

A Strategic and Theoretical Study of Cancer in National Hospital for Oncology and Hematology

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Asmahan asad M ahmood¹, Ali Falah Hassan², Maryam hakim³, Rusul A. Ghazi⁴, Mohammed Hayder Al-zuhairi⁵, shaymaa awad kadhim⁶

^{1,2,3,5,6} University of Kufa, Faculty of Science, Department of Physics, Najaf, Iraq

⁴ University of Babylon, Faculty of Science, Department of Physics, Babylon, Iraq

ABSTRACT

Radiation therapy is a cornerstone and highly effective treatment for malignant tumors. It has witnessed rapid technological and methodological advancements aimed at achieving a balance between delivering the necessary dose to eradicate the tumor and minimizing damage to surrounding healthy tissues. The biological effects of radiation depend on several factors, including the dose, the type of radiation, and tissue sensitivity. This can lead to complications ranging from acute effects, such as inflammation of the mucous membranes (especially in head and neck cancers), to chronic effects such as osteoporosis and bone loss. To ensure radiation safety, protection procedures are based on fundamental principles including justification, optimization, and dose control. The training of medical personnel and the use of modern monitoring technologies are also crucial to minimizing errors that may arise from the interaction between human factors and operational technologies and systems. Chemotherapy is also used, either alone or in conjunction with radiation therapy, particularly in advanced cases or those inoperable. While this therapeutic integration enhances treatment efficacy, it may also increase toxicity, necessitating meticulous dose planning and continuous monitoring of side effects. On the practical side of the study, a field review was conducted of all procedures followed at the National Oncology and Hematology Hospital, including workflow, patient management mechanisms, and treatment preparation methods and types, to compare them with approved international protocols and procedures. The results demonstrated a high degree of conformity with global standards, enhancing the reliability and efficiency of the institution's medical performance. This study is among the first to address this type of comparative evaluation. Future directions focus on developing advanced radiotherapy techniques and targeted pharmacotherapy to improve treatment efficacy and reduce risks, while emphasizing the importance of continuous evaluation and the application of preventive measures to ensure patient safety and improve clinical outcomes.

1. INTRODUCTION

Radiation therapy is a primary and effective treatment for malignant tumors. It has undergone significant technological and methodological advancements aimed at balancing the dose necessary to eradicate the tumor with the need to minimize damage to surrounding healthy tissues [1]. The biological effects of radiation depend on factors such as the dose, type of radiation, and tissue sensitivity, leading to potential complications ranging from acute effects (such as inflammation of the mucous membranes, particularly in head and neck cancers) to chronic effects (such as fibrosis and osteonecrosis) [2]. To ensure safety, radiation protection is based on key principles of justification, optimization, and dose control, along with the importance of staff training and the use of modern monitoring techniques to avoid errors that often arise from human error interfering with technology and regulatory processes [3]. Chemotherapy is also used, either alone or in conjunction with radiation therapy, especially in advanced cases or those that cannot be surgically removed. While this combination increases

the effectiveness of the treatment, it can also increase toxicity, necessitating careful dose planning and continuous monitoring of side effects [4]. Future research will remain focused on developing advanced radiation technologies and specific drugs to enhance therapeutic effectiveness and reduce risks, while emphasizing the importance of continuous assessment and prevention as the basis for improving clinical outcomes and patient safety [5]. Radiation therapy is a cornerstone of cancer treatment, used in a large percentage of cancer patients (approximately 50-60%), either to achieve a cure or to alleviate symptoms in advanced stages. Radiation therapy contributes to approximately 40% of cancer cures when used alone or in combination with other treatments such as surgery or chemotherapy [6]. Radiation therapy relies on the use of ionizing radiation, which can damage the genetic material (DNA) within cells, leading to inhibition of cancer cell division or cell death. This damage occurs either directly or indirectly through the ionization of water molecules within the cell and the formation of free radicals [7]. In addition to the above, evaluating the quality of healthcare in oncology is not limited to the type of technologies used, but extends to the efficiency of

