

ORIGINAL ARTICLE

Mineral Supplements' Prescribing Practices in Critically Ill Cancer Patients: A Study Investigating Physicians' Prescribing Practices and Roles of Nutrition Support Pharmacists at a Tertiary Cancer Center

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Abstract

Objective: This study aimed to explore physicians' prescribing practices and roles of nutrition support pharmacists in managing mineral deficiencies in critically ill cancer patients admitted to intensive care units (ICU) at a tertiary cancer center.

Methods: A retrospective analysis of 9949 electronic records of critically ill cancer patients admitted to the ICU from January 2020 to December 2022 was performed. All mineral supplement prescriptions by physicians and nutrition support pharmacists' interventions were recorded. Analysis was performed utilizing the Jamovi statistical package 2022

Results: The study population comprised pediatric patients and adult patients. Major minerals were most frequently prescribed in ICU cancer patients, followed by trace minerals. Potassium was the most prescribed mineral supplement, followed by Sodium, Calcium, and Magnesium. The least prescribed was Lithium. The most frequent intervention of pharmacists was initiating mineral supplement use, followed by discontinuing mineral supplement use. The acceptance rate of interventions by physicians was 88%.

Conclusion: Potassium was the most prescribed mineral supplement in critically ill cancer patients at a tertiary cancer center. Nutrition support pharmacists' interventions were highly accepted by physicians. The prevailing intervention was the initiation of mineral supplement use. Further studies are needed to explore the barriers to implementing nutrition support services in different healthcare settings.

Keywords: Clinical pharmacy, nutrition support pharmacy, minerals, critical care

INTRODUCTION

Clinical pharmacy is an area of pharmacy practice focused on the philosophy of pharmaceutical care [1]. It aims to optimize pharmacotherapy, improving patient outcomes [2]. The Board of Pharmacy Specialties (BPS) administers certifications in various specialties such as oncology, critical care, and nutrition support pharmacy [2].

Critical care clinical pharmacists are essential members of intensive care teams. They ensure the safe and efficacious use of medications in this vulnerable population [3-11]. Clinical pharmacists also provide nutrition support pharmacy services, including evaluating nutritional status and managing micro-nutrient deficiencies [12-20].

Clinical pharmacy services enhance patient outcomes and reduce healthcare-related expenditures [12-20]. They provide various services which lead to optimizing pharmacotherapy in intensive care units (ICU). Clinical pharmacists also provide nutrition support pharmacy services. These activities improve patients' quality of life, reduce mortality and morbidity, improve patient outcomes, and decrease treatment-related costs [12-20]. Timely nutritional therapy should be considered for cancer patients at risk of malnutrition [12-29].

Micronutrients are nutrients the body needs in minute amounts. However, deficiency in micronutrients can affect the body's overall health and can lead to severe and even life-threatening conditions [21,32].

Minerals and vitamins are the classes most community pharmacists recommend for complementary and alternative medicines [33,34]. Few studies explored the role of clinical pharmacists in managing mineral use in critical care settings [35].

A limited number of studies explore the role of nutrition support pharmacy services in the Middle East, and none were conducted in Jordan [36].

This study aimed to explore physicians' prescribing practices and roles of nutrition support pharmacists in managing mineral deficiencies in critically ill cancer patients admitted to intensive care units (ICU) at a tertiary cancer center in Jordan.

METHODS

A retrospective analysis of electronically reported clinical pharmacist interventions for patients admitted to King Hussein Cancer Centre (KHCC) in Amman, Jordan, was conducted from January 2020 to December 2022. Electronic records of 9949 patients admitted to intensive care units were extracted. All mineral supplement prescriptions by physicians and nutrition support pharmacists interventions were recorded. This study was approved by the Ethics Committee (EC) / Institutional Review Board (IRB) at King Hussein Cancer Centre (KHCC) on 25 October 2021 with the approval number RC/2021/153. Enrolled participants were critically ill cancer patients admitted either to the adult or pediatric ICU services from January 2020 to December 2022. Patients' age groups were classified into two categories: the pediatric group for patients 18 years old or less and the adult group for patients older than 18. Descriptive statistics were utilized to evaluate the results in frequencies and percentages.

The Mann-Whitney U test was used to compare the means of the time taken by clinical pharmacists to intervene between the pediatric and adult ICU service groups. Analysis was performed using the Jamovi statistical package 2022 [30,31]. A p-value less than 0.05 was considered significant.

