

Staff Nurses Compliance with Covid-19 Preventive Measures during Caring of Patients with Bone Marrow Transplantation and Its Affecting Factors

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Abstract

Background: Patients who undergo bone marrow transplantation experience a sequential suppression of host defenses, resulting in varying infectious risk at different phases of the transplantation process, so such group of patients are at increased risk for contracting infectious diseases (covid-19) with high morbidity and mortality rates. **Aim** of study was to assess staff nurses compliance with covid-19 preventive measures during caring of patients with bone marrow transplantation and its affecting factors. **Design:** A descriptive exploratory design was utilized to achieve the aim of the study. **Setting:** The present study was carried out in the bone marrow transplantation unites at two settings, Dar El Salam oncology center and Naser institute hospital. **Study subjects:** A convenient sample of all available staff nurses (n=50),25 nurses in each selected setting. **Tools:** I. Nurses' self-administered questionnaire, it included demographic characteristics, knowledge assessment & factors influencing compliance: II - Nurses' practice observational checklist. III. Nurses' attitude Likert scale and V. Nurses compliance assessment scale. **Result:** revealed that (56%) of studied nurses had good level of knowledge, (30%) of them had average level of knowledge and (14%) of them had poor level of knowledge regarding COVID -19 preventive measures, 74% of the studied nurses reported low affecting factors, 14% of them reported moderate affecting factors and 12% of them reported high factors affecting their compliance with COVID-19 preventive measures. As well , (58%) of studied nurses had high competency level of practice, (26%) of them had moderate competency level and (16%) of them had low competency level regarding covid-19 preventive measures during caring of patients with BMT. Besides, (64%) of the studied nurses had positive attitude, (36%) of them had negative attitude. Regarding nurses compliance, (56%) of them had high level of compliance, (26%) of them had moderate level of compliance and (18%) of them had low level of compliance. **Conclusion:** more than two quarter of the studied nurses had good level of knowledge, half of them had good competency level of practice and more than half of them had positive attitude. Also, more than half of them had high level of compliance. And more than three quarters of them reported low factors affecting their compliance with Covid-19 preventive measures during caring of patients with bone marrow transplantation. Additionally, there was highly statistically significant positive correlation between the studied nurses total level of knowledge, practice, attitude, affecting factors and their compliance with COVID-19 preventive measures. **Recommendation.**Importance of continuous inservice training program for nurses staff regarding covid-19 preventives measures during caring of patients with bone marrow transplantation t taking into consideration the studied affecting factors to improve their performance and consequently their compliance .

Key words: bone marrow transplantation, coronavirus 2019, preventive measures, nurses' compliance, affecting factors

Introduction

The new coronavirus SARS-CoV-2 has rapidly spread over the world causing the disease by WHO called COVID-19. This pandemic poses unprecedented stress on the health care system including programs performing allogeneic and autologous

hematopoietic stem cell transplantation (HSCT) and cellular therapy such as with chimeric antigen receptor t cells. The European Society for Blood and Marrow Transplantation (ESBMT) has therefore developed recommendations for transplant programs and physicians caring for these patients. These guidelines were developed by

experts from the Infectious Diseases Working Party and have been endorsed by ESBMT's scientific council and board. This work intends to provide guidelines for transplant centers, management of transplant candidates and recipients, and donor issues until the COVID-19 pandemic has passed (*Ljungman, 2020*).

A bone marrow transplantation (BMT) is the medical treatment that replaces the patient's bone marrow with healthy cells, the replacement cells can either come from the patient own body or from donors. The BMT can be used to treat certain types of cancer, such as leukemia, myeloma, and lymphoma, and other blood and immune system diseases that affect the bone marrow (*Ahnach, 2020*).

Compliance is the level of precision and constancy in following prescribed standard protocols to achieve the desired outcomes. Compliance is the extent to which certain behavior is in accordance with the set instructions or health care advice compliance with infection control behaviours can be difficult. Previous literature has reported on difficulties in the general population with adhering to protective behaviours such as facemask wearing and using hand sanitizing during infectious disease outbreaks (*Aboelfetoh, 2021*).

The main facilitators of compliance in the general population appear to be susceptibility, perceived severity of being afflicted and perceived benefits of compliance, as well as accurate knowledge about the disease and the recommended behaviours, while major barriers include discomfort, embarrassment and practical issues. A review of healthcare workers' perceptions of barriers and facilitators to compliance with guidelines during respiratory outbreaks suggested that protective practices are influenced by understanding of guidelines, support received from managers, communication about guidelines, sufficient resources, perceived value of following guidance, comfort of personal protective equipment (PPE), perceived impact of PPE on patients and workplace culture (*Esmail, 2019*).

The phases of BMT can be identified as the pre-transplant period, during transplant, the immediate post-transplant period, and the late post-transplant period. Nurses play an integral role in the care of patients with BMT thorough all phases. The role of the nurse in BMT settings is crucial. Responsibilities include supporting patients through the procedure and the recovery phase, by monitoring changes in their condition and administering a range of therapeutic interventions (such as blood products or antibiotics) whilst the clotting and immune-responses remain compromised (*Zemrani et al., 2020*).

