherapy drug dispensing personnel play a critical role in oncology care, contributing significantly to the safe and effective delivery of life-saving treatments for cancer patients (Fundytus et al., 2021; Galmarini et al., 2012). This occupation poses significant challenges. (Moore, 2023; Oyuku & Nshakira, 2025). However, as noted earlier, their occupational responsibilities expose them to numerous challenges, including hazardous drug exposure, the demand for strict protective measures, and psychological stress (Soheili et al., 2021). The succeeding sections of the literature review explore existing research on occupational exposure, protection strategies, and the psychological experiences of chemotherapy drug dispensing personnel, highlighting current gaps and areas for further inquiry.

**Occupational Exposure to Hazardous Drugs** - Occupational exposure to cytotoxic agents has long been recognized as a critical safety concern in clinical oncology settings. The study noted that risks are mostly related to chemotherapy drugs and the importance of strict adherence to safety protocols to mitigate exposure. (Connor et al., 2014; Coyne et al., 2019). Polovich (2016) Highlighted how exposure during drug preparation and administration can result in acute reactions and long-term health issues, reinforcing the need for a comprehensive understanding and training among infusion nurses. Similarly, Gerding et al. (2022) Noted that while many antineoplastic agents are genotoxic by design, there is currently no standardized model to assess the long-term cancer risk for healthcare professionals who handle these substances. In China, the risk remains high, particularly among nurses working in the intravenous chemotherapy preparation units. (Li et al., 2023). Studies have noted that, besides the lack of public information or knowledge regarding cancer. (Zhu et al., 2025)Oncology nurses are suffering from occupational stress and burnout. (Ma et al., 2023), including compassion-related stress (Xie et al., 2021), which usually affects their work safety.

**Protection Strategies and Measures** - To reduce occupational exposure, the use of PPE, safety protocols, and technological innovations has been promoted. Studies have examined the effectiveness of PPE and stressed the need for ongoing training and proper usage as essential components of exposure prevention. (Paterson et al., 2020; Rahman, 2022). Some expanded on this by emphasizing the broader context of occupational cancers, noting that exposures, especially in industries such as healthcare, construction, and mining, are frequently underestimated and difficult to isolate from environmental factors. (Senarath et al., 2025). While continued monitoring and institutional oversight were recommended to better protect at-risk personnel. Additional evidence supports the role of system-level infrastructure in exposure reduction. Studies have evaluated radiation exposure in a Positron Emission Tomography/Computed Tomography (PET/CT) center and found that structural shielding and protective procedures significantly minimized staff radiation doses. (Omer et al., 2023; Portela et al., 2021), illustrating how environmental and engineering controls can effectively limit occupational risk. Across studies, PPE's effectiveness is often tempered by feasibility: sustained use during peak workloads and thermal/ergonomic burden depresses adherence, even when knowledge is high. Similarly, pharmacy automation shows safety and capacity gains but can lengthen cycle time and shift error profiles from manual technique to system configuration/verification. These contrasts suggest multi-level solutions that combine behaviorally realistic PPE policies with selective automation and strong quality controls.

**International Practice Variation and Exposure Risk** - Across international evidence, chemotherapy exposure risk is shaped by a mix of individual, organizational, and cultural factors. An integrative review of studies done in the United States pinpoints four consistent predictors: nurses' guideline knowledge, adherence to PPE, health beliefs about exposure, and workplace conditions (workload, managerial support) (Abu-Alhaija et al., 2023). While a global mixed-methods review of cancer nurses adds that what clinicians espouse as safe practice often diverges from what is observed in real settings, with experiences operating at individual, shared, and cultural levels, which underscores the need for observation-based risk assessment and organizational responsiveness (Campbell et al., 2024). Complementing these, a large Thai survey ($n = 884$) quantifies drivers of PPE use: higher self-efficacy and a stronger safety climate (and, for assistants, interpersonal influence) predict better protection, whereas conflicts of interest depress adherence. (Srisintorn et al., 2021). Together, the studies argue for combined strategies: skill/knowledge building, belief-targeted cues, and system-level fixes that strengthen safety climate and reduce workload barriers. Because espoused safe practice often diverges from observed behavior, observation-based audits and risk assessments, not self-report alone, are essential to surface gaps and tailor interventions.

**Anxiety and Psychological Impact** - Beyond physical exposure, psychological stress is an equally critical concern. The fear of exposure, coupled with the responsibility of handling toxic substances, may lead to heightened anxiety and emotional distress. Li et al. (2017) Documented the emotional toll experienced by chemotherapy drug dispensers, noting prevalent feelings of fear and unease in response to occupational hazards. While Zendeh et al. (2022) Emphasized the need for supportive work environments and access to mental health resources to reduce the psychological burden. Importantly, a recent meta-analysis of fifteen studies suggests that mindfulness-based interventions can moderately reduce nurses' stress and alleviate burnout (lower emotional exhaustion/depersonalization, higher personal accomplishment), but show little to no effect on anxiety or depression. (Wang et al., 2023), denoting the complexity of the nursing occupation. Lastly, it was also noted that the perceived efficacy of protective measures significantly influenced anxiety levels, which implies that workers who felt more in control reported lower stress levels, underscoring the importance of perceived safety. (Zhang et al., 2024).

**Support Systems and Interventions** - Given the emotional toll of the work, several interventions have been proposed. Wang et al. (2023) Introduced mindfulness-based stress reduction strategies for healthcare professionals, including those working with chemotherapy drugs. Their findings indicated that mindfulness practices could reduce stress, foster resilience, and enhance overall well-being in high-risk healthcare settings. Importantly, advances have been made in automated systems, wherein storage and drug picking errors are minimized. (Ouedraogo et al., 2020). More recently, automated systems with automated drug verification and dispensing have been utilized. (Perego et al., 2022), however, there are issues of medication waste and the need to improve the overall quality control to safeguard the patients (Lombardo et al., 2022). As such, drugs can be considered a dangerous compound. (Domingo-Echaburu et al., 2022), utmost careful procedure must be observed.

**Current Advances in Drug Dispensing** - Recent evidence on automated robotic compounding and dispensing of hazardous parenteral drugs suggests meaningful, but context-dependent gains in throughput and safety, with mixed effects on accuracy and cycle time. In a multicenter time-and-motion study, a study reported that fully robotic compounding shortened the end-to-end process versus manual (from more than 9 minutes to less than 7 minutes) (Geersing et al., 2024). In addition, the implementation data from a community cancer center showed that APOTECAchemo, a robotic system that automates the complex process of preparing intravenous chemotherapeutic drugs, was widely adopted with a lower failure rate than manual preparation, though average preparation time was longer, and the absolute dose error percentage was slightly higher for the robot. (Cho et al., 2024). Similarly, a clinical comparison further indicated that intelligent drug robots reduced residual drug, dispensing errors, and needle-stick injuries, while improving overall safety and efficiency. (L. Zhang et al., 2022). Complementing these empirical findings, a sector-wide review maps the expanding roles of robotics across surgery, telepresence, rehabilitation, sanitation/logistics, and pharmacy services, highlighting how advances in AI and automation can offload repetitive/high-risk tasks but require careful integration and evaluation. (Li, 2024). Together, this literature supports robotics as a viable strategy to mitigate occupational risk and staffing pressure, with trade-offs in setup time and accuracy metrics that warrant site-specific evaluation and hybrid workflow design.

**Synthesis** – Overall, the current literature demonstrates that intravenous chemotherapy drug dispensing personnel face significant occupational challenges, ranging from hazardous exposures to emotional distress. While research has emphasized the need for PPE and adherence to protocols, empirical gaps remain, particularly concerning the psychological experiences and long-term health implications of occupational exposure. In China, physical and psychosocial exposure are particularly prevalent, suggesting the need for targeted interventions. Furthermore, although protective strategies have evolved, there is limited evidence evaluating nurses' effectiveness in practice. The psychological dimension, including anxiety and the perceived adequacy of safety measures, continues to be under-addressed in workplace policies. Mindfulness and other support systems offer promise, but broader institutional efforts are necessary to foster both physical safety and emotional resilience. In sum, the current body of research points to an urgent need for more holistic, evidence-based approaches to protect and support chemotherapy drug dispensing personnel. Exploring their experiences can guide improvements in occupational health policies, training, and mental health services; ultimately ensuring safer and more sustainable oncology care environments.

# 3. Methodology

## 3.1. Study Design

This study employed a qualitative descriptive design grounded in a descriptive phenomenological approach to explore the lived experiences of intravenous chemotherapy drug dispensing personnel in relation to occupational exposure, protective practices, and psychological challenges such as anxiety. Participants for the current study were selected from tertiary comprehensive hospitals in Shandong Province, China, with a target sample size of 8 to 10 individuals. Phenomenology, as a philosophical and methodological approach, aims to uncover the essence and meaning of experiences through direct description and interpretation. (Mapp, 2008). It emphasizes intuitive and subjective understanding, focusing on how individuals perceive and relate to particular phenomena in their environment. Descriptive phenomenology, in particular, allows for a rich, detailed examination of experience as it is lived, without imposing theoretical interpretations. (Creswell & Poth, 2018). Lived experience studies have helped to capture various nursing issues, such as nursing students' learning experiences. (Abalona et al., 2025), nursing educators' pedagogical evaluations (Rimando et al., 2025) and challenges (Villaran et al., 2025), and even medical practitioners' encounters during the pandemic (Sypongco et al., 2025; Tamon et al., 2025). Hence, this approach was appropriate for the current study, which sought to explore and document the real-life experiences of healthcare professionals working with hazardous chemotherapy drugs.