treatment protocol implementation, the accuracy of diagnostic procedures, clinical decision-making mechanisms, and post-treatment patient follow-up systems. Patient follow-up is a fundamental element of the cancer treatment system, as it contributes to the early detection of disease recurrence, the assessment of treatment response, and the monitoring of long-term side effects, which directly impacts quality of life and increases survival rates [8]. Furthermore, standardizing medical procedures according to internationally recognized protocols, such as those issued by specialized international bodies, is one of the most important factors in ensuring the provision of comprehensive, evidence-based healthcare [9]. This includes determining treatment dosages, selecting the most appropriate treatment plans, organizing treatment and follow-up schedules, and adopting precise criteria for evaluating treatment response [10]. In this context, the importance of studying the practical application in local healthcare institutions and analyzing their adherence to these protocols becomes clear, as does identifying strengths and weaknesses in treatment procedures. Comparison with global practices also provides an opportunity to identify gaps and improve clinical performance by adopting the latest methods and technologies [11]. Furthermore, the rapid advancements in artificial intelligence and big data analytics have unlocked new possibilities for improving diagnostic accuracy, personalizing treatment for each patient, and predicting treatment outcomes, potentially leading to a significant transformation in cancer patient management [12]. Therefore, conducting comparative studies between local practices and international standards is a crucial step towards developing healthcare services, enhancing the quality of care provided to cancer patients, and achieving the best possible treatment outcomes [13]. Furthermore, recent scientific research indicates that improving treatment outcomes depends not only on the use of advanced technologies but also on integrating meticulous clinical planning with effective data management systems [14]. The application of technologies such as 3D simulation, advanced intraoperative imaging, and artificial intelligence in dose planning contributes to increased tumor targeting accuracy and reduced damage to healthy tissue, a practice known as "Precision Radiotherapy [15]."

The implementation of these modern technologies also necessitates continuous evaluation of procedures within healthcare institutions, from diagnosis to post-treatment follow-up, to ensure adherence to global treatment protocols and alignment with international standards. This highlights the need for comparative studies that assess the integration of modern technologies with daily clinical practices in local hospitals, such as the National Oncology and Hematology Hospital in Najaf, against global best practices [16].

This integration of modern scientific knowledge, advanced treatment technologies, and patient monitoring systems provides a solid foundation for improving the quality of healthcare, reducing complications, increasing recovery rates, and placing the local institution on a path of continuous modernization and development in accordance with international treatment standards [17].

1.2 Previous Studies (Literature Review)

Several studies have investigated the effectiveness of radiotherapy and chemotherapy, along with their biological and clinical impacts on cancer treatment.

Early clinical evidence by Herskovic et al. (1992) demonstrated that concurrent chemoradiotherapy significantly improved survival rates in patients with esophageal cancer compared to radiotherapy alone. This study laid the foundation for combined treatment strategies [18]. Subsequently, Delaney et al. (2005) reported that radiotherapy is a cornerstone of cancer management, being utilized in approximately 50% of cancer cases, and plays a crucial role in improving cure rates and tumor control [19]. Advancements in treatment modalities were further explored by Durante and Loeffler (2010), who highlighted the effectiveness of proton therapy in achieving optimal dose distribution while minimizing radiation exposure to surrounding healthy tissues [20]. In the same context, Begg et al. (2011) emphasized that progress in understanding cancer molecular biology has facilitated the development of more effective therapeutic strategies, including the integration of radiotherapy with targeted therapies to enhance treatment response and reduce adverse effects [21]. Baskar et al. (2012) provided a comprehensive review of modern radiotherapy techniques, demonstrating that technologies such as intensity-modulated radiation therapy (IMRT) and image-guided radiation therapy (IGRT) significantly improve dose precision and reduce damage to normal tissues [22]. Similarly, Cooper et al. (2012) investigated concurrent chemoradiotherapy in head and neck cancers, reporting improved local tumor control and higher complete response rates compared to single-modality treatments [23].

Further clinical evidence by Stahl et al. (2013) showed that combining chemotherapy with radiotherapy in esophageal cancer treatment enhances survival rates and contributes to tumor downstaging prior to surgical intervention [24].

Technological advancements continued with Baumann et al. (2016), who demonstrated that the incorporation of advanced digital technologies and artificial intelligence into radiotherapy planning has improved treatment accuracy and minimized side effects [25]. From a radiobiological perspective, Hall and Giaccia (2019) explained that ionizing radiation exerts its therapeutic effect primarily through DNA damage in cancer cells, leading to inhibition of cell division or cell death, although some normal tissues may also be affected [26]. More recently, Gunderson and Tepper (2020) reported that modern techniques such as proton therapy enable highly precise dose delivery within tumors, thereby reducing radiotoxicity and enhancing overall treatment efficacy [27].