Preventative measures for patients with BMT; included; encouraging them to avoid crowded places and public transport, using good hand hygiene measures and remaining in self-isolation for 14 days prior to the start of conditioning. Careful history taking to determine whether the patient has had a recent contact with an individual proven to have COVID-19 or symptoms suggestive of COVID-19. Any planned transplant should be reviewed and deferred if possible, following the National Institute for Health and Care Excellence Rapid Guidance (*Cristian, 2020*).

Preventing the exponential spread ability of Covid-19 infection among the patients undergoing BMT completely relies on the nurses for the use of an effective PPE which includes face masks/respirators, gloves, goggles/face shields, and gowns, Face Mask/Respirators, according to the recent report of WHO (March 29th 2020) who describes Covid-19 may be an air born infection transmitted through, respiratory droplets (*Bahl, 2020*).

Nursing is an integral member of the multidisciplinary team who care for the patients undergoing BMT. The pre-transplant period is intensive for delivery of preparative therapy, management of early complications, and teaching and support to the patient and family. Culmination of this period occurs on the day of the marrow transplant, and the focus of care then shifts to address a whole new group of potential problems (*Ali, 2019*).

Nurses are being part of the inter professional team with a strong shoulder-to-shoulder workforce together with physicians, physiotherapist, dietitians, social workers or chaplains, the nurses have unique role in being present with the patients 24/7 during the treatment but also in the time before and after the treatment. Nurses take over the responsibility to educate patients before the treatment about any aspects that are important to successfully undergo the procedure. Over the past decades, many nurses not only developed clinical skills but are also excellent researchers looking deeper into the phenomena of patients, family members and measuring outcomes based on a reflective way of practicing nursing. The field of nursing research in HSCT has evolved from reflecting on symptom management and service development to quality of life and long-term survival topics (*Balduzzi, 2017*).

Significance of the study

As reported by (*WHO, 2021*). covid-19 is affecting 220 countries, there had been 187,519,798 confirmed cases of covid-19, with 4,049,372 deaths and 172,513,695 recovered. In Egypt, there had been 283, 320 confirmed cases with 16,412 deaths and 219,525 recovered.

According to the National Marrow Donor Program, 2.4% of people who donated bone marrow experienced a serious complication. Around the world, researchers looked at over 27,000 people who had donated bone marrow in 35 countries of these people, there was one death and 12 serious complications (namely bacterial infection was the most common, and viral, fungal & other infections can also occur) (*Li, 2021*).

The statistical record at the selected hospitals (2021), revealed that total patients admitted with BMT at Dare El Salam oncology center were 100, of them 10 patients dead representing 10% of total admitted and 110 patients admitted in Naser institute hospital, of total admission of them 14 dead representing 14%.

Aim of the Study

The aim of this study was to assess staff nurses compliance with covid-19 preventive measures during caring of patients with bone marrow transplantation and its affecting factors.

It was achieved through the following:

1. Assessing nurses' compliance level with Covid-19 preventive measures during caring of patients with bone marrow transplantation.
2. Assessing factors that influence nurses' compliance with Covid-19 preventive measures during caring of patients with bone marrow transplantation.

Research questions

This study directed to answer these questions:

1. What is the nurses' compliance level with Covid-19 preventive measures during caring of patients with bone marrow transplantation?
2. What are the factors that influence nurses' compliance with Covid-19 preventive measures during caring of patients with bone marrow transplantation?

Subjects and Methods

Technical design

The technical design was included research design, setting, subjects and tools of data collection.

Research design

A descriptive exploratory design was used to achieve the aim of this Study.

Setting

This study was conducted in BMT unites at two settings, Dar El Salam oncology center, consisting of 6 departments with different specialties distributed within hospitals and BMT unit located in the third floor, consisting of 14 beds .Naser institute hospital consisting of 8 departments with different specialty distributed within hospital and BMT unit

located in the seven floor consisting of 20 beds.

Subjects:

A convenient sample of all available nurses working in BMT units at the previously mentioned setting included in this study. Total nurses were (50), 25 nurses in each selected setting.

Tools of data collection

The study included four tools:

Tool 1: Nurses self-administered questionnaire:

These tools consisted of the following parts:

Part 1: Nurses demographic characteristic.

It consisted of seven items such as [age, sex, social status, level of education, years of experience, specified department, and attendance of training program about covid-19 preventive measures during caring of patient with BMT

Part 2: Nurses Knowledge assessment:

It was developed by investigator after reviewing recent and related literatures (Warner, 2021; Gugliesi, 2020; Zephir, 2019 and Jaeger, 2018) It used to assess nurses' level of knowledge towards covid-19 preventive measures during caring of patients with BMT. (Def, Types, indication, contraindication, management& covid-19 preventive measures. It consisted of (32) M.C.Q.