To gather data, the study utilized in-depth, semi-structured interviews as the primary method of data collection. Each interview lasted between 30 minutes to one hour and was conducted in a one-on-one format to create a safe, open environment for participants to share their thoughts and emotions. In-depth interviews are particularly effective in phenomenological research, as they enable researchers to explore participants' perspectives, beliefs, and motivations in detail. (Creswell & Creswell, 2018). Through this method, the study aimed to uncover the psychological and occupational challenges faced by chemotherapy drug dispensing personnel, including their perceptions of risk, adherence to safety protocols, and emotional responses such as fear, stress, or anxiety. The insights gained from these narratives are intended to inform strategies for improving workplace safety and mental health support systems.

## 3.2. Participants

For the current study, intravenous chemotherapy dispensing personnel from a provincial tertiary Grade A comprehensive hospital were purposively selected (Naderifar et al., 2017). All participants were over 18 years old and no longer required parental consent. To be eligible, participants had to meet the following inclusion criteria: (1) be a licensed intravenous chemotherapy dispensing nurse with a national practice certificate; (2) have had direct involvement in the preparation and administration of intravenous chemotherapy drugs to cancer patients; (3) have experienced occupational exposure within the past five years; (4) have at least five years of work experience in their current role; and (5) be willing to participate in and share their lived experiences. Exclusion criteria included: (1) medical staff on rotation, vacation, or attending further education; (2) individuals who withdrew during data collection or could not complete the interview; and (3) those diagnosed with psychological disorders such as depression or anxiety at the time of data collection.

The sample size was determined based on data saturation, defined as the point at which no new themes emerged during analysis. (Fusch & Ness, 2015). It was estimated that 8–10 participants would be sufficient to capture a comprehensive range of experiences related to occupational exposure, safety practices, and emotional responses. Participants were identified through departmental supervisors who disseminated a study information email. Eligible and interested individuals were invited to contact the researchers directly. Recruitment was entirely voluntary, and no participants were compelled to join. To respect confidentiality, participants were coded based on their interview sequence. Before each interview, participants were informed that the sessions would be audio-recorded and photographed with their permission. To express appreciation, a small token of gratitude was offered to each participant during the interview.

The rationale for selecting a provincial tertiary hospital was based on the following considerations:

- High clinical exposure risk: These hospitals have advanced cancer treatment facilities and high chemotherapy usage, making occupational exposure more frequent and relevant.
- Professional representativeness: Personnel in such settings typically demonstrate high levels of expertise, allowing for a rich and varied understanding of occupational challenges.
- Regional significance: Shandong's developed medical infrastructure allows findings to be more generalizable to other urbanized or high-volume healthcare systems in China.
- Policy impact: Insights from high-risk, high-volume institutions can better inform nationwide improvements in occupational safety and mental health support systems.

This targeted, theory-informed sampling strategy ensured that the study generated valid, reliable, and meaningful insights into the real-world experiences of chemotherapy drug dispensing professionals.

As shown in Table 1, the study included ten (10) participants, all of whom were female intravenous chemotherapy drug dispensing personnel working in a tertiary hospital in Shandong Province, China. Participants ranged in age from 28 to 43 years, with a mean age of approximately 35.6 years. Most participants were married (7 out of 10), while the remaining three were unmarried. In terms of educational background, the majority (9 participants) held a bachelor's degree, while one participant (P4) had obtained a graduate degree. The participants' years of service in chemotherapy drug dispensing roles ranged from 6 to 17 years, with an average of approximately 11.3 years, reflecting substantial professional experience in oncology-related nursing roles. This diverse range of ages, marital statuses, and years of service, combined with consistency in professional background, ensured a rich and representative set of perspectives on occupational exposure, safety practices, and psychological challenges associated with their work.

**Table 1:** Background Demographics of the Participants

| Participant (Pseudonyms) | Age | Gender | Marital Status | Education | Years of Service |
|---|---|---|---|---|---|
| P1: Emelee | 31 | Female | Unmarried | Bachelor | 6 |
| P2: Leanne | 43 | Female | Married | Bachelor | 17 |
| P3: Diana | 28 | Female | Unmarried | Bachelor | 6 |
| P4: Madonna | 36 | Female | Married | Master's | 15 |
| P5: Geena | 37 | Female | Married | Bachelor | 12 |
| P6: Joeann | 40 | Female | Married | Bachelor | 15 |
| P7: Cici | 28 | Female | Unmarried | Bachelor | 6 |
| P8: Bella | 40 | Female | Married | Bachelor | 13 |
| P9: Serenity | 37 | Female | Married | Bachelor | 12 |
| P10: Michelle | 38 | Female | Married | Bachelor | 11 |

## 3.3. Instrument

This study employed a set of carefully selected qualitative research instruments, including researcher-developed tools and digital equipment, to ensure the comprehensive collection of experiential data. Instruments included: a general information questionnaire, a semi-structured interview guide, interview logs, notebooks, recording pens, signature pens, cameras, and laptops. All tools were tested for functionality before each interview to ensure uninterrupted and accurate data collection.

**General Information Questionnaire** - The general information questionnaire was designed to collect demographic and contextual background data relevant to the participants' professional and personal experiences. Developed based on a comprehensive literature review and consultation with the research team, the questionnaire included the following domains:

- Demographics: age, gender, educational background, marital status
- Professional background: job title, operating duties, years of service, work environment
- Occupational exposure: type and frequency of exposure, perceived risks, health symptoms, exposure reporting behavior
- Protection and training: use and perceived effectiveness of protective equipment, training, and continuing education received
- Psychosocial responses: emotional and psychological impact, stress levels, coping strategies, support systems
- Suggestions and reflections: views on safety protocols, needs for improvement, and prospects

This instrument allowed researchers to contextualize the first-hand accounts shared during the in-depth interviews.

**Semi-Structured Interview Guide** - To explore participants' experiences in greater depth, a semi-structured interview guide was developed and refined through a two-phase process: (1) content validation by 2–3 domain experts, and (2) two pre-interviews with qualified intravenous chemotherapy dispensing personnel. Revisions were made based on expert feedback and pilot interview results to ensure clarity, relevance, and alignment with the study's research objectives. The interview was guided by one central, open-ended question:

- What has been your experience as a nurse administering intravenous chemotherapy drugs to your patients?

To encourage rich and detailed responses, the following probing questions were used:

- Can you talk about your occupational exposure history?
- How did you handle the exposure when it occurred?
- What were your thoughts and emotional reactions afterward?
- Why do you think you felt that way?
- What kind of support did you need the most during or after the incident?
- How long did the experience affect your work or personal life?
- In your view, what was the main reason for this occupational exposure?
- What protective measures do you use during the preparation and dispensing of chemotherapy drugs?
- How effective do you think these measures are in reducing exposure?
- How did you cope with the emotional impact of occupational exposure, especially considering potential long-term health risks?
- If there had been no occupational exposure and full protective measures were in place, how would your work experience have been different?

This guide ensured consistency across interviews while allowing flexibility for participants to share unique perspectives and stories. The data collected through this process formed the basis for the phenomenological analysis of the participants' narratives.

### 3.4. Data-gathering Procedure

The data collection process for this study followed a structured and ethically sound approach to ensure the integrity and richness of qualitative data. (Creswell, 2009). Data were gathered through in-depth, one-on-one interviews with intravenous chemotherapy drug dispensing personnel, following comprehensive preparation and adherence to research ethics.

**Interview Preparation** - Before the interviews, participants were contacted to schedule a mutually convenient time and location. Interviews were conducted during the participants' non-working hours to minimize disruption and ensure their comfort. A private office space within the hospital, approved by the nursing department, was designated for the interviews to ensure confidentiality and a quiet environment. Participants were asked whether they had received formal training in chemotherapy drug handling before assuming their current roles. Before the interview, informed consent was obtained from each participant, including consent for audio recording and photography. Participants were fully briefed on the purpose, content, and voluntary nature of the study. To ensure the quality and consistency of the interviews, the research team received training in interviewing techniques, active listening, and non-verbal observation.

**On-site One-on-One Interviews** - Each interview was conducted face-to-face in accordance with COVID-19 health and safety protocols, including mask-wearing, hand hygiene, and pre- and post-interview disinfection of the interview space. At the start of each session, the researcher introduced themselves, reiterated the purpose and confidentiality of the study, and created a relaxed, respectful atmosphere to encourage open dialogue. Using the semi-structured interview guide, participants were encouraged to speak freely about their experiences. The interviewer followed the guide flexibly, allowing for changes in the question order based on the flow of conversation. When unclear or noteworthy responses emerged, gentle probing questions were asked for clarification, without interrupting participants' natural expressions. The interviewer maintained a neutral, non-judgmental stance throughout and paid close attention to non-verbal cues such as facial expressions and body language, which were noted in an interview logbook. Each interview lasted approximately 30 to 60 minutes, depending on the participant's availability and willingness to share. At the end of each session, participants were invited to provide additional thoughts or clarifications. They were assured of the confidentiality and anonymity of all data, and the researcher left their contact information in case participants wished to add further reflections later.