1.3 Study Objective

This study aims to evaluate and compare patient follow-up mechanisms and treatment procedures at the National Oncology and Hematology Hospital in Najaf with international standards and protocols for cancer treatment. The study objectives include:

Identifying the fundamental principles of radiotherapy and chemotherapy in cancer treatment. Reviewing modern radiotherapy techniques, such as Intensity-Modulated

Radiotherapy (IMRT), Image-Guided Radiotherapy (IGRT), and Proton Therapy. Studying the acute and chronic side effects associated with radiotherapy and chemotherapy. Evaluating the effectiveness of combining radiotherapy and chemotherapy in treating certain types of cancer, such as esophageal cancer. Analyzing and comparing patient follow-up procedures and clinical workflow within the hospital with internationally recognized methods and their alignment with international treatment protocols. Discussing future trends and the role of modern technologies and artificial intelligence in improving treatment outcomes and enhancing the Quality of healthcare.

2.1 Differences in Chemotherapy Protocols

There is no universal treatment protocol for all cancer patients. The treatment plan is individualized based on a comprehensive assessment of the following factors as shown in fig 1:

1. Cancer Type and Location

Certain cancer types (e.g., breast or colon cancer) respond better to specific medications [28].

2. Stage of the Disease

Treatment strategies vary between localized tumors and advanced, metastatic cases [29].

3. General Health Status

Evaluation of liver and kidney function, as well as the patient's physical endurance, is crucial [30].

4. Therapeutic Goals

Goals may focus on complete remission or on controlling symptoms and reducing tumor growth [31].

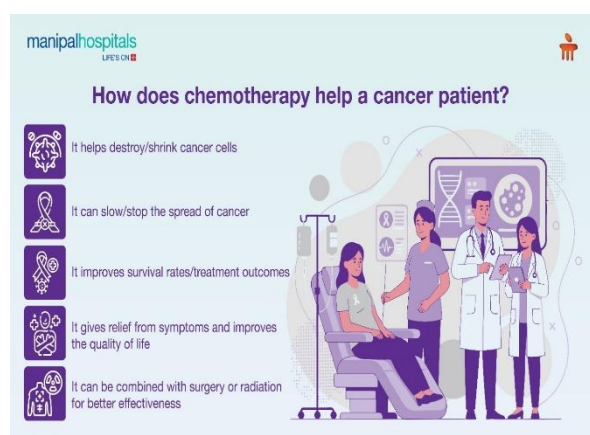


Fig 1: Chemotherapy Treatment: Procedure, Duration & Effects [32].

2.2 Calculation of Chemotherapy Dose

Chemotherapy dosage is determined with precision to maximize therapeutic efficacy while minimizing toxicity. The dose is not random but depends on several patient-specific and pharmacological factors [33]:

2.2.1 Key Factors in Dose Determination

1. Patient's Weight and Body Surface Area (BSA)

o Dosage is often calculated based on BSA (m^2), reflecting blood volume and organ size [34].

o Example: DuBois Formula:

$$BSA (m^2) = 0.007184 \times \text{Weight (kg)}^{0.425} \times \text{Height (cm)}^{0.725}$$

Liver and Kidney Function

o These organs metabolize and excrete the drug. Impairment requires dose adjustment to prevent toxicity [35].

2. Type of Chemotherapy Drug

o Each drug has a standard dose determined by clinical studies, with different potency and toxicity [36].

3. Stage and Severity of Cancer

o Higher doses may be used when aiming for a cure; lower doses are used for disease control [37].

4. Age and General Health Condition

o Elderly patients or those with chronic conditions may require reduced doses [38].

5. Treatment Schedule

o Drugs may be administered daily, weekly, or in cycles. Total dose depends on the number of cycles and rest periods [39].

Conclusion: Chemotherapy dose is a result of precise calculation, integrating BSA, organ function, drug type, and patient condition [40]. The type of chemotherapy clears in fig 2.



Fig 2. Types of Chemotherapy [41].