Scoring system of part 2:

The correct answer was scored "1 "while the incorrect answer took" zero" with total score was (32) grades distributed as the following:

- $<60\% = <20$ grade was considered poor knowledge
- $60 - <85\% = 20 - <28$ grades were considered average knowledge
- $\geq 85\% = \geq 28$ grade was considered good knowledge

Part3: Factors influencing nurses' compliance:

It was developed by investigator after reviewing recent and related literatures (Mizumoto, 2020; Zhao, 2020 and Hafez, 2019). It was used to assess factors influencing nurses' compliance with covid-19 preventive measures, it included human related factors (5) items and non-human related factors (23) items with total 28 items.

Scoring system of part 3: The items for each statement were scored 1 mark for yes/present and zero for no/ absent. Total score was 28 grades classified as the following.

- $< 60\% = <17$ grade indicated high affecting factors
- $60 - <85\% = 17 - <24$ grades indicated moderate affecting factors
- $\geq 85\% = \geq 24$ grade indicated low affecting factors

Tool 2: Nurses' practice observational checklist.

It was adapted from Dorgahm, (2016) & modified by investigator. It was used to assess nurses practice regarding covid-19 preventive measures during caring of patients with BMT, including. Hand washing (48 steps), PPE (69 steps), caring of patients with BMT (32steps) & the care of BMT unit, apheresis room and reprocessing materials and handling pallets (20 steps) with total steps were (169).

Scoring system: the respond for each step was scored by done correctly took "one" mark while done incorrectly or not done took "zero ". with total score of 169 grades classified as the following:

- $<60\% = < 101$ grade was considered low competency level.
- $60 - < 85\% = 101 - < 144$ grades were considered moderate competency level.
- $\geq 85\% = \geq 144$ grade was considered high competency level.

Tools 3: Nurses attitude Likert scale.

This tool adapted from Negrinho, (2017) and modified by investigator. It used to assess nurses attitude regarding covid-19 preventive measures during caring of patients with BMT.

Scoring system.

The nurses asked to respond on 5point Likert scale, ranged from 1to5 (strongly agree =5, agree=4, neutral=3, disagree=2, strongly disagree=1). for calculating the total score of this scale taking into consideration that strongly agree or agree as a positive attitude while strongly disagree, disagree, neutral as negative attitude. Attitude scale comprised of (24 items) with total score ranged from 24-120 grades classified as the following

- $<60\% = <72$ grade was considered negative attitude.
- $\geq 85\% = \geq 102$ grade was considered positive attitude.

Tools 4: Nurses compliance assessment scale.

This tool adapted from **Quan, (2015)** and modified by investigator. It used to assess nurses 'compliance with COVID-19 preventive measures during caring of patients with BMT and consisted of (33) items.

Scoring system

Compliance level was ranged from 1-5 (5 usually, 4 always, 3 often, 2 sometimes, 1 never). with total score ranged from 33-165 grades and classified as the following.

- $<60\% = <99$ grade was considered low compliant.
- $60 - <85 = 99 - <140$ grades were considered moderate compliant.
- $\geq 85\% = \geq 140$ grade was considered high compliant.

II- Operational design

It included preparatory phase, tools validity & reliability, ethical consideration, pilot study and fieldwork.

Preparatory phase

It included reviewing of related literatures and theoretical knowledge of various aspects of the study using books, articles, internet, periodicals and magazines to develop tools for data collection.

Tools validity & reliability.

Data collected tools were established by panel of seven expertise from medical

surgical nursing at Ain shams university (3 professors and 4 assistant professors) who reviewed the tools for clarity, relevance, comprehensive, understanding, applicability, and easiness for administration. The tools reliability tested statistically by Alpha Cronbach test to assure the internal consistency. Tool 1 nurses' self-administered questionnaire 0.857, tool 2 nurses' practice observational checklist 0.792, tool 3 nurses' attitude Likert scale 0.845 and tool 4 nurses' compliance assessment scale 0.902.

Ethical considerations:

The ethical research consideration in the study included the following:

- The investigator approval obtained from the ethical committee in the faculty of nursing at Ain Shams University before starting the study.
- The investigator clarified the objective and aim of the study to nurses included in the study.
- The investigator was assuring maintaining anonymity and confidentiality of subject's data.
- Nurses informed that they were allowed to choose to participate or not in the study and they had the right to withdraw from the study at any time.

Pilot study:

A pilot study was carried out on 10% of total study subjects (5 nurses) in order to test whether the used tools were clear, understandable, feasible, applicability and to estimate the time needed and minor modifications were done according to the results of pilot study. The nurses included in the pilot study were recruited in the current study subjects.

Field work:

- An approval was obtained from the selected hospital & nursing directors before starting the study.
- The purpose of the study was be simply explained to the nurses under study prior to any data collection.

- The investigator was available two days/week (1 day in each selected hospital) in the morning and afternoon shifts to fulfill data collection in each hospital with following manner.
- The investigator observed the practice of each nurse regarding covid-19 preventive measures while caring of patients with BMT, the investigator observed about 2 nurses in each shift.
- Self-administered questionnaire was filled by the nurses under study, it took about 15 minutes to be fulfilled from each nurse.
- Nurses attitude Likert scale and compliance scale were filled by the nurses under study, it took about half an hour from each nurse.
- Data collection was started and expected to be completed within 4 months.