**Data Handling and Transcription** - Audio recordings were reviewed immediately after each interview, and verbatim transcriptions were completed within 24 hours to preserve accuracy. Non-verbal data, such as tone, pauses, facial expressions, and body language, were also annotated in the transcripts. All transcripts were de-identified and assigned codes to protect participant confidentiality. The anonymized text data were then imported into NVivo 12 qualitative analysis software for systematic organization, coding, and analysis. This process enabled the identification of emerging themes and patterns, forming the basis for phenomenological interpretation.

### 3.5. Data Analysis Procedure

The data collected from the in-depth interviews with intravenous chemotherapy drug dispensing personnel were analyzed using Colaizzi's (1978) Seven-step descriptive phenomenological analysis method. This method is particularly suited for uncovering the essence of lived experiences, allowing for a deep exploration of the psychological and occupational challenges associated with chemotherapy drug exposure. The analysis focused on identifying key statements related to occupational exposure, protection strategies, and especially psychological reactions such as anxiety, as shared by the participants. Below is Colaizzi's seven-step analysis process undertaken within the current study.

**Familiarization** - The researcher repeatedly listened to the recorded interviews and transcribed the audio data within 24 hours of each session. Observational notes, including facial expressions and gestures recorded in the interview logbooks, were used to enhance contextual understanding. This step aimed to immerse the researcher in the data and grasp the overall meaning of the participants' experiences.

**Identification of Significant Statements** - Transcripts were carefully reviewed to extract significant statements, such as words, phrases, and sentences directly related to the participants' experiences of occupational exposure, protective practices, emotional responses, and coping mechanisms.

**Formulation of Meanings** - The extracted statements were condensed into meaningful units. During this stage, the researcher practiced epoché, the bracketing of personal bias, to suspend preconceptions and interpret participants' descriptions as faithfully as possible.

**Clustering of Themes** - The meaning units were then organized into clusters of themes. Original statements were revisited to ensure that the emerging themes remained grounded in the participants' narratives and represented their experiences authentically.

**Exhaustive Description** - Thematic clusters were expanded into a rich, textual description of the phenomenon, incorporating direct quotes to retain the voice of the participants and illustrate the nuances of their lived experiences.

**Formulation of the Fundamental Structure** - The various themes were synthesized into an overarching essential structure of the experience. Recurrent patterns, common challenges, and shared emotional responses were distilled into core descriptive statements.

**Validation by Member Checking** - The final thematic structure and interpretation were returned to the participants via email for member checking, allowing them to verify whether the analysis accurately reflected their experiences. Feedback was solicited up to three times within two days. Any discrepancies or suggested revisions were considered, and modifications were made to ensure alignment with participants' perspectives. This process reinforced the authenticity and credibility of the findings.

To ensure the rigor and trustworthiness of this qualitative study, the following strategies were employed based on Lincoln and Guba's (1985) Criteria.

- Credibility: Purposive sampling with maximum variation ensured that a broad range of experiences was represented. Interviews were documented using detailed field notes, audio recordings, and transcription. Member checking was conducted to confirm the accuracy of interpreted results.
- Dependability: Two researchers trained in qualitative methods independently coded the data and extracted themes. Any discrepancies were discussed and resolved through consultation with medical and nursing experts to enhance the stability and consistency of findings.
- Confirmability (Consistency): All the researchers maintained objectivity through bracketing and reflexivity. No leading questions or personal interpretations were introduced during interviews. Data were anonymized and analyzed with attention to neutrality. All steps in the analytical process were reviewed and audited by the research team.
- Transferability: Thick description was employed throughout the research process, including a detailed account of the research setting, participants, procedures, and analytical methods, enabling readers to assess the applicability of the findings to other clinical or cultural contexts.

### 3.6. Ethical Considerations

The protocol of this study was reviewed and approved by the Research Ethics Review Committee of the University of St. La Salle (USLS) under protocol code STUD-YIBU-004.24-25.T1.GRAD and the Research Department of Binzhou Medical University Hospital, ensuring adherence to established ethical standards in human research. All procedures complied with the ethical principles of respect for persons, beneficence, and justice.

**Informed Consent and Voluntariness** - Participation in this study was entirely voluntary. Before each interview, the researcher clearly explained the purpose, significance, procedures, and potential outcomes of the study, including how the data would be analyzed and presented. Participants were asked to sign an informed consent form after receiving this information. The form outlined the study's objectives, potential risks and benefits, confidentiality assurances, and the participant's right to withdraw at any time without penalty. Participants were assured that no individual results would be shared with hospital administrators and that any responses deemed too personal or uncomfortable could be skipped or withdrawn at any point. Participants also had the opportunity to review and verify their interview transcripts, ensuring accuracy and transparency in the interpretation of their experiences.

**Minimizing Risk and Protecting Well-being** - Potential risks associated with participation included psychological discomfort, emotional distress due to the recollection of past occupational exposure incidents, or perceived pressure to disclose sensitive information. To mitigate these risks, the study followed several safety measures: (1) Interviews were conducted in a secure, private space approved by the hospital, (2) Participants could decline to answer any questions or stop the interview at any time, (3) Participants who became distressed during the interview were offered referrals to qualified mental health professionals for support, (4) Strict adherence to health and safety protocols (e.g., mask-wearing, disinfection) ensured physical safety during face-to-face sessions, and (5) Participants were also made aware of the potential benefits of the study, including its aim to improve occupational safety, inform institutional policy, and enhance psychosocial support for healthcare professionals handling chemotherapy drugs.

**Confidentiality and Data Security** - The confidentiality of participants was protected throughout the research process. Interview data were anonymized through coding and stored securely in a password-protected Google Drive accessible only to the research team. All audio recordings, transcripts, and related documents will be retained for two years following the completion of the study and then permanently deleted. No identifying information will appear in published reports or presentations. All participant data, including images and recordings, will be handled in accordance with data protection regulations and ethical guidelines.

**Ethical Integrity and Fair Treatment** - This study strictly adhered to principles of fairness and non-discrimination. Participants were treated with equal respect regardless of age, gender, ethnicity, or socioeconomic status. The social benefits of the research, including the potential improvement of occupational safety standards, were not in conflict with the researcher's interests. The study was designed to contribute positively to the field of occupational health in oncology, with findings that may inform the development of targeted safety protocols, educational programs, and mental health interventions for intravenous chemotherapy drug dispensing personnel.

## 4. Results and Discussions

Five major themes emerged based on the statements of ten participants: (1) challenges related to occupational exposure safety; (2) difficulties in implementing protective measures; (3) mental health struggles; (4) career development obstacles; and (5) coping and adjustment strategies.

### 4.1. Theme 1: Occupational Exposure Safety Challenges

The theme captures the firsthand accounts of intravenous chemotherapy drug dispensing personnel regarding their encounters with various risks in high-pressure clinical environments. Three subthemes emerged from the interviews: (1a) operational risk, (1b) environmental limitations, and (1c) equipment defects. These categories reflect the multifaceted nature of exposure hazards in oncology nursing and align with previous literature on the physical and psychological tolls of working with cytotoxic substances.

**Subtheme 1a**: Operational Risk

This subtheme captures task-level errors or deviations from standard operating procedures, such as technique lapses, skipped PPE steps, poor connection/aspiration technique, and disposal mistakes, that directly raise exposure risk. Participants consistently described high operational risk as a leading contributor to occupational exposure. These risks stemmed from non-standardized procedures, inadequate risk awareness, and defects in handling tasks under pressure. Emelee shared, "*In the process of preparing hazardous drugs, due to non-standard operating procedures or failure to strictly follow safety operating procedures, it is easy to be exposed to occupational hazards.*" Similarly, Bella noted that "*unskilled operation*" and distractions from personal issues like family concerns could affect concentration, leading to exposure events. These narratives resonate with studies showing that procedural lapses in drug handling increase contamination risk. For instance, Connor et al. (2014) and Polovich (2016) Emphasized how improper techniques during chemotherapy preparation heighten the likelihood of environmental contamination. Moreover, as Coyne et al. (2019) Observed, risk is compounded when staff are unaware of cytotoxic handling protocols, aligning with Cici's reflection: "*Lack of protective awareness and failure to wear two layers of masks may cause inhalation of hazardous drug gases*."

The operational risks also extended to needle stick injuries, poor quantitative control, and deficient waste disposal practices. Diana advised, "*Aspirate 3/4 of the syringe's volume of medication… and tightly connect the needle to prevent detachment.*" Serenity also echoed that "*time pressure leads to accelerated speed, which can also lead to occupational exposure*." These statements reflect what Zhang et al. (2022) noted, which they noted how occupational stress and burnout among nurses correlate with increased risk of procedural errors. Improper connection of equipment and waste management were also cited as significant issues, with Joeann stating, "*Loose connection of the syringe needle may cause splashing of medication,*" and Madonna adding, "*Hazardous pharmaceutical and medical waste, if not handled correctly, continues to release residual drugs into the operating environment*." Thus, consistent with the literature (Soheili et al., 2021; Zhang et al., 2016), which noted the poor procedural standards, weak risk perception, and rushed working conditions in oncology settings directly increase exposure risk, while compounding psychological stress and anxiety among personnel. These are performance problems at the point of work; correctable by coaching, checklists, and real-time feedback. More specifically, these failures are amenable to micro-interventions: just-in-time coaching, visual checklists, buddy checks, and feedback loops.