2.2.2 Practical Example: Doxorubicin Dosage Calculation

Patient Data:

- Weight: 70 kg
- Height: 170 cm
- Medication: Doxorubicin
- Prescribed Dose: 60 mg/m^2 per course

Step 1: Calculate BSA using the DuBois formula

$$1. \text{ Weight } ^{0.425}: 70^{0.425} \approx 4.3570$$

$$2. \text{ Height } ^{0.725}: 170^{0.725} \approx 38.5$$

$$3. \text{ Multiply by } 0.007184: BSA \approx 1.20 m^2$$

Step 2: Calculate the Dose

$$\text{Dose (mg)} = \text{Prescribed Dose (mg/m}^2\text{)} \times \text{BSA (m}^2\text{)} = 60 \times 1.2 \approx 72 \text{ mg}$$

Step 3: Adjust Dose if Necessary

- Reduce by 20–30% if liver or kidney function is impaired.
- Divide the dose over multiple days if the treatment course is repeated.

Summary: Dose calculation formula [42]:

Actual Dose = BSA $\times$ Standard Dose $\times$ Adjustment Factor (if any). The treatments are arranged and summarized in the table below [43].

Table 1. Common Chemotherapy Drugs[44].

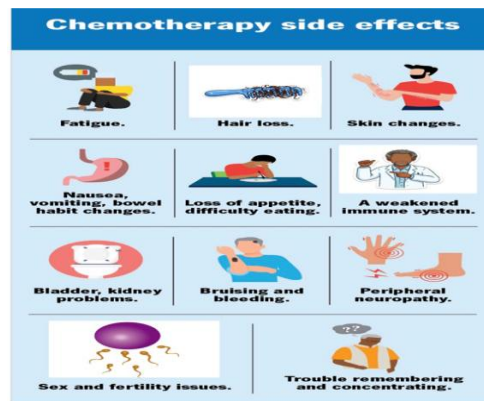
Drug	Type	Chemical Formula	Mechanism of Action
Doxorubicin	Anthracycline	$C_{27}H_{29}NO_{11}$	Inhibits topoisomerase, preventing DNA replication in cancer cells
Cisplatin	Platinum-based	$PtCl_2(NH_3)_2$	Binds DNA, preventing replication and inducing cancer cell death
Paclitaxel	Taxane	$C_{47}H_{51}NO_{14}$	Stabilizes microtubules, preventing cancer cell division
Fluorouracil (5-FU)	Antimetabolite	$C_4H_3FN_2O_2$	Mimics uracil, disrupting DNA synthesis
Irinotecan	Topoisomerase I inhibitor	$C_{33}H_{38}N_4O_6$	Prevents DNA relaxation during replication, causing cancer cell death

Important Notes:

- Chemotherapy drugs can be plant-derived (e.g., Paclitaxel) or synthetic (e.g., Cisplatin).
- Knowing chemical formulas is useful for research and pharmacy, but patient dosing relies on BSA and standard dose [45].

2.4 Effects of Chemotherapy on the Body

- Skin and Hair**
 - Hair loss, dry skin, rashes, redness, and sensitivity to sunlight or infections [46].
- Mucous Membranes**
 - Ulcers in mouth, throat, and stomach, leading to eating and swallowing difficulties [47].
- Vital Organs**
 - Liver and kidneys: Drug metabolism and excretion stress; functions may be affected.
 - Heart and lungs: Some drugs (e.g., Doxorubicin) may weaken heart muscle long-term.
 - Bone marrow: Suppression of blood cell production, causing anemia or immunodeficiency.

**Fig 3.** Effects of Chemotherapy on the Body [48].**2.5 Interactions of Chemotherapy Drugs [49]:**

- With Other Medications**
 - Can increase toxicity or reduce effectiveness (e.g., Cisplatin + Gentamicin → increased kidney risk).
- Within the Body**
 - Drugs are metabolized in the liver; some metabolites are active or toxic, requiring dose adjustment.
- With Nutrients or Supplements**
 - Certain supplements (e.g., vitamin E, licorice) may alter drug effectiveness [50], as shown in fig 3.