III- The administrative design:

An official approval with written letter, clarifying, the purpose and setting of the study was obtained from director of the faculty of nursing at Ain Shams University to the directors of the selected setting.

Statistical design

The collected data was revised, coded, and tabulated using Statistical Package for Social Sciences (22), version 22.0 (SPSS Inc., Chicago, Illinois, USA). The statistical presentation and analysis of the present study was conducted using the mean and standard deviation (SD) and Pearson's correlation coefficient (r) test was used to assess the degree of association between two sets of variables.

Degrees of significance of results were considered as follow:

- P value > 0.05 insignificant (NS)
- P value ≤ 0.05 significant (S)
- P value ≤ 0.001 highly significant (HS)

Results

Table (1) shows that; 60% of the studied nurses aged 20<30 with mean

29.60±7.98, 58% of them were females and 72% of them were married. As regards qualification, nursing technical institute were 52%, with 70% of them were from urban, 46% of them had 5-10 nursing experience in BMT and 84% attended training program about covid-19 preventive measures during caring of patients with BMT.

Table (2) reveals that 66%,62%&60% respectively of the studied nurses had good knowledge regarding BMT, overview about covid-19 & patients with BMT at high risk for infection and COVID-19 preventive measures during caring of patients with BMT. Also,56% of them had good knowledge about general COVID-19 preventive measures. While, 34% of them had poor knowledge about anatomy and physiology of bone marrow.

Fig. (1) reveals total level of the studied nurses knowledge, whereas, 56% of them had good level of knowledge, 30% of them had average level of knowledge and 14% of them had poor level of knowledge regarding COVID -19 preventive measures during caring of patients with BMT.

Fig. (2) reveals that; 74% of the studied nurses reported low affecting factors, 14% of them reported moderate affecting factors and 12% of them reported high affecting factors on their compliance with COVID-19 preventive measures during caring of patients with BMT.

Table (3) reveals that, more than half of the studied nurses had high competency level of practice about PPE, washing hand and caring of patients with BMT. (62%, 60% & 56% respectively). Besides, 50% of the studied nurses had high competency level regarding the care of BMT unit, apheresis room and reprocessing materials and handling pallets.

Fig. (3) shows total level of the studied nurses practice whereas; 58% of them had high competency level of practice, 26% of them had moderate competency level and 16% of them had low competency level

regarding covid-19 preventive measures during caring of patients with BMT.

Fig. (4) Shows that; 64% of the studied nurses had positive attitude level. While, 36% of them had negative attitude level regarding COVID -19 preventive measures during caring of patients with BMT.

Fig. (5) shows total level of the studied nurse's compliance whereas, 56% of them had high level of compliance. 26% of them had moderate level of compliance and 18% of them had low level of compliance regarding COVID -19 preventive measures during caring of patients with BMT.

Table (4) reveals that there was highly significant positive correlation between total scores of the studied nurses

Table (1): Frequency and percentage distribution of the studied nurses regarding demographic characteristic (N=50).

| Items | No. | % |
|--|------------|------|
| Age (years) | | |
| 20-<30 years | 30 | 60.0 |
| 30-<40 years | 18 | 36.0 |
| ≥40-60 years | 2 | 4.0 |
| Mean±SD | 29.60±7.98 | |
| Gender: | | |
| Female | 29 | 58.0 |
| Male | 21 | 42.0 |
| Marital status | | |
| Single | 14 | 28.0 |
| Married | 36 | 72.0 |
| Divorce | 0 | 0.0 |
| Widow | 0 | 0.0 |
| Qualification | | |
| Diploma in Nursing | 6 | 12.0 |
| Nursing technical institute | 26 | 52.0 |
| Bachelor | 18 | 36.0 |
| Postgraduate | 0 | 0.0 |
| Residence | | |
| Urban | 35 | 70.0 |
| Rural | 15 | 30.0 |
| Past experience | | |
| 1-<5 years | 15 | 30.0 |
| 5-<10 years | 23 | 46.0 |
| 10-<20 years | 12 | 24.0 |
| Training program about covid-19 preventive measures during caring of patient with BMT | | |
| Yes | 42 | 84.0 |
| No | 8 | 16.0 |

knowledge, practice, attitude, factors influencing compliance and their compliance with COVID -19 preventive measures during caring of patients with BMT.at p-value <0.001.

Table (2): Frequency and percentage distribution of the studied nurses’ knowledge level regarding bone marrow transplantation and COVID -19 preventive measures (N=50).

| Items | Poor knowledge <60% | | Average knowledge 60-85% | | Good knowledge >85% | |
|--|---------------------|------|--------------------------|------|---------------------|------|
| | No. | % | No. | % | No. | % |
| Anatomy and physiology of bone marrow | 17 | 34.0 | 10 | 20 | 23 | 46.0 |
| BMT | 7 | 14.0 | 11 | 22.0 | 33 | 66.0 |
| Overview about covid-19 & patients with BMT at high risk for infection | 7 | 14.0 | 12 | 24.0 | 31 | 62.0 |
| General COVID-19 preventive measures | 8 | 16.0 | 14 | 28.0 | 28 | 56.0 |
| COVID-19 preventive measures during caring of patients with BMT | 7 | 14.0 | 13 | 26.0 | 30 | 60.0 |

Figure (1) Percentage distribution of the studied nurses’ total level of knowledge regarding bone marrow transplantation and COVID -19 preventive measures (n=50).