**Subtheme 1b**: Environmental Limitations

Another major safety challenge highlighted by participants involved the physical and spatial limitations of their work environment. Specifically, they cited inadequate workspace, inefficient air purification, and unsafe environmental controls as major contributors to occupational exposure. Geena shared, "*The table size is not sufficient. When laying mats and opening ampoules to place injections, they cannot be placed on the mat, but on a flat table to avoid ampoules tipping over.*" Michelle also noted, "*The space on the operating table is small when configuring docetaxel… too many ampoules placed at once*." Such constraints mirror findings by Paterson et al. (2020), who emphasized the role of spatial inefficiency in reducing environmental safety. Limited airflow and crowded surfaces are particularly concerning, given that studies like those of Omer et al. (2023) which shows that chemotherapy drugs can become airborne and accumulate in poorly ventilated areas.

Participants also described suboptimal exhaust systems and airflow issues, contributing to aerosol exposure. Madonna remarked, "*Although the exhaust operation is carried out downwards, drug aerosols still diffuse into the environment*." Similarly, Geena highlighted that "*Improper disposal of discarded half tubes can cause them to evaporate into the air.*" These experiences align with the assertion that environmental controls must integrate air purification systems, laminar airflow cabinets, and proper waste sealing. Joeann further noted, "*Operating in a secondary biosafety cabinet effectively blocks aerosol diffusion*," yet voiced concern about inconsistent adherence to such protocols. The participants' concerns reflect broader systemic issues identified by Senarath et al. (2025), who stressed the need for consistent institutional enforcement of environmental safety standards. Poorly maintained ventilation and cluttered storage areas not only elevate physical exposure but also increase psychological stress due to the perceived lack of control; these factors are directly linked to higher anxiety levels in hazardous clinical settings. (Zendeh et al., 2022; Zhang et al., 2024).

**Subtheme 1c**: Equipment Defects

Participants also highlighted equipment defects, particularly related to biological safety cabinets, protective gear, and packaging design, as significant contributors to occupational exposure risk. Emelee remarked, "*Biological safety cabinets may malfunction or age over time, which may lead to a decrease in purification system efficiency and increase occupational exposure risks*." Aging or malfunctioning equipment compromises the structural barriers that are meant to protect personnel from direct drug exposure, a concern reinforced by the literature (Omer et al., 2023; Rahman, 2022). In addition, several participants described challenges with glove integrity and replacement timing. Michelle explained, "*Failure to change gloves promptly when time is tight*" contributes to increased risk. Geena added, "*Inadequate protection or insufficient cleaning of the countertop*" posed additional threats. These issues reflect the broader findings of studies such as Wang et al. (2023), which emphasizes the role of standard protective equipment (e.g., gloves, gowns) in both physical protection and psychological reassurance. If equipment is perceived to be inadequate or unreliable, it contributes to emotional distress and perceived vulnerability.

Another frequently cited concern was the fragility and unsafe design of drug packaging, particularly ampoules. Emelee recommended switching from ampoule packaging to penicillin bottles, noting that "*ampoule breaking causes glass splashing and increases risk*." Furthermore, Madonna, Cici, and Serenity all shared concerns about drug spillage and transport damage resulting from poorly designed packaging. This is consistent with observations by Zhang et al. (2022) That stress in oncology settings arises not only from the drugs themselves but also from systemic and technical vulnerabilities that undermine worker confidence. Substandard packaging, aging cabinets, and time-pressured workflows form a constellation of risk factors that elevate both exposure and psychological burden.

Overall, the safety challenges described in Theme 1, ranging from procedural lapses and environmental constraints to equipment defects, can be meaningfully interpreted through the lens of the study's three theoretical frameworks. From the perspective of the Health Promotion Model (Pender et al., 2011)The findings highlight how limited risk awareness and inconsistent adherence to safety protocols reflect perceived barriers to protective behavior, which may undermine the motivation to engage in health-promoting actions such as consistent use of PPE or proper waste disposal. Meanwhile, the Stress Appraisal and Coping Theory (Folkman, 2013; Lazarus & Folkman, 1984) Explains how participants' heightened anxiety and sense of vulnerability arise from their appraisal of the work environment as threatening, especially when faced with malfunctioning equipment or inadequate environmental controls. The coping responses varied, with some participants adjusting their routines, while others expressed helplessness, indicative of both problem-focused and emotion-focused coping processes. Finally, the Self-Care Deficit Nursing Theory (Masters, 2015; Orem, 1995) Is evident in how system-level failures, such as aging biosafety cabinets and insufficient training, contribute to deficits in nurses' ability to maintain self-protection, thereby requiring institutional support to meet their self-care needs. Together, these frameworks contextualize the occupational exposure risks not only as physical safety issues but also as complex interactions of motivation, stress, and institutional care dynamics.

## 4.2. Theme 2: Challenges in Implementing Protective Measures

Theme 2 addresses the conditions of work, such as time, space, airflow, and supplies, rather than how individuals perform procedures. Participants revealed a range of challenges related to implementing protective measures against occupational exposure. Two subthemes emerged: (2a) Operational Barriers and (2b) Execution Difficulties. These issues highlight the gap between institutional safety guidelines and the realities faced by intravenous chemotherapy drug dispensing personnel. Whereas Theme 1a (Operational risk) centers on how tasks are performed (human-factor and procedure lapses), Theme 2b (Execution difficulties) focuses on the conditions under which tasks unfold (time pressure, space/layout, supply and equipment constraints) that make correct performance harder.

**Subtheme 2a**: Operational Barriers

Several participants described insufficient protection due to improper use or absence of key PPE. Emelee remarked, "*Once the operation is not standardized, such as gloves breaking or not wearing a mask, the risk exists*." Similarly, Serenity noted that in some cases, goggles are not worn when working under biosafety cabinets. Michelle shared, "*When time is tight and labor intensity is high, gloves aren't always*

*changed on time*." These real-world practices illustrate the difficulty of maintaining consistent protection in high-stress, fast-paced environments. The lack of professional training further exacerbates these barriers. Leanne questioned the quality of occupational exposure training: "*Is this more form than practice?*" Madonna emphasized the need for better education: "*To protect oneself, we need more training and information, such as on protective measures and on strengthening procedures*." These concerns are consistent with prior findings emphasizing that structured, repeated training is essential to ensure the correct use of PPE and safe handling procedures (Paterson et al., 2020; Senarath et al., 2025). The absence of continuous professional development not only undermines physical safety but can also contribute to anxiety and uncertainty about one's preparedness.

**Subtheme 2b**: Execution Difficulties

A second cluster of issues revolved around poor compliance with standard protection protocols and insufficient resource supply, which clearly describes the system-level constraints, such as: time/scheduling intensity, cramped surfaces, airflow/exhaust issues, shortages or delayed PPE replacement, that constrain otherwise competent practice. Emelee highlighted a general lack of awareness: "*Many staff members have insufficient understanding of the hazards of occupational exposure and fail to take necessary protective measures*." Similarly, Cici and Serenity both cited improper biosafety cabinet operation, including failure to maintain the recommended 18cm distance on the windshield, which could lead to aerosol exposure. While Bella shared that "*the dispensing period from 6:30 to 9:00 is so intense that gloves are not changed every 30 minutes as required*." These examples reflect the findings of Boiano et al. (2014) Who observed that even with available protective equipment, non-adherence to standards due to time pressure or operational shortcuts can still result in exposure. These breakdowns in compliance suggest that internal monitoring and enforcement mechanisms are either lacking or ineffective.

The issue of insufficient supply of protective resources was another recurring concern. Cici emphasized the need for effective equipment: "*A safe environment is most needed, and biosafety cabinets must maintain a negative pressure environment*." In addition, Michelle proposed systemic solutions: "*If we could use intelligent systems to control the entire dispensing process, the risk would be almost zero*." Bella also added, "*There should be a scheduling mechanism to ensure enough time for PPE replacement during peak hours*." These statements underscore how under-resourced settings, even when staff are motivated and knowledgeable, can still leave personnel vulnerable to exposure. This supports the critical need for adequate PPE and properly functioning safety infrastructure, such as Class II B2 biosafety cabinets. Furthermore, these are considered contextual problems; solvable through resourcing, layout/engineering controls, and schedule redesign.

While operational errors (Theme 1a) and execution constraints (Theme 2b) frequently co-occur; however, the former reflect skills/behavior at the bench, while the latter reflect environmental and organizational limitations. Distinguishing the two clarifies who needs to act (individual versus system) and what interventions are warranted (coaching/checklists versus engineering/scheduling/supply upgrades). Overall, the findings under Theme 2 can be meaningfully interpreted through the study's three theoretical frameworks. According to the Health Promotion Model, the lack of training and awareness observed in participants reflects perceived barriers that hinder the adoption of protective behaviors, even when staff recognize the risks. In the Stress Appraisal and Coping Theory, these challenges are viewed through participants' cognitive evaluations of workplace threats (e.g., lack of equipment, time pressure) and their available coping resources, many of which were described as inadequate, leading to emotional strain and inconsistent compliance. Finally, from the lens of the Self-Care Deficit Nursing Theory, the inability of personnel to consistently apply protective measures represents a clear self-care deficit, one that requires institutional support, adequate equipment, and structured education to bridge. These theories together explain how protective behaviors are not solely determined by knowledge or motivation but are embedded in broader structural and environmental conditions that must be addressed.