RESULTS

The total number of interventions related to the management of minerals was 300. The study population comprised pediatric patients

($n = 96$, 32.0 %) and adult patients ($n = 204$, 68.0 %). Most of the study population were males ($n = 151$, 50.3 %) (Table 1).

Table 1: Characteristics of participants

						Percentiles		
	Gender	Service	N	Median	IQR	25th	50th	75th
Age (years)	F	ICU-Adult	108	57.0	16.00	49.00	57.00	65.0
		ICU-Pediatric	41	9	7.00	6.00	9.00	13.0
	M	ICU-Adult	96	58.0	23.75	44.75	58.00	68.5
		ICU-Pediatric	55	10	7.00	6.00	10.00	13.0

Distribution of participants based on admission date:

Most participants with mineral supplement prescriptions were admitted to the ICU in 2022. The number of patients admitted to the ICU with interventions related to minerals in 2022 was ($n = 112$, 37.3 %). The number of patients admitted in 2021 was ($n = 106$, 35.3 %), and in 2020 was ($n = 82$, 27.3 %).

Analysis of mineral supplements prescribing practices in ICU cancer patients:

Major minerals ($n = 282$, 94.0 %) were most frequently prescribed in ICU cancer

patients, followed by trace minerals ($n = 18$, 6.0 %). Potassium was the most prescribed mineral ($n = 39$, 35.7 %), followed by Sodium ($n = 92$, 30.7 %), Calcium ($n = 66$, 22.0 %), and Magnesium ($n = 12$, 4.0 %). The least prescribed mineral was Lithium ($n = 1$, 0.3 %). The frequencies of mineral supplement prescriptions are described in Table 2, and the frequencies of minerals' forms are described in Table 3.

Table 2: Frequencies of mineral supplement prescriptions

Supplement	Counts	% of Total	Cumulative %
Calcium	66	22.0 %	
Iron	3	1.0 %	
Lithium	1	0.3 %	
Magnesium	12	4.0 %	
Phosphate	2	0.7 %	
Potassium	107	35.7 %	
Sodium	92	30.7 %	
Zinc	17	5.7 %	

Table 3: Frequencies of supplement form

Supplement form	Counts	%of Total	Cumulative %
Calcium Carbonate	9	3.0 %	
Calcium Chloride	1	0.3 %	
Calcium Gluconate	36	12.0 %	
Calcium Polystyrene Sulfonate	20	6.7 %	
Iron Sucrose	3	1.0 %	
Lithium	1	0.3 %	
Magnesium Chloride	2	0.7 %	
Magnesium Oxide	2	0.7 %	
Magnesium Sulfate	8	2.7 %	
Phosphate	2	0.7 %	
Potassium Acetate	1	0.3 %	
Potassium Chloride	92	30.7 %	
Potassium Glucoheptonate	5	1.7 %	
Potassium Phosphate	10	3.3 %	
Sodium Alginate	4	1.3 %	
Sodium Bicarbonate	22	7.3 %	
Sodium Chloride	37	12.3 %	
Sodium Hyaluronate	2	0.7 %	
Sodium Phosphates	26	8.7 %	
Zinc Oxide	12	4.0 %	
Zinc Sulfate	5	1.7 %	

Analysis of pharmacists' interventions for managing mineral use:

The acceptance rate of nutrition support pharmacists' interventions by physicians was 88 %. The initiation of mineral use ($n = 88$, 29.3 %) was found to be the most frequent

intervention of pharmacists in the management of minerals in critically ill cancer patients admitted to ICU, followed by discontinuation of mineral use ($n = 67$, 22.3 %). Table 4 depicts the frequencies of interventions.

Table 4: Frequencies of Intervention

Intervention	Counts	% of Total	Cumulative %
Allergy Information Clarified	3	1.0 %	
Clarification of orders	8	2.7 %	
Conversion from intravenous (IV)- to- oral (PO) done	4	1.3 %	
Discontinuation of mineral use	67	22.3 %	
Dose clarified/evaluated.	41	13.7 %	
Drug Information provided	1	0.3 %	
Drug levels monitored	3	1.0 %	
Duration of RX Order Clarified	35	11.7 %	

Intervention	Counts	% of Total	Cumulative %
Fluid type clarification	5	1.7 %	
Infusion Rate clarified	2	0.7 %	
Initiation of mineral use	88	29.3 %	
Lab Evaluation	25	8.3 %	
Medication reconciliation/Discharge	2	0.7 %	
Medication reconciliation/Admission	3	1.0 %	
Medication start date clarified	1	0.3 %	
Route of administration clarified	7	2.3 %	
Therapeutic duplication avoided	5	1.7 %	

Analysis of time taken by pharmacists to intervene:

The clinical pharmacist performed 300 interventions related to the management of mineral use. The sum of the times taken was

3902 minutes. The minimum time was 1, and the maximum time was 40 minutes. Table 5 describes the distribution of intervention time taken according to the type of intervention.