3.Results and Discussion**3.1 Study Context and Site**

The practical study was conducted at the Oncology Center (National Oncology and Hematology Hospital, Najaf) on Thursday, November 13, 2025, at 11:47 AM. The study aimed to observe the workflow of chemotherapy preparation and administration, assess the medications available, and understand the protocols applied for patient treatment. The visit included three main components:

- Visiting the Pharmacy Supervisor's Office
- Observing the Medication Preparation Room
- Observing Patients During Treatment Infusions

3.2 Visit to the Pharmacy Supervisor's Office.

During the visit, the researcher conducted an in-depth interview with the pharmacy supervisor. Key topics addressed included:

3.2.1 Medications Available in the Pharmacy

The pharmacy maintains an inventory of over 150 medications used for chemotherapy and supportive care. Medications can be categorized as:

- Dispensed Medications:** Readily available for patients as prescribed.
- High-Cost Medications:** Some medications are not routinely dispensed due to their high cost (exceeding 1 million Iraqi dinars), requiring special approval or patient financial support. Figure 1 and Table 1, Shows the distribution of medications between dispensed medications (73%) and expensive medications (27%) using a pie chart.

3.2.2 Protocols for Medication Administration

The type and schedule of chemotherapy protocols depend on the patient's diagnosis and the treating physician's instructions. Typical considerations include:

- **Treatment Cycles:** Chemotherapy is usually administered in cycles (e.g., six cycles of 21 days each). Each dose is delivered after a predefined interval, allowing the patient to recover between sessions.
- **Adjustment of Protocols:** The dosage, concentration, or protocol may be modified due to:
 - o Changes in Body Surface Area (BSA) from weight loss or general weakness.
 - o Hair loss and other treatment side effects.
 - o Compromised immunity or low blood counts.
 - o Financial limitations, where some high-cost medications are unavailable.

Table 2. Medications Available

Category	Number of Medications	Percentage (%)
Dispensed Medications	110	73%
High-Cost (Restricted)	40	27%
Total	150	100%

3.2 Protocol Adjustments

Figure 3.2 and table 3.2, Shows the factors affecting treatment outcomes (medication availability, patient condition, financial constraints, and quality of monitoring) using a table with icons to explain each factor.

3.2.3 Common or Frequent Medical Conditions

- **Breast Cancer:** The most commonly treated cancer at the center.
- Other frequently observed cancers were noted in patient records but were outside the focus of this study.

Table3. Cancer Types

Cancer Type	Frequency Level
Breast Cancer	High
Gastrointestinal	Moderate
Other Cancers	Low

3.2.4 Other Services in the Pharmacy

Main Services:

1. Specialist Physicians
2. Pharmacy Staff
3. Medication Preparation Facilities

Secondary Services:

1. Patient rooms during treatment
2. Air conditioning and sterilization systems
3. Cleaning staff and hygiene services
4. Restrooms and patient amenities
5. Two small gardens for patient recreation

Table 4. Services in center

Service Type	Components
Main Services	Physicians, Pharmacy staff, Drug preparation
Secondary	Patient rooms, AC systems, cleaning, restrooms, gardens

3.3 Visit to the Medication Preparation Room

The medication preparation room is a controlled environment where chemotherapy drugs are prepared for intravenous administration. Key observations included:

1. **Computers and Digital Records:**
 - o Each patient's information and treatment schedule are recorded digitally, including prescribed dosages.
2. **Medications:**
 - o All chemotherapy drugs are organized by patient name to minimize errors during preparation.
3. **Preparation Rooms:**
 - o These are enclosed rooms with strict aseptic protocols to prevent contamination.
 - o Staff wear protective equipment, including gloves, masks, and gowns, to ensure safety and sterility.

Scientific Note: The controlled preparation environment aligns with international standards for intravenous chemotherapy compounding, minimizing the risk of drug degradation and occupational exposure.

Table 5. Preparation Room.

Component	Description
Digital Records	Patient data and dosage tracking
Drug Organization	Sorted by patient
Aseptic Environment	Controlled sterile rooms
Protective Equipment	Gloves, masks, gowns

3.4 Observations in Patient Rooms During Treatment

The researcher observed several patient wards where chemotherapy infusions were administered:

1. **Ward Layout:**
 - o Some wards had a high density of beds, while others were smaller with fewer patients, depending on room capacity.
2. **Patient Monitoring:**
 - o Patients were closely monitored for adverse reactions, such as nausea, dizziness, or infusion site complications.
 - o Nurses maintained vital signs records and adjusted infusion rates as required.
3. **Safety Protocols:**
 - o Infusion equipment, including IV lines and pumps, were checked regularly.
 - o Sterility and hygiene standards were strictly maintained throughout the process.