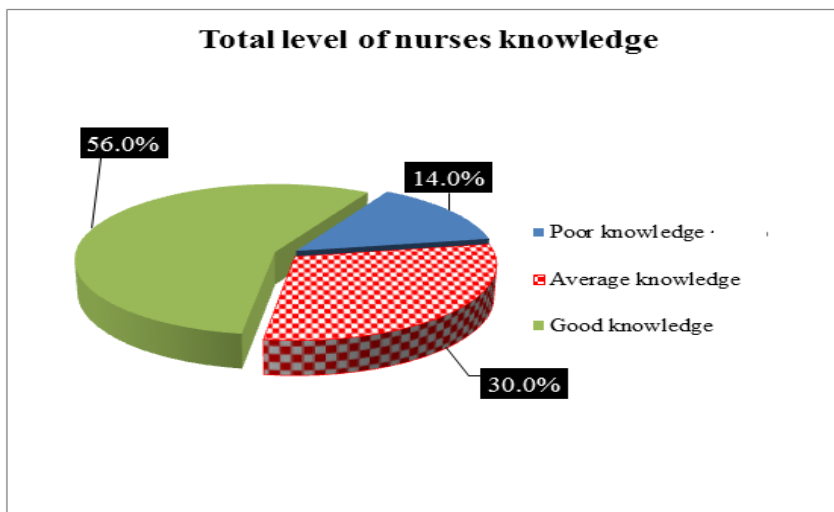


Figure (2): Percentage distribution of the studied nurses regarding total affecting factors on their compliance with COVID-19 preventive measures (n=50).

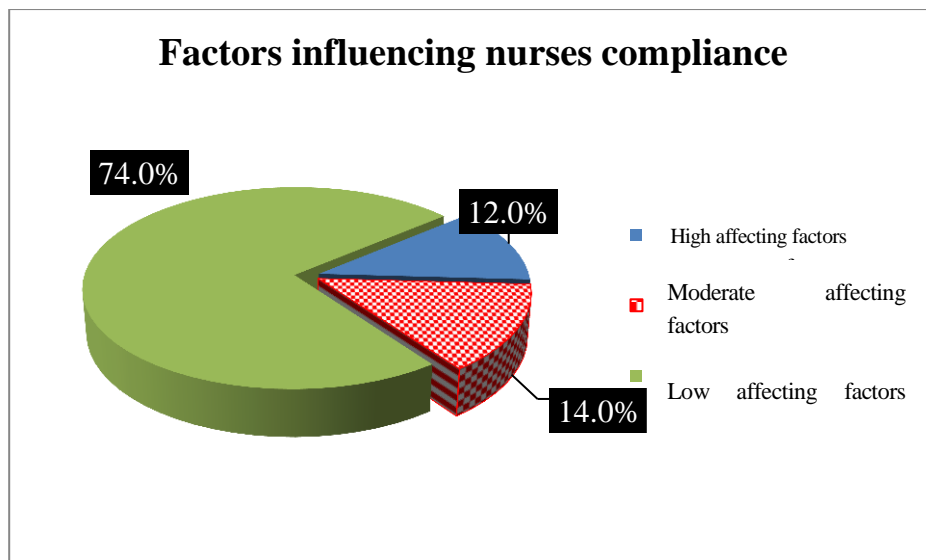


Table (3): Frequency and percentage distribution of the studied nurses practice level regarding covid -19 preventive measures during caring of patients with bone marrow transplantation (N=50).

| Main items | low <60% | | Moderate 60-85% | | High >85% | |
|--|----------|------|-----------------|------|-----------|------|
| | No. | % | No. | % | No. | % |
| Washing hand | 7 | 14 | 13 | 26 | 30 | 60 |
| Applying PPE | 8 | 16.0 | 11 | 22.0 | 31 | 62.0 |
| Caring of patients with BMT | 9 | 18.0 | 14 | 28.0 | 28 | 56.0 |
| The care of BMT unit, apheresis room and reprocessing materials and handling pallets | 5 | 13.0 | 16 | 32.0 | 25 | 50.0 |

Figure (3) Percentage distribution of the studied nurses' total practice level regarding covid-19 preventive measures during caring of patients with bone marrow transplantation (N=50)