Table 5: Time taken by clinical pharmacists to intervene

	Intervention		N	Median	IQR	25th	50th	75th
Time Taken	Allergy Information Clarified	3	10	4.000	6.00	10.00	10.00	
	Clarification of orders	8	10.00	0.000	10.00	10.00	10.00	
	Conversion from intravenous (IV)-to-oral (PO) done	4	5.00	7.500	5.00	5.00	12.50	
	Discontinuation of mineral use	67	15	0.000	15.00	15.00	15.00	
	Dose clarified/evaluated.	41	10	5.000	10.00	10.00	15.00	
	Drug Information provided	1	3	0.000	3.00	3.00	3.00	
	Drug levels monitored	3	10	5.000	10.00	10.00	15.00	
	Duration of RX Order Clarified	35	10	2.500	7.50	10.00	10.00	
	Fluid type clarification	5	10	0.000	10.00	10.00	10.00	
	Infusion Rate clarified	2	17.50	7.500	13.75	17.50	21.25	
	Initiation of mineral use	88	15.00	0.000	15.00	15.00	15.00	
	Lab Evaluation	25	5	5.000	5.00	5.00	10.00	
	Medication reconciliation/Discharge	2	1.50	0.500	1.25	1.50	1.75	
	Medication reconciliation/admission	3	15	0.000	15.00	15.00	15.00	
	Medication start date clarified	1	30	0.000	30.00	30.00	30.00	
	Route of administration clarified	7	10	0.000	10.00	10.00	10.00	
	Therapeutic duplication avoided	5	5	0.000	5.00	5.00	5.00	

Time taken by clinical pharmacists to intervene in paediatric ICU compared to adult ICU.

The means of time taken by clinical pharmacists to intervene in the pediatric ICU group compared to the adult ICU group using the Mann-Whitney U T-test. The test showed no significant difference between the population means (p-value 0.568).

DISCUSSION

Major minerals were found to be the most used in ICU cancer patients, followed by trace minerals. Potassium was the most used mineral, followed by Sodium, Calcium, and Magnesium. The initiation of mineral use was found to be the most frequent intervention of pharmacists in critically ill cancer patients admitted to ICU, followed by discontinuation of mineral use. The number of clinical nutrition support pharmacists' interventions for managing mineral use was relatively low compared to the total number of clinical pharmacists' interventions in the ICU. This is consistent with a Chinese prospective study [35].

Cancer is an overwhelming problem worldwide and the burden of cancer is increasing. The incidence rate of cancers is increasing among Jordanians and the number of 5-year prevalent cases in Jordan was 34172 in 2022 which leads to increased patient morbidity and mortality [44,45]. Several international studies have shown that clinical pharmacists play an important role in enhancing patients' survival rate, quality of life, and prognosis [35-43]. However, there is a lack of evidence at the local level.

Clinical pharmacists are integral members of the multidisciplinary medical team at the intensive care units. Clinical pharmacists at King Hussein Cancer Center are highly qualified pharmacists holding a Doctor of

Pharmacy (Pharm.D) degree or a master's degree in clinical pharmacy. Some are board-certified in pharmacotherapy, oncology pharmacy, and nutrition support pharmacy by the American Board of Pharmacy Specialties. They attend medical rounds in the ICU, cooperate with other healthcare professionals, and are available for consultation. The interventions of clinical pharmacists were highly accepted by physicians compared to the acceptance rate reported by a recent Dutch study which reflects physicians' confidence and trust in clinical pharmacists at KHCC [43].

Nutrition support pharmacy practices are uncommon practices in Jordanian hospitals and can only be reported at a King Hussein Cancer Center. There are several barriers to applying these services. For instance, the study plans for the pharmacy and medicine undergraduate programs in Jordan do not include a sufficient number of courses in the field of nutrition. More studies are needed to explore the barriers to implementing nutrition support therapy services. More studies are also needed to investigate the impact of nutrition support therapy practices on critically ill patients' outcomes.