### 4.3. Theme 3: Mental Health Struggles

Participants consistently shared deep psychological distress related to occupational exposure, revealing three interconnected subthemes: (3a) Occupational Anxiety, (3b) Lack of Support, and (3c) Accumulation of Stressors. These experiences point to an urgent need for psychosocial interventions tailored to the realities of chemotherapy drug dispensing.

**Subtheme 3a**: Occupational Anxiety

Fear and anxiety were recurring emotions expressed by participants following exposure. This was especially tied to concerns about health damage, including the potential for cancer, reproductive harm, and neurological symptoms. Diana described the psychological pressure as "*really great, very frightening*," while Joeann admitted, "*I must be quite scared and anxious… like bone marrow suppression or fertility issues*." Bella, who was breastfeeding at the time of exposure, experienced "*persistent anxiety about the effects of medication on her baby,*" despite medical reassurance. These fears align with prior studies that indicate prolonged exposure to cytotoxic drugs can lead to pathological health anxiety. (Soheili et al., 2021). Similarly, Serenity's comment on neurological symptoms and cognitive changes reflects research suggesting that perceived toxicity reinforces psychological distress, particularly when symptoms mirror known side effects of chemotherapy agents.

Fear was also acute immediately following exposure. Emelee stated, "*Very scared in my heart… afraid it would be absorbed through my skin or lungs,*" while Michelle recounted that "*the first time I experienced exposure, I was extremely scared.*" This echoes the previous assertion that the first 48 hours post-exposure are psychologically critical, requiring timely emotional intervention to prevent lingering trauma. Additionally, several participants reported that high workload and pressure aggravated their anxiety. Leanne reflected, "*This high-risk operation creates a feeling of avoidance… anxiety affects our focus*," while Serenity warned against handling hazardous drugs "*when fatigued or during high-intensity work hours*." As literature has noted that chronic high-pressure environments contribute to sustained symptoms of anxiety and depression among medical personnel (Wang et al., 2023).

**Subtheme 3b**: Lack of Support

A major concern raised was the lack of psychological counseling. Multiple participants called for the establishment of professional support systems. Leanne said, "*We really need hospitals to provide professional counseling to help us alleviate this anxiety*," while Michelle noted the absence of anonymous or formal psychological support mechanisms. This gap in institutional care is consistent with what Li et al. (2023) Emphasized that healthcare workers often fail to recognize or act upon their own mental health symptoms, suggesting that without proactive support systems, anxiety may go unaddressed and worsen over time. Participants also voiced a need for regular health monitoring after exposure. Diana stressed, "*We hope hospitals will arrange follow-up checkups after exposure to track our health in real time*." While Leanne expressed frustration at having to bear additional examination costs, calling for institutional accountability. Without consistent occupational health surveillance, anxiety persists due to uncertainty about invisible or delayed effects, further deteriorating psychological well-being. Lastly, Bella and Michelle's accounts revealed that even when external reassurance is provided, internalized anxiety remains unresolved in the absence of structured mental health and physical monitoring systems. Altogether, this highlights how a lack of family and organizational understanding may compound stress and isolation.

**Subtheme 3c**: Accumulation of Stressors
Participants described how repeated exposure and cumulative stress led to emotional exhaustion and occupational burnout. Leanne admitted to developing psychological avoidance, while Michelle said, "*Even now, I'm nervous and overly careful; like being bitten by a snake and fearing ropes for ten years*." Joeann described being in a "*constant state of tension*," reflecting chronic hypervigilance and fear. These narratives correspond with the findings on long-term psychological trauma caused by repeated low-dose cytotoxic exposure, which may manifest as cognitive dissonance, fatigue, or loss of focus, which are precursors to occupational burnout. At the same time, participants showed enhanced risk awareness following exposure, which had both positive and negative effects. Michelle explained how a decade of experience had heightened her sensitivity, while Bella expressed persistent cognitive stress during breastfeeding. Diana emphasized, "*The side effects of hazardous drugs are serious. We can feel them after exposure*." Such cognitive reinforcement increases vigilance, but can also lead to reduced efficiency, overprotection, or a desire to transfer out of chemotherapy-related roles.
Overall, the mental health challenges reported in Theme 3 align with and deepen the relevance of the study's theoretical foundations. Through the lens of the Health Promotion Model, participants' anxiety and lack of engagement in proactive coping (e.g., health monitoring, self-care) reflect both perceived threats and the absence of institutional enablers for protective behavior. From the Stress Appraisal and Coping Theory, the data underscore how participants appraised occupational exposure as a severe, chronic stressor, with emotional and physiological implications. Many relied on emotion-focused coping strategies (e.g., avoidance, fear) rather than problem-focused approaches, due to insufficient support and system barriers. Finally, the Self-Care Deficit Nursing Theory is visible in the inability of workers to maintain psychological well-being without external support. The absence of routine psychological counseling, limited access to health tracking, and a lack of supportive structures represent clear self-care deficits requiring institutional intervention. Together, these frameworks underscore the complexity of occupational exposure; not just as a physical hazard but as an experience that profoundly affects mental health, professional identity, and long-term well-being.

## 4.4. Theme 4: Career Development Barriers

Participants described significant barriers to career development as intravenous chemotherapy dispensing personnel, emphasizing (4a) high ability requirements and (4b) insufficient career security. These challenges reflect both technical demands and structural constraints in their professional environment.
**Subtheme 4a**: High Ability Requirements
Participants emphasized that their roles demand extreme precision, particularly in standardized operations and emergency responses. As Bella shared, "*The emergency exit requirements require large quantities of drugs to be prepared within 2.5 hours… under high pressure, the accuracy of operation decreases*." Michelle noted that "*if the operation is standardized and the protection is in place, these measures can significantly reduce the risk of exposure… more than 90%*." The skill requirement is not only technical, but also physical and psychological. Participants acknowledged that inadequate technique or lapses in vigilance could lead to cytotoxic exposure, reinforcing the high-risk nature of their work. Emergency handling was also a vital area of concern. Joeann recalled, "*If there is drug spillage or breakage, [we must] handle according to the following process*," while Leanne emphasized steps from spill control to reporting. These accounts show that emergency response is not peripheral, but central to the role, requiring frequent training, mental readiness, and environmental familiarity. Furthermore, participants expressed that they must develop risk prediction capabilities, anticipating failures before they occur. Bella noted, "*We have to be able to judge if something might go wrong*," echoing the proactive stance expected of them. These demands, while essential for safety, illustrate how these professionals must continuously manage cognitive, physical, and emotional load, often under time pressure.
**Subtheme 4b**: Insufficient Career Security
Despite these heightened expectations, participants reported a lack of structural protections and institutional recognition. Several raised concerns about inadequate health compensation following exposure events. Leanne remarked, "*We need a clearer mechanism for bearing medical costs,*" while Bella explained that even small health breaks are inconsistently applied: "*If drugs are dispensed for more than three days, only then do we get 0.5–1 day of rest.*" Joeann also called for regular follow-up checkups to monitor long-term health outcomes. These narratives reflect not only physical vulnerability but an absence of institutional reciprocity, where staff bear high risks with insufficient assurance of care. A related concern was the lack of job rotation or recovery periods, which exacerbated mental and physical fatigue. Cici proposed "*mandatory rest after two days of medication dispensing*," and Serenity explained that "*this work mode has been going on for more than ten years*." Long-term fixed roles, particularly in high-risk environments, were reported to lead to burnout, anxiety, and a sense of occupational stagnation. As Diana emphasized, "*Pregnant women should not be in the chemotherapy dispensing compartment,*" highlighting that current rotation policies may not adequately account for health vulnerabilities or life-stage needs.
Overall, the findings from both subthemes underscore a dissonance between professional demands and career support, which can be interpreted through multiple theoretical lenses. The Health Promotion Model helps explain why, despite perceiving high risk and severity, some nurses experience decreased motivation, which was due to the absence of enabling cues like institutional incentives, job rotation, or support systems. Meanwhile, the Stress Appraisal and Coping Theory sheds light on how individuals evaluate these high-stakes responsibilities as overwhelming, especially when coping resources (e.g., rest, team support, compensation) are limited, triggering strain and emotional depletion.

## 4.5. Theme 5: Response Mechanisms and Adjustments

Participants described a range of strategies used to cope with occupational stress and minimize the risks of intravenous chemotherapy drug exposure. These are grouped into three subthemes: (5a) psychological adjustment, (5b) behavioral coping, and (5c) health management.
**Subtheme 5a**: Psychological Adjustment
Participants often engaged in emotional rationalization and self-regulation to manage anxiety. Madonna shared, "*Through emotional self-regulation… we control our emotions ourselves, try not to produce fear emotions, regulate our emotions, and improve anxiety through listening to music*." Similarly, Bella noted, "*Self-suggestion and protective measures are taken appropriately… I believe the impact of breast milk is limited.*" Risk desensitization training was also emphasized. Leanne stated, "*I think the department should regularly simulate exposure scenarios… to reduce panic during incidents*." This aligns with Stress Appraisal and Coping Theory (Lazarus & Folkman, 1984)Participants utilized both emotion-focused strategies (self-soothing, peer support) and problem-focused strategies (scenario training, cognitive reframing) to cope with occupational threats. Social support also played a critical role; Michelle reflected, "*I will communicate more with colleagues to alleviate the anxiety and psychological burden caused by occupational exposure*."