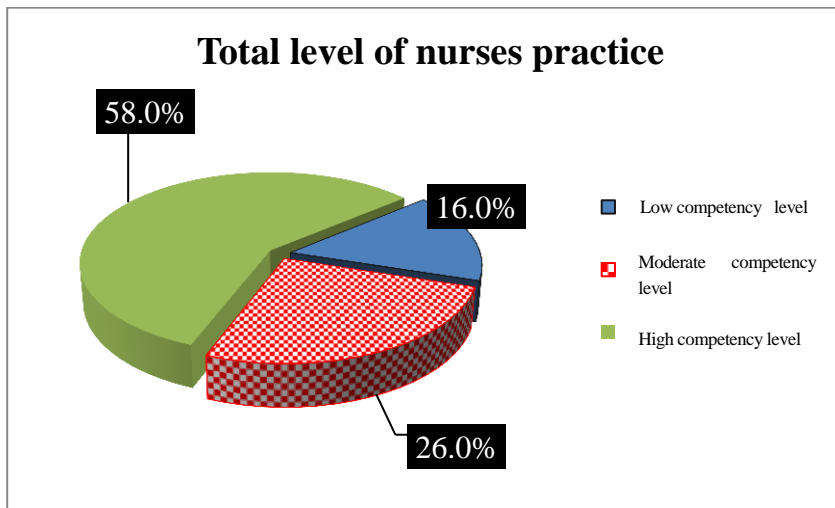


Figure (4) Percentage distribution of the studied nurses' total attitude level regarding covid-19 preventive measures during caring of patients with bone marrow transplantation (N=50).

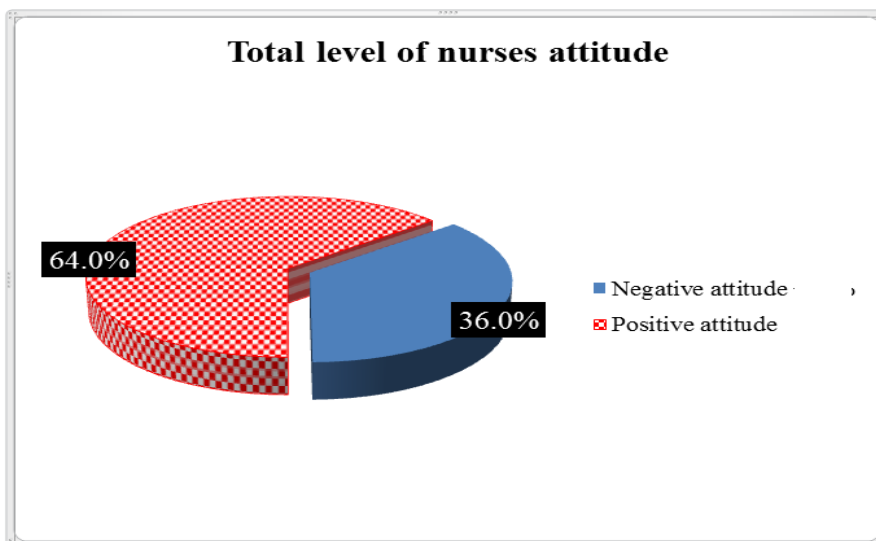


Figure (5): Percentage distribution of the studied nurses' total level of compliance regarding COVID-19 preventive measures during caring of patients with bone marrow transplantation(N=50).

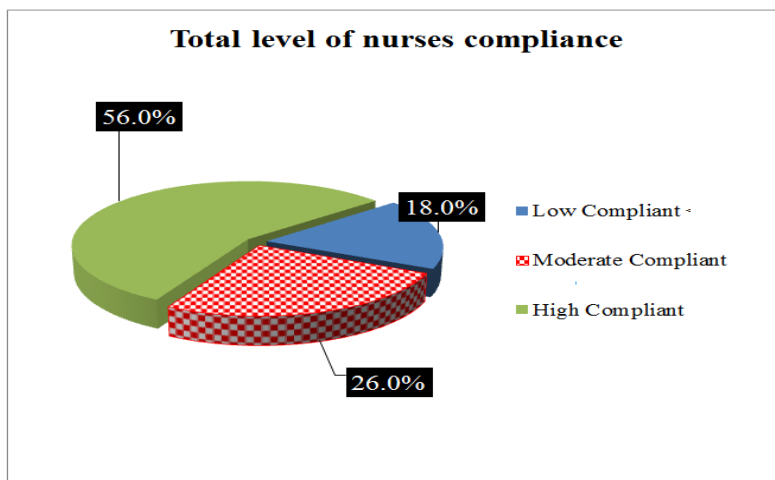


Table (4): Correlation matrix between total scores of the studied nurses knowledge, practice, attitude, factors influencing their compliance and their compliance with COVID-19 preventive measures during caring of patients with bone marrow transplantation (N=50).

| | | Total score of knowledge | Total score of affecting factors | Total score of practice | Total score of attitude | Total score of compliance |
|----------------------------------|----------------|--------------------------|----------------------------------|-------------------------|-------------------------|---------------------------|
| Total score of knowledge | <i>r-value</i> | | 0.683 | 0.868 | 0.743 | 0.866 |
| | <i>p-value</i> | | <0.001** | <0.001** | <0.001** | <0.001** |
| | <i>N</i> | | 50 | 50 | 50 | 50 |
| Total score of affecting factors | <i>r-value</i> | 0.683 | | 0.746 | 0.709 | 0.682 |
| | <i>p-value</i> | <0.001** | | <0.001** | <0.001** | <0.001** |
| | <i>N</i> | 50 | | 50 | 50 | 50 |
| Total score of practice | <i>r-value</i> | 0.868 | 0.746 | | 0.843 | 0.898 |
| | <i>p-value</i> | <0.001** | <0.001** | | <0.001** | <0.001** |
| | <i>N</i> | 50 | 50 | | 50 | 50 |
| Total score of attitude | <i>r-value</i> | 0.743 | 0.709 | 0.843 | | 0.797 |
| | <i>p-value</i> | <0.001** | <0.001** | <0.001** | | 0.000 |
| | <i>N</i> | 50 | 50 | 50 | | 50 |
| Total score of compliance | <i>r-value</i> | 0.866 | 0.682 | 0.898 | 0.797 | |
| | <i>p-value</i> | <0.001** | <0.001** | <0.001** | <0.001** | |
| | <i>N</i> | 50 | 50 | 50 | 50 | |