The available evidence on the role of pharmacists in managing vitamin and mineral supplements is limited [33,34]. To our knowledge, the present study was the first to investigate pharmacists' interventions in managing mineral deficiencies in critically ill cancer patients admitted to intensive care units in Jordan. It is one of the strengths of the study.

The current practice guidelines recommend assessing and treating nutritional deficiencies in all cancer patients even though the current evidence on the efficacy of most dietary factors appears inadequate to recommend their use [34]. Malnutrition leads

to poor prognosis and decreased quality of life in cancer patients [34]. More research is needed on the effects of micronutrient supplementation on cancer patients' outcomes.

To the best of our knowledge, this is the first study to explore the mean time the nutrition support pharmacists took to intervene in mineral use in ICU cancer patients. It is another strength of the study.

The interventions of specialized nutrition support pharmacists took between 1 and 40 minutes in the present study. In another study conducted at a university hospital, clinical pharmacists' interventions took 15 – 30 minutes to complete [39]. More studies are needed to analyze factors related to optimizing and implementing specialized nutrition support pharmacy services in different patient populations.

The limitations of the current study are the recall bias and incomplete documentation of

interventions due to the retrospective design.

CONCLUSION

Potassium was the most prescribed mineral supplement in critically ill cancer patients at a tertiary center. Nutrition support pharmacists' interventions in managing mineral use in critically ill patients admitted to the ICU were highly accepted by physicians. The prevailing intervention was the initiation of mineral use. Further studies are needed to explore the barriers to implementing nutrition support services in different healthcare settings and the factors affecting the needed time to provide these services across different populations and health services.

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Conflict of interest

No potential conflict of interest relevant to this study was reported.

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ممارسات وصف مكملات المعادن لمرضى السرطان في العناية الحثيثة: دراسة حول ممارسات الصرف من قبل الأطباء و أدوار صيادلة الدعم الغذائي في مركز سرطان متخصص

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الملخص

الخلفية والاهداف : تهدف هذه الدراسة إلى استكشاف ممارسات وصف الأطباء وأدوار صيادلة الدعم الغذائي في معالجة نقص المعادن لدى مرضى السرطان المصابين بأمراض خطيرة الذين يتم إدخالهم إلى وحدات العناية المركزة في مركز سرطان متخصص. منهجية الدراسة : تم إجراء تحليل بأثر رجعي لـ 9949 سجلاً إلكترونياً لمرضى السرطان الذين تم إدخالهم إلى وحدة العناية المركزة من يناير 2020 إلى ديسمبر 2022. تم تسجيل جميع وصفات المكملات المعدنية من قبل الأطباء وتدخلات صيادلة الدعم الغذائي . تم إجراء التحليل باستخدام حزمة جاموفي .

النتائج : تألف مجتمع الدراسة من المرضى الأطفال والمرضى البالغين. تم وصف المعادن الرئيسية في أغلب الأحيان في مرضى السرطان في وحدة العناية المركزة ، تليها المعادن النزرة. كان البوتاسيوم هو المكمل الأكثر وصفاً ، يليه الصوديوم والكالسيوم والمغنيسيوم و كان الليثيوم هو المكمل الأقل وصفاً . كان التدخل الأكثر شيوعاً للصيادلة هو النصيحة حول بدء استخدام المكملات المعدنية ، يليه النصيحة بالتوقف عن استخدام المكملات المعدنية. و قد بلغ معدل قبول التدخلات من قبل الأطباء 88 %.

الاستنتاجات : كان البوتاسيوم أكثر المكملات المعدنية الموصوفة في مرضى السرطان في العناية الحثيثة في مركز سرطان متخصص. تم قبول تدخلات صيادلة دعم التغذية بشكل كبير من قبل الأطباء. كان التدخل السائد هو النصيحة حول بدء استخدام المكملات المعدنية. هناك حاجة إلى مزيد من الدراسات لاستكشاف الحواجز التي تحول دون تنفيذ خدمات دعم التغذية في أماكن الرعاية الصحية المختلفة.

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الكلمات الدالة: الصيدلة السريرية ، صيدلية دعم التغذية ، المعادن ، العناية الحثيثة.