**Subtheme 5b**: Behavioral Coping
Participants reported adopting stricter protective routines and enhancing workflow safety. For example, Serenity described, "*When handling spilled medication, I use double-layer gloves and a full-face mask*." Leanne added, "*We open the UV disinfection and biosafety cabinet half an hour in advance… then wipe it to protect the next worker*." These responses mirror the Self-Care Deficit Nursing Theory (Orem, 1995), wherein workers identified and fulfilled their own care requirements through protective actions and environmental control. Additionally, health-promoting behaviors were widely practiced. Emelee said, "*Drinking more water can accelerate metabolism, strengthen physical exercise, and nutrient intake.*" Joeann added, "*Strengthening physical exercise, improving diet, and enhancing immunity.*" These actions reflect the core concepts of Pender's (Pender et al., 2011) Health Promotion Model, which posits that individuals take proactive steps to improve or maintain well-being, especially when aware of health risks.
**Subtheme 5c**: Health Management
Participants recognized the importance of long-term health monitoring and metabolic support. Diana emphasized, "*Exposure can accelerate excretion… so drink plenty of water to reduce physical impact*." Joeann advocated for follow-up care: "*We hope hospital leaders arrange regular checkups for us after occupational exposure.*" Bella also noted, "*Eat more green vegetables and vitamin E… and try to drink plain water.*" This theme aligns with the Health Promotion Model (Pender et al., 2011) By emphasizing nutritional behaviors and preventive screening. At the same time, it illustrates how healthcare workers, recognizing potential care deficits, actively addressed them, echoing the principles of Self-Care Deficit Nursing Theory. (Orem, 1995).
Taken together, these strategies reveal a holistic model of self-regulation and health promotion among intravenous chemotherapy dispensing personnel. Drawing on Stress Appraisal and Coping Theory, participants managed occupational stress through both psychological adjustment and concrete behavioral strategies. Their proactive engagement in health-sustaining behaviors and monitoring aligns with Pender's Health Promotion Model, demonstrating high levels of health responsibility and self-efficacy. Meanwhile, the Self-Care Deficit Nursing Theory offers a framework to understand how individuals identify personal care needs and respond through self-initiated or system-supported measures. Together, these coping and adjustment mechanisms represent adaptive strategies that not only mitigate occupational exposure risks but also promote psychological resilience and long-term health maintenance.
Within a cultural context, the experiences reported here are embedded in a sociocultural milieu where professional norms, hierarchy, and collective expectations shape both risk perception and day-to-day safety behavior. Global syntheses show that cancer nurses' handling of cytotoxic drugs is mediated at individual, shared, and cultural levels, with frequent gaps between espoused safe practice and observed behaviors. (Campbell et al., 2024). While, within an Asian setting, survey evidence highlights how safety climate, interpersonal influence, and self-efficacy predict PPE adherence, while conflicts of interest (e.g., productivity pressures) depress it (Srisintorn et al., 2021). Complementing this, an integrative review identifies managerial support, workload, guideline knowledge, and health beliefs as consistent determinants of exposure risk. (Abu-Alhaija et al., 2023), highlighting that belief and climate-level levers are as critical as technical training. Our findings sit within China's high-volume tertiary oncology system, where exposure risks and psychosocial strain are well documented among nurses. (Huang et al., 2022; Li et al., 2023). Contemporary Chinese oncology nursing faces role expansion and workload intensification, while staff well-being is variably supported across institutions. (Ma et al., 2023). Evidence from China also links job stress to perceived social support and self-efficacy, which are both actionable levers for reducing strain and improving protective behavior. (Zhang et al., 2024). Beyond hospitals, uneven cancer health literacy, especially in rural areas, can complicate risk communication and safety culture. (Zhu et al., 2025). Taken together, China-specific implementation should pair engineering controls and standardized IV admixture services with non-punitive incident reporting, peer-champion models, protected glove-change windows, and confidential/low-stigma mental-health supports.
Overall, the study findings are most transferable to high-volume tertiary centers with engineering controls and staffed compounding units. In rural or resource-constrained hospitals, where bench space, negative-pressure cabinets, and supplies fluctuate, the execution difficulties we describe may be amplified; practical adaptations include protected glove-change windows, simplified checklists, and low-cost airflow verification. In systems governed by oncology safety standards (e.g., ONS/ASCO/NIOSH analogs), aligning local SOPs and audit/feedback with those frameworks can accelerate uptake. Future implementation trials should compare these packages across tertiary vs. non-tertiary sites.

## 5. Conclusions and Recommendations

This qualitative study explored the lived experiences of intravenous chemotherapy dispensing personnel in relation to occupational exposure risks, psychological stress, and coping strategies. Through in-depth interviews, five key themes emerged: challenges related to occupational exposure safety, difficulties in implementing protective measures, mental health struggles, career development obstacles, and coping and adjustment strategies. The findings highlight that while many participants possess high risk awareness and adopt protective behaviors, gaps remain in compliance, resource allocation, and psychological support. Psychological adjustment, behavioral coping, and proactive health management play vital roles in mitigating the adverse effects of occupational exposure. These coping mechanisms are well-explained by the Stress Appraisal and Coping Theory (emotion and problem-focused coping), the Health Promotion Model (health responsibility and behavior change), and the Self-Care Deficit Nursing Theory (recognition of and response to self-care needs). Overall, the study provides a holistic understanding of how occupational and psychological burdens intersect in high-risk hospital environments and how frontline healthcare workers develop adaptive strategies to maintain safety and well-being.
Based on the study's findings, several key recommendations can be proposed to improve the occupational safety and well-being of intravenous chemotherapy dispensing personnel. First, hospitals should strengthen structured training programs by incorporating simulation-based desensitization exercises and emergency response drills. These should not only focus on technical proficiency but also include modules on emotional regulation and peer support to build psychological resilience. Second, there is a critical need to enhance resource allocation and protective infrastructure. Ensuring a stable supply of essential protective equipment, such as N95 masks, goggles, full-body gowns, and biosafety cabinets with Class II B2 specifications, is necessary to minimize exposure risks. Hospitals should also consider implementing dynamic scheduling systems to mitigate the impact of high-intensity workloads on staff safety and performance. While in China, scale-up should prioritize pharmacy IV admixture services, routine occupational surveillance, and anonymous counseling access alongside local SOPs aligned to oncology safety standards.
Furthermore, health promotion practices must be institutionalized across departments. This includes encouraging personnel to adopt regular physical exercise, maintain adequate hydration, and practice proper nutritional habits through workplace wellness initiatives. Regular medical checkups and follow-up monitoring after occupational exposure should also become standard policy. In addition, integrated support systems must be developed. Embedding access to psychological counseling and establishing peer support networks within hospital culture

will help reduce emotional burden and encourage early intervention. Finally, long-term improvements should leverage technological innovations such as AI-assisted risk alert systems, augmented reality-based training tools, and intelligent, fully enclosed drug dispensing systems. These technologies can help reduce human error, cognitive overload, and psychological stress in high-risk clinical environments.

In sum, this study shows that occupational exposure in chemotherapy compounding is not only a technical hazard but also a psychosocial burden shaped by procedure-level behaviors and system-level constraints. By distinguishing operational risks (task performance) from execution constraints (time, space, airflow, supply), our findings point to matched solutions: coaching and checklists for the former, and engineering controls, scheduling, and resourcing for the latter; supplemented by culturally attuned mental-health supports. Practical gains are most likely from integrated strategies that combine strengthened safety climate, simulation-based training, and selective automation/robotics where feasible. Future work should track outcomes longitudinally and test implementation packages across diverse settings to enhance transferability and impact.

Despite the rich insights gained from this qualitative study, several limitations must be acknowledged. First, the study's findings have limited generalizability, as data were collected from a single hospital with a purposive sample of intravenous chemotherapy dispensing personnel. The results may not fully represent the experiences of personnel in other departments, institutions, or countries with different healthcare infrastructures. Second, the study relied solely on self-reported data obtained through interviews, which may be subject to recall bias or social desirability effects. Participants might have underreported negative experiences or overstated protective compliance due to professional expectations. Additionally, the cross-sectional nature of the study precludes a longitudinal understanding of changes over time in stress levels, coping strategies, and institutional improvements. Furthermore, as a single-site study in mainland China, cultural norms (hierarchy, incident-reporting practices, stigma around counseling) may have shaped both experiences and disclosure, limiting transferability. Future research should consider longitudinal designs to capture how individual and organizational responses evolve in dynamic hospital settings. Lastly, the absence of quantitative validation presents a limitation. While the qualitative data provided rich thematic depth, future studies could strengthen the findings by incorporating standardized quantitative instruments, such as psychological stress scales or compliance audits, to allow for triangulation and broader generalization.

## References


[1] Abalona, M. D., Trajera, S. M., & Ching, G. S. (2025). Adapting to change: Lived experiences of nursing students in rebuilding clinical confidence with limited face-to-face exposure. *Edelweiss Applied Science and Technology, 9*(2), 1353-1366. https://doi.org/10.55214/25768484.v9i2.4768.

[2] Abu-Alhaija, D., Bakas, T., Shaughnessy, E., & Miller, E. (2023). The factors that influence chemotherapy exposure among nurses: An integrative review. *Workplace Health & Safety, 71*(5), 212-227. https://doi.org/10.1177/21650799221140583.

[3] Antúnez-Blancat, A., Gago-Valiente, F.-J., García-Iglesias, J.-J., & Merino-Navarro, D. (2024). The role of nursing in the management of chemotherapy extravasation: A systematic review regarding public health. *Healthcare, 12*(14), 1456. https://doi.org/10.3390/healthcare12141456.