Table 6. Patient Observation

Observation Aspect	Details
Ward Layout	Variable capacity
Monitoring	Vital signs, side effects
Safety Measures	IV checks, sterile procedures

3.5 Scientific Integration and Notes

- The study highlighted the interdependence of pharmacy availability, preparation protocols, and patient monitoring, emphasizing the complexity of delivering safe and effective chemotherapy.
- Observations reinforced that financial constraints, patient health status, and protocol adjustments directly affect treatment outcomes.
- The practical study serves as a basis for understanding real-world challenges in chemotherapy administration and provides empirical data for research on dosage optimization, workflow efficiency, and patient safety.

1. Drug Availability:

The study results indicate that 73% of drugs are readily available, while 27% are expensive and not consistently available. Globally, health organizations such as the WHO recommend that essential cancer drugs be available in approximately 90–100% of specialized centers.

→ This indicates a gap in drug availability that may affect the quality of treatment.

2. Protocol Adjustment:

The results showed that dosage adjustments are based on health status, body surface area, and financial circumstances. In contrast, international standards are based on: Adjustment based solely on BSA and clinical condition. The treatment plan is not influenced by economic factors.

→ This suggests that financial factors present an additional challenge locally compared to global practices.

3. Preparation Environment:

The study showed that drug preparation takes place in a sterile environment using protective equipment. This aligns with international standards such as: USP <797>

ISO Class 5 Cleanroom

→ This demonstrates good compliance with international standards regarding safety and preparation.

4. Patient Monitoring:

Continuous monitoring of vital signs and side effects was recorded. This is consistent with international protocols that emphasize: Continuous monitoring during infusion. Rapid intervention in case of complications.

→ This indicates good application of clinical safety standards.

5. Patient Density and Services (Healthcare Infrastructure):

Variations in patient density were observed within the wards. International standards recommend a ratio of: One nurse for every 2–4 patients in chemotherapy units.

→ This may indicate strain on human and service resources. Overall, the study results show that: There is good alignment with international standards in the following areas: Medication preparation. Safety procedures. Patient monitoring. Conversely, there are clear gaps in: Medication availability. The impact of

economic factors. Patient density and services. This reflects the challenges related to resources and capabilities compared to leading global centers.

Table 7. Key Findings for analysis.

Factor	Effect on Treatment Outcome
Drug availability	Limits treatment options
Patient condition	Affects dosage
Financial constraints	Delays or modifies therapy
Monitoring quality	Improves safety

4 Conclusion

• Effects on Skin and Organs:

The effects of chemotherapy and radiation on the skin and vital organs are common and expected, but their severity varies depending on the type of medication or radiation, the administered dose, and the individual patient's condition. Continuous monitoring and adjustment of doses are essential to minimize toxicity.

• Chemical and Biological Reactions:

Chemotherapy drugs may interact chemically with other medications, nutrients, or body metabolites, which is why precise dosing, periodic laboratory analyses, and careful supervision by medical staff are crucial. Similarly, radiation's biological effects depend on dose, radiation type, and tissue sensitivity, potentially causing both acute (e.g., mucosal inflammation) and chronic complications (e.g., fibrosis, bone necrosis).

• Integration of Chemotherapy and Radiation:

Chemotherapy is often used alone or in combination with radiation therapy, particularly in advanced or non-surgical cases. While this combination can enhance therapeutic effectiveness, it may also increase toxicity, requiring meticulous dose planning, monitoring, and follow-up to ensure patient safety.

• Safety and Technical Considerations:

Advances in radiation therapy and chemotherapy techniques aim to maximize tumor control while minimizing harm to healthy tissues. Principles of justification, dose optimization, staff training, and modern control systems are critical to reducing errors associated with human and organizational factors.

4.1 Future Directions:

Ongoing research focuses on developing advanced radiotherapy techniques and improved pharmacological formulations to enhance treatment efficacy, reduce adverse effects, and improve overall patient safety. Continuous evaluation, prevention strategies, and evidence-based dose adjustments remain fundamental for optimizing clinical outcomes.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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