Discussion

Regarding to demographic characteristic the current study showed that two thirds of studied nurses were females, aged from twenty to less than thirty years old and about

three quarters of them were married. In addition, the highest percentage of them were holding nursing technical institute, from urban having five to less than ten years of experience in BMT and attended training program about covid-19 preventive measures

during caring of patient with BMT. This study result due to the most of bed side nurses who work in governmental hospital had technical nursing degree, females nurses are more interested in nursing than males. As well, traditionally nursing has to be considered a woman's occupational and the old stereotypes that nature of nursing is feminine and nurse were dominated the nursing profession. But today men are employed as registered nurse than any other time and urbans have more awareness in nursing study than rural. In addition, critical care units as BMT require nurses with experience because of complexity of the work as well the need to safe life of such group of patients throughout recovery time.

This present study is in the same line with *Abd El-mageed et al., (2021)*, they studied Willingness of Nurses to Work during A Covid-19 Pandemic: The Role of Knowledge, Attitude, and Practices, and revealed that three-fifths of nurses were females, married, graduated from the technical institute, years of experience were from five to less than ten years, and approximately half of the nurses attended training courses of infection control and BMT. Also, this result is incompatible with *Gouda et al., (2022)*, they studied Maternity Staff Nurses' Knowledge and Compliance for Protective Measures against Corona Virus and revealed that the majority of the studied nurses had more than ten years of experience and diploma degrees in nursing.

As regard to the studied nurses' total level of knowledge regarding BMT and COVID -19 preventive measures the current study revealed that more than half of the studied nurses had good knowledge about covid-19 & patients with BMT at high risk for infection, COVID-19 preventive measures. This may be due to the highest percentage of the studied nurses attended training programs conducted by the Ministry of Health, hospitals and online caregivers to understand COVID-19 preventive measures during caring of patients with BMT.

This currant study result is in the same line with *Rodrigues et al., (2020)*, who

studied Covid-19 containment measures adopted in bone marrow transplantation service, and revealed that more than half of the studied nurses had good knowledge about covid-19, patients with BMT at high risk for infection, and COVID-19 preventive measures during caring of patients with BMT

Also, this study result revealed that about less than one third of them had poor knowledge about anatomy and physiology of bone marrow. From investigator's point of view many nurses consider it as the most complex subject regardless of its importance.

this result is compatible with *Oshima et al., (2021)*, they studied Blood and marrow transplantation during the emerging COVID-19 pandemic: the Seattle approach, and reported that about third quarter of the participants had poor knowledge regarding bone marrow anatomy and physiology.

As regard to the studied nurses' total level of knowledge about BMT and COVID -19 preventive measures during caring of patients with BMT. this study revealed that more than half of studied nurses had good level of knowledge, one third of them had average level of knowledge and less than one fifth of them had poor level of knowledge. This may be related to the highest percentage of the studied nurses had more experience and attended training programs regarding COVID-19 preventives measures during caring of patients with BMT.

This present study result is in the same line with *Odikpo et al., (2022)*, who revealed that half of studied nurses had good level of knowledge regarding assessment of COVID-19. Also, this result is compatible with *Izumi et al., (2019)*, who carried out study entitled Enhancing Advance Care Planning Conversations by Nurses in a Bone Marrow Transplantation Unit, and displayed that slightly about one third of the studied nurses had average level of knowledge regarding assessment of patients with BMT.

As regard to the studied nurses' total factors affecting their compliance with COVID-19 preventive measures, this study displayed that about three quarter of them reported low

affecting factors, while less than one fifth of them reported moderate affecting factors. This may be due to different factors that nurses face while dealing with the disease as changed workspaces, schedules and availability of PPE. All their studied affecting factors should be taken into consideration for enhancing their compliance.

This current study result is compatible with *Abed Alah et al., (2021)*, who revealed that more than two thirds of them reported low affecting factors on their compliance with COVID-19 preventive measures during caring of patients with BMT. Also, this result is in the same line with *Mohamad et al., (2022)*, who conducted study entitled Compliance to infection prevention and control practices among healthcare workers during COVID-19 pandemic in Malaysia and reported that the highest percentage of the studied nurses had low factors affecting. On compliance with COVID-19 preventive measures.

As regard to the studied nurses total level of practice regarding covid -19 preventive measures during caring of patients with BMT, this study showed that more than half of them had high competency level of practice about PPE, washing hands & caring of patients with BMT.