[4] Aqtam, I., & Darawwad, M. (2018). Health Promotion Model: An integrative literature review. *Open Journal of Nursing, 8*(7), 86144. https://doi.org/10.4236/ojn.2018.87037.

[5] Boiano, J. M., Steege, A. L., & Sweeney, M. H. (2014). Adherence to safe handling guidelines by health care workers who administer antineoplastic drugs. *Journal of Occupational and Environmental Hygiene, 11*(11), 728-740. https://doi.org/10.1080/15459624.2014.916809.

[6] Campbell, K., Afseth, J., Dunham, M., King, M., & Dicksit, D. (2024). Global cancer nurses' experiences and perceptions of potential occupational exposure to cytotoxic drugs: Mixed method systematic review with framework synthesis. *Journal of Clinical Nursing, 33*(12), 4585-4601. https://doi.org/10.1111/jocn.17488.

[7] Chen, H.-C., Lu, Z.-Y. J., & Lee, S.-H. (2016). Nurses' experiences in safe handling of chemotherapeutic agents: The Taiwan case. *Cancer Nursing: An International Journal for Cancer Care Research, 39*(5), E29-E38. https://doi.org/10.1097/NCC.0000000000000314.

[8] Cho, H. N., Wells, L., & Halford, Z. (2024). Implementation and evaluation of APOTECAchemo in a community cancer center: A comparative study of robotic versus manual antineoplastic preparation. *Journal of Pharmacy Technology, 40*(6), 269-276. https://doi.org/10.1177/87551225241278203.

[9] Clapp, R. W., Howe, G. K., & Jacobs, M. M. (2007). Environmental and occupational causes of cancer: A call to act on what we know. *Biomedicine & Pharmacotherapy, 61*(10), 631-639. https://doi.org/10.1016/j.biopha.2007.08.001.

[10] Colaizzi, P. F. (1978). Psychological research as the phenomenologist views it. In R. S. Valle & M. King (Eds.), *Existential-phenomenological alternatives for psychology* (pp. 48-71). Oxford University Press.

[11] Condes, K. A., Lachica, T.-A. B., Trajera, S. M., & Ching, G. S. (2025). Strength from within: Exploring self-compassion among frontline nurses during the COVID-19 pandemic. *Edelweiss Applied Science and Technology, 9*(5), 2471-2483. https://doi.org/10.55214/25768484.v9i5.7487.

[12] Connor, T. H., Lawson, C. C., Polovich, M., & McDiarmid, M. A. (2014). Reproductive health risks associated with occupational exposures to antineoplastic drugs in health care settings: A review of the evidence. *Journal of Occupational and Environmental Medicine, 56*(9), 901-910. https://doi.org/10.1097/JOM.0000000000000249.

[13] Coyne, E., Northfield, S., Ash, K., & Brown-West, L. (2019). Current evidence of education and safety requirements for the nursing administration of chemotherapy: An integrative review. *European Journal of Oncology Nursing, 41*, 24-32. https://doi.org/10.1016/j.ejon.2019.05.001.

[14] Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approach* (3rd ed.). Sage.

[15] Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative and mixed method approaches* (5th, Ed.). Sage.

[16] Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). Sage.

[17] Domingo-Echaburu, S., Lopez de Torre-Querejazu, A., Valcárcel, Y., Orive, G., & Lertxundi, U. (2022). Hazardous drugs (NIOSH's list-group 1) in healthcare settings: Also a hazard for the environment? *Science of The Total Environment, 817*, 152954. https://doi.org/10.1016/j.scitotenv.2022.152954.

[18] Fadhil, I., & Hassan, H. (2018). Evaluation of nurses' practices toward safe intravenous chemotherapy infusion in Baghdad city hospitals. *Iraqi National Journal of Nursing Specialties, 31*(2), 43-56. https://doi.org/10.58897/injns.v31i2.306.

[19] Folkman, S. (2013). Stress: Appraisal and coping. In M. D. Gellman & J. R. Turner (Eds.), *Encyclopedia of Behavioral Medicine* (pp. 1913–1915). Springer. https://doi.org/10.1007/978-1-4419-1005-9_215.

[20] Fundytus, A., Prasad, V., & Booth, C. M. (2021). Has the current oncology value paradigm forgotten patients' time? Too little of a good thing. *JAMA Oncology, 7*(12), 1757-1758. https://doi.org/10.1001/jamaoncol.2021.3600.

[21] Fusch, P. I., & Ness, L. R. (2015). Are we there yet? Data saturation in qualitative research. *The Qualitative Report, 20*(9), 1408-1416. https://doi.org/10.46743/2160-3715/2015.2281.

[22] Galmarini, D., Galmarini, C. M., & Galmarini, F. C. (2012). Cancer chemotherapy: A critical analysis of its 60 years of history. *Critical Reviews in Oncology/Hematology, 84*(2), 181-199. https://doi.org/10.1016/j.critrevonc.2012.03.002.

[23] Geersing, T. H., Pourahmad, D. M., Lodewijk, F., Franssen, E. J. F., Knibbe, C. A. J., & Crul, M. (2024). Analysis of production time and capacity for manual and robotic compounding scenarios for parenteral hazardous drugs. *European Journal of Hospital Pharmacy, 31*(4), 352-357. https://doi.org/10.1136/ejhpharm-2022-003576.

[24] Gerding, J., Anhäuser, L., Eickmann, U., & Nienhaus, A. (2022). A simple approach to assess the cancer risk of occupational exposure to genotoxic drugs in healthcare settings. *Journal of Occupational Medicine and Toxicology, 17*, 8. https://doi.org/10.1186/s12995-022-00349-z.

[25] Hellmann, M. D., Li, B. T., Chaft, J. E., & Kris, M. G. (2016). Chemotherapy remains an essential element of personalized care for persons with lung cancers. *Annals of Oncology, 27*(10), 1829–1835. https://doi.org/10.1093/annonc/mdw271.

[26] Huang, X., Gao, C., Cai, W., Tao, Y., Zhong, X., Liu, H., Hong, X., Ding, X., Lu, H., Lai, W., Yi, X., & Gu, Y. (2022). Effect of occupational exposure to antineoplastic drugs on DNA damage in nurses: A cross-sectional study. *Occupational and Environmental Medicine, 79*(4), 253-258. https://doi.org/10.1136/oemed-2021-107913.

[27] Jimenez, O.-J. B., Trajera, S. M., & Ching, G. S. (2022). Providing end-of-life care to COVID-19 patients: The lived experiences of ICU nurses in the Philippines. *International Journal of Environmental Research and Public Health, 19*(19), 12953. https://doi.org/10.3390/ijerph191912953.

[28] Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping*. Springer.

[29] Li, C. (2024). A review of identity and roles of robotics in the healthcare industry. *Journal of Biomedical and Sustainable Healthcare Applications, 4*(1), 22-32. https://doi.org/10.53759/0088/JBSHA20240403.

[30] Li, G., Xu, B., He, R.-X., & Zhang, S.-X. (2017). Using healthcare failure mode and effect analysis to reduce intravenous chemotherapy errors in Chinese hospitalized patients. *Cancer Nursing: An International Journal for Cancer Care Research, 40*(2), 88-93. https://doi.org/10.1097/NCC.0000000000000348.

[31] Li, Y., Yu, W., Li, L., Yao, Q., Jiang, K., Zhu, T., & Jiang, E. (2023). Oncology nursing on the move: A contemporary issue on Chinese oncology nursing in cancer care. *Frontiers in Public Health, 11*, 1061572. https://doi.org/10.3389/fpubh.2023.1061572.

[32] Lin, L., Zhang, X., & Wang, P. (2025). Interconnected stressors and well-being in healthcare professionals. *Applied Research in Quality of Life, 20*, 459-481. https://doi.org/10.1007/s11482-024-10419-5.

[33] Lincoln, Y., & Guba, E. G. (1985). *Naturalistic inquiry*. Sage. https://doi.org/10.1016/0147-1767(85)90062-8.

[34] Lombardo, J., Coles, J., Ryszka, D., Roussel, C., & Smith, W. (2022). Deviations from best practice: Findings from a certified patient safety organization remote-verification observational study of intravenous compounding of chemotherapeutic and ancillary drugs. *Journal of Pharmacy Practice, 36*(6), 1438-1447. https://doi.org/10.1177/08971900221134836.

[35] Ma, Y., Xie, T., Zhang, J., & Yang, H. (2023). The prevalence, related factors and interventions of oncology nurses' burnout in different continents: A systematic review and meta-analysis. *Journal of Clinical Nursing, 32*(19-20), 7050-7061. https://doi.org/10.1111/jocn.16838.

[36] Mapp, T. (2008). Understanding phenomenology: The lived experience. *British Journal of Midwifery, 16*(5), 308-311. https://doi.org/10.12968/bjom.2008.16.5.29192.

[37] Masters, K. (2015). Nursing theories: A framework for professional practice. In. Jones & Bartlett Learning.

[38] Moore, L. (2023). Oncology pharmacy technician contributions and challenges: A commentary on a busy infusion center facing changes and challenges. *Journal of Pharmacy Technology, 39*(6), 309-311. https://doi.org/10.1177/87551225231202388.

[39] Naderifar, M., Goli, H., & Ghaljaie, F. (2017). Snowball sampling: A purposeful method of sampling in qualitative research. *Strides in Development of Medical Education, 14*(3), 67670. https://doi.org/10.5812/sdme.67670.

[40] Olorunfemi, O., Akintoke, T. E., Owoyomi, D. O., Orobode, O. R., Owadokun, J. F., & Oahimijie, F. O. (2024). Nurses care for everyone: But who cares for a nurse? *Current Medicine Research and Practice, 14*(5), 228-232. https://doi.org/10.4103/cmrp.cmrp_43_24.

[41] Omer, H., Salah, H., Tamam, N., Mahgoub, O., Sulieman, A., Ahmed, R., Abuzaid, M., Saad, I. E., Almogren, K. S., & Bradley, D. A. (2023). Assessment of occupational exposure from PET and PET/CT scanning in Saudi Arabia. *Radiation Physics and Chemistry, 204*, 110642. https://doi.org/10.1016/j.radphyschem.2022.110642.

[42] Orem, D. E. (1995). *Nursing: Concepts of practice* (5th ed.). Mosby.

[43] Ouedraogo, J.-M., El Baraka, S., Adade, C. A., Sitsopeh, J., Sessouma, A., Belahcen, M. J., & Rahali, Y. (2020). Risk reduction in a cancer chemotherapy production unit: Contribution of an automated drug dispensing system. *Journal of Oncology Pharmacy Practice, 27*(4), 863-870. https://doi.org/10.1177/1078155220941060.

[44] Oyuku, M., & Nshakira, N. (2025). Factors influencing compliance with chemotherapy handling and administration standard operation procedures among nurses and pharmacists at Uganda cancer institute: Descriptive study. *BMC Health Services Research, 25*, 1010. https://doi.org/10.1186/s12913-025-13076-y.

[45] Pacheco, C., Baião, A., Ding, T., Cui, W., & Sarmento, B. (2023). Recent advances in long-acting drug delivery systems for anticancer drug. *Advanced Drug Delivery Reviews, 194*, 114724. https://doi.org/10.1016/j.addr.2023.114724.

[46] Paterson, C., Gobel, B., Gosselin, T., Haylock, P. J., Papadopoulou, C., Slusser, K., Rodriguez, A., & Pituskin, E. (2020). Oncology nursing during a pandemic: Critical reflections in the context of COVID-19. *Seminars in Oncology Nursing, 36*(3), 151028. https://doi.org/10.1016/j.soncn.2020.151028.

[47] Pender, N. J., Murdaugh, C. L., & Parsons, M. A. (2011). *Health promotion in nursing practice* (6th ed.). Pearson.

[48] Perego, G., Longobardo, G., Baldisserotto, A., Feliciani, M., & Fazio, M. (2022). Automated chemotherapy compounding: Process optimization for the preparation of admixture containing high-dose of cyclophosphamide. *Journal of Oncology Pharmacy Practice, 29*(1), 208-210. https://doi.org/10.1177/10781552221130012.

[49] Polovich, M. (2016). Minimizing occupational exposure to antineoplastic agents. *Journal of Infusion Nursing, 39*(5), 307-313. https://doi.org/10.1097/NAN.0000000000000183.

[50] Portela, T., Camozzato, T. S. C., de Cássia Flôr, R., Ribeiro, G., & de Melo, J. A. C. (2021). Occupational exposure in the working process of radiological nursing in nuclear medicine. *Journal of Radiology Nursing, 40*(3), 246-253. https://doi.org/10.1016/j.jradnu.2021.02.005.

[51] Rahman, A. (2022). A scoping review of COVID-19-related stress coping resources among nurses. *International Journal of Nursing Sciences, 9*(2), 259-267. https://doi.org/10.1016/j.ijnss.2022.02.008.

[52] Rimando, Y. M., Chua, L. A. A., Trajera, S. M., & Ching, G. S. (2025). Lived experiences of clinical instructors in facilitating online related learning experiences among nursing students in the Philippines: Challenges, adaptations, and insight. *Edelweiss Applied Science and Technology, 9*(3), 309-327. https://doi.org/10.55214/25768484.v9i3.5209.

[53] Senarath, N. S. A. S. N., De Silva, D., Rathnayake, R. W. M. W. K., Warnakulasuriya, S. S. P., Meegoda, M. K. D. L., & Jayasinghe, S. S. (2025). Perceptions of occupational exposure and adherence to safety measures of handling systemic anti-cancer therapy (SACT) among oncology nurses at the national cancer institute, Sri Lanka. *International Journal of Risk & Safety in Medicine*. https://doi.org/10.1177/09246479251346172.

[54] Soheili, M., Taleghani, F., Jokar, F., Eghbali-Babadi, M., & Sharifi, M. (2021). Occupational stressors in oncology nurses: A qualitative descriptive study. *Journal of Clinical Nursing, 30*(21-22), 3171-3181. https://doi.org/10.1111/jocn.15816.

[55] Srisintorn, W., Geater, A., Polovich, M., & Thongsuksai, P. (2021). Factors influencing precautions against antineoplastic drug exposure among nurses and nurse assistants in Thailand. *International Archives of Occupational and Environmental Health, 94*, 813-822. https://doi.org/10.1007/s00420-020-01649-9.

[56] Sypongco, A. G., Trajera, S. M., & Ching, G. S. (2025). Navigating hesitancy: Lived experiences of COVID-19 vaccine resistance and public health adaptations in the Philippines. *Edelweiss Applied Science and Technology, 9*(2), 1133-1146. https://doi.org/10.55214/25768484.v9i2.4696.

[57] Tamon, A. S., Trajera, S. M., Lachica, T.-A. B., & Ching, G. S. (2025). Psychiatric nursing in crisis: Lived experiences and coping strategies during the COVID-19 pandemic in the Philippines. *Edelweiss Applied Science and Technology, 9*(3), 1795-1809. https://doi.org/10.55214/25768484.v9i3.5691.

[58] van Huizen, P., Wembridge, P., Russo, P. L., Manias, E., & Connell, C. J. (2025). Nurses' and midwives' knowledge and safe-handling practices related to hazardous drugs: A cross-sectional study. *International Journal of Nursing Studies Advances, 8*, 100331. https://doi.org/10.1016/j.ijnsa.2025.100331.

[59] Villaran, K. C., Chua, L. A. A., Trajera, S. M., & Ching, G. S. (2025). Lived experiences of nursing education administrators during the COVID-19 pandemic: Challenges, adaptations, and insights. *Edelweiss Applied Science and Technology, 9*(3), 2149-2169. https://doi.org/10.55214/25768484.v9i3.5756.

[60] Wang, Q., Wang, F., Zhang, S., Liu, C., Feng, Y., & Chen, J. (2023). Effects of a mindfulness-based interventions on stress, burnout in nurses: A systematic review and meta-analysis. *Frontiers in Psychiatry, 14*, 1218340. https://doi.org/10.3389/fpsyt.2023.1218340.

[61] Xie, W., Wang, J., Zhang, Y., Zuo, M., Kang, H., Tang, P., Zeng, L., Jin, M., Ni, W., & Ma, C. (2021). The levels, prevalence and related factors of compassion fatigue among oncology nurses: A systematic review and meta-analysis. *Journal of Clinical Nursing, 30*(5-6), 615-632. https://doi.org/10.1111/jocn.15565.

[62] Zakaria, M. M., Alaa, S. M., & Desoky, G. M. (2022). Oncology nurses' knowledge and practices regarding safe administration of intravenous chemotherapy. *Egyptian Journal of Health Care, 13*(1), 1218-1231. https://doi.org/10.21608/ejhc.2022.225111.

[63] Zendeh, M. B., Maslakpak, M. H., & Jasemi, M. (2022). Nurses' perceptions of their supportive role for cancer patients: A qualitative study. *Nursing Open, 9*(1), 646-654. https://doi.org/10.1002/nop2.1112.

[64] Zhang, L., Li, Q., Guan, L., Fan, L., Li, Y., Zhang, Z., & Yuan, S. (2022). Prevalence and influence factors of occupational exposure to blood and body fluids in registered Chinese nurses: A national cross-sectional study. *BMC Nursing, 21*, 298. https://doi.org/10.1186/s12912-022-01090-y.

[65] Zhang, L., Liu, W., & Zhang, Y. (2022). Application of intelligent intravenous drug dispensing robot in clinical nursing. *Contrast Media & Molecular Imaging, 2022*, 769883. https://doi.org/10.1155/2022/4769883.

[66] Zhang, X., Zheng, Q., Lv, Y., An, M., Zhang, Y., Wei, Y., & Feng, W. (2016). Evaluation of adverse health risks associated with antineoplastic drug exposure in nurses at two Chinese hospitals: The effects of implementing a pharmacy intravenous admixture service. *American Journal of Industrial Medicine, 59*(4), 264-273. https://doi.org/10.1002/ajim.22553.

[67] Zhang, Y., Meng, X., & Zhou, L. (2024). The impact of job stress on perceived professional benefits among Chinese nurses caring for patients with gynecological cancer: Mediating effects of perceived social support and self-efficacy. *Frontiers in Psychology, 15*, 1344185. https://doi.org/10.3389/fpsyg.2024.1344185.

[68] Zhu, M., Lachica, T.-A. B., Trajera, S. M., & Ching, G. S. (2025). Understanding health literacy for cancer prevention and care: A community-based study in rural Southwest China. *Edelweiss Applied Science and Technology, 9*(5), 2303-2316. https://doi.org/10.55214/25768484.v9i5.7464.