This existent result is compatible with *Hossain et al., (2021)*, they studied Healthcare workers practice regarding personal protective equipment for the prevention of COVID-19 and showed that about more than half of studied nurses had high practice levels regarding PPE. Also, this result is in the same line with *El-Sokkary et al., (2021)*, they revealed that most of participants had high practice regarding PPE.

As regard to the studied nurses' total practice about covid-19 preventive measures during caring of patients with BMT, the current study showed that about more than half of them had high competency level of practice, around one quarter of them had moderate competency level and less than one fifth of them had low competence level. These findings could be elucidated by the fact that educational campaigns, conducted

particularly by ministry of health in Egypt, focused more on signs and symptoms of COVID-19 and preventive measures for enhancing their practice and the need for continuous in-service training courses to improve level of practice among all the studied nurses.

This ongoing result is in the same line with *Tien et al., (2021)*, who performed study entitled Knowledge, attitudes, and practices regarding COVID-19 prevention among Vietnamese healthcare workers, and revealed that three fifth of studied participants had high level of practice regarding COVID-19 prevention. Besides, this result is compatible with *Al-Dossary et al., (2020)*, who studied Awareness, attitudes, prevention, and perceptions of COVID-19 outbreak among nurses in Saudi Arabia, and revealed that the majority of nurses had high levels of COVID-19 preventive practices

Regarding to the studied nurses' total attitude level the current study showed that around two thirds of them had positive attitude and one third of them had negative attitude. This may be due to continuous training and awareness campaigns conducted by ministry of health and WHO regarding disease complications and disease preventive measures. This study result is supportive with studies findings conducted by *Tien et al., (2021)* & *Al-Dossary et al., (2020)*.

Regarding to the studied nurses' total level of compliance with COVID-19 preventive measures this study showed that more than half of them had high level of compliance. While, around one quarter of the studied nurses had moderate level of compliance and less than one fifth of them had low level of compliance. This may be due to nurses' desire to cut the chain of infection to prevent disease transmission during caring of patients with BMT to protect themselves and their patients.

This result is compatible with *Zenbaba et al., (2022)*, who carryout this study entitled Healthcare workers' compliance with COVID-19 preventive measures, and associated factors, in Ethiopia: A systematic

review and meta-analysis, and revealed that about two thirds of the studied participants had high level of compliance regarding COVID-19 preventive measures. Also, this result is in the same line with *Ezike et al., (2022)*, they studied Risk Perception, risk Involvement/Exposure and compliance to preventive measures to COVID-19 among nurses in a tertiary hospital in Asaba, Nigeria, and revealed that half of nurses had high level of compliance regarding COVID-19 preventive measures.

As regard to correlation matrix between total scored of the studied nurses knowledge, practice, attitude, factors influencing compliance and their compliance with COVID-19 preventive measures ,the current study revealed that there was highly significant positive correlation between the above studied variables. This can be explained by the fact that more knowledge leads to increased practice. whereas the nurses who had sufficient information, they were able to practice effectively. which reflected positively on their attitude & compliance & vice versa

This result is compatible with *Latif et al., (2022)*, they proved that there was statistical significant positive correlation between total knowledge and factors influencing nurses' compliance with COVID-19 preventive measures. Also, this result is in the same line with *Wen et al., (2021)*, they conducted study on knowledge, attitude, and practice of nursing staff and influencing factors on COVID-19, and revealed that there was highly statistical significant positive correlation between the studied variables.

These results are in the same line with *Gabr et al., (2020)*, who studied Knowledge, attitudes, and practices toward COVID-19 at Menoufia Governorate, Egypt and revealed that there was a significant positive correlation between knowledge and practice of the studied group toward COVID19. Another study with conducted by *Erfani et al., (2020)*, in Iran on "Knowledge, Attitude, and Practice regarding the Novel Coronavirus (COVID19) epidemic" and discovered a strong relationship between the

participants' knowledge, attitude, and practice of COVID-19 preventive measures.

Conclusion

Based on findings of the current study, it can be concluded that:

more than two quarters of the studied nurses had good level of knowledge, half of them had good competency level of practice, more than half of them had positive attitude. and more than three quarters of them reported low affecting factors on their compliance. As well as, more than half of the studied nurses had high level of compliance with Covid-19 preventive measures during caring of patients with BMT. Additionally, there was highly statistically significant positive correlation between total score of the studied nurses knowledge, practice, attitude, factors affecting compliance and their compliance with COVID-19 preventive measures during caring of patients with BMT.

Recommendations

Based on the current study's findings the following recommendations were proposed

- Importance of continuous inservice training program for nurses staff regarding covid-19 preventives measures during caring of patients with BMT to taking into consideration the studied affecting factors to improve their performance and consequently their compliance
- Availability of posters to be continuous reminder for all health care providers namely nurses in BMT units help to contribute to a culture of using covid-19 preventive measures during caring of all assigned patients.
- Replication of study should be conducted with large sample size in different BMT settings in order to increase generalizability of the study findings.
- More research is necessary to assess other factors affecting nurses

compliance with covid-19 preventives measures during caring of patients with BMT.

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