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Review Article

Effectiveness of Integrated Demonstration Program on Knowledge and Competency Skills on IV Cannulation Therapy in Terms of Management and Prevention of Chemotherapy Related Intravenous Complications Among the Nursing Staff from Selected Hospital, Mumbai, HBNI, India

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Abstract

Background: Intravenous Cannulation is a process of placement of cannula in the vein. Chemotherapeutics are mostly preferred by intravenous route. Intravenous cannulation can produce infection, thrombophlebitis, hematoma, infiltration, injury of the nerves, hemorrhage, pulmonary embolism, necrosis, extravasation fatal tissue injury leading to amputation and death.

Objectives: The Primary objective being finding out the level of knowledge on intravenous cannulation in management of chemotherapy related IV complications in control and experimental group pre and post the integrated demonstration program among Nursing staff. The secondary objectives being finding out the level of competence on intravenous cannulation, assessing the comparison of knowledge and competence gained, finding out the association between demographic data and knowledge and the association between demographic data and competency. Research approach was quantitative true experimental research design, Methodology was randomized control trial with the probability sampling.

Results: The scores at baseline on knowledge for control and experimental arms were not significant. The score at 2nd assessment for knowledge in control arm was <0.001 and experimental arm was <0.0001. The score at 3rd assessment for knowledge in control arm was <0.001 and experimental arm was <0.0001 showing a high statistical significance. Follow-up assessments (day 7 and day 30) showed that the experiment group consistently outperformed the control group in terms of median competency scores, with statistically significant differences (<0.001 and <0.001). The correlation between the total scores on knowledge and competency was assessed. Correlation at second assessment with both groups were 0.630 with p <0.001. Correlation at third assessment was 0.613 which was slightly less with p <0.001 indicating a good correlation among the knowledge and competency and a slight reduction due to retention problem. Conclusion- integrated demonstration program has increased the knowledge and competency.

Keywords: Integrated demonstration program, Intravenous therapy, Knowledge and competence

Introduction

Intravenous therapy is aimed for life saving procedure to introduce medications, blood and blood products, fluids, dye, total parenteral nutrition and collection of blood and administration of chemotherapeutics in an oncology setting.

Research based results suggest nursing staff have inadequate knowledge about chemotherapy. They should have better knowledge about chemotherapy through in- service education, said Hui. Chemotherapy should be administered by specialist nurses. Those with an oncology qualification are able to talk with patients well and handle chemotherapy related aspects said Faith Gibson. Evidence-based research has highlighted the issue of nurses having insufficient knowledge about chemotherapy, which can affect the best care of quality provided to cancer patients. According to Hui, this gap in knowledge should be addressed through enhanced education in nursing schools. Hui argues that nurses should receive more thorough instruction on chemotherapy during their studies to better prepare them for the complexities of cancer treatment. Education should be prioritized in healthcare settings to keep nurses updated on the latest chemotherapy practices, safety protocols, and advancements in oncology [1,2].

Primary Objective

To find out the level of knowledge on intravenous cannulation in management of chemotherapy related IV complications in control and experimental group of pre and post the integrated demonstration program among Nursing staff

Secondary Objectives

I. To find out the level of competence on intravenous cannulation in management of chemotherapy related IV complications in control and experimental group of pre and post the integrated demonstration program among Nursing staff.

II. To find out the comparison of knowledge and competence gained in management of chemotherapy related IV complications between control group and experimental group post the integrated demonstration program among Nursing staff.

III. To find out the association between demographic data and knowledge on intravenous cannulation in management of chemotherapy related IV complications among Nursing staff.

IV. To find out the association between demographic data and competency skill on intravenous cannulation in management of chemotherapy related IV complications among Nursing staff.

Scope and Utility

Limitation Administration of Chemotherapy, side effects and safety precautions were not considered in this aspect.

Research Approach

quantitative true experimental research design with randomized control trial. Sampling technique and identification by probability. Population - Nursing staff who were permanent at the tertiary cancer center (TMH & ACTREC). Sample size –308 Nursing staff. Data confidentiality and institutional ethical approval (CTRI/2022/10/046914) was maintained

Methodology

Randomization was followed centrally at the clinical research secretariat. The trial statistician generated permuted - block randomization sequence using variable sized blocks of 2 or 4 without any stratification factor. Participants were randomly assigned into either of the groups that were control or experimental by the concealed slips. Informed consent obtained from all the participants.

Control arm - Control arm had a pretest on assessment of knowledge and competence on day 0 with day 7 and day 30 as next point assessments. No intervention was provided.

Experimental arm - was assessed for knowledge and competence by pretest on day 0. Intervention was given by integrated demonstration program and didactic lecture. Assessment for competency was done on day 0 as the first time point. Two-point assessments on knowledge and competency were done on day 7 and day 30. Total of the tool consisted of 50 points.

Setting - In the clinical setting

Independent variables - Integrated demonstration program

Dependent variables- knowledge and competency on Intravenous Cannulation

Inclusion criteria

I. Nursing staff who were working in TMH and ACTREC

II. Those who were permanent.

III. Nurses who had educational qualification of GNM, B.Sc. / Diploma in Oncology Nursing/ M.Sc. Nursing

Exclusion criteria

1. Nurses who had problems with dexterity due to CNS involvement.
2. Who had problems with eyesight for cannulation.
3. staff with biohazard precautions such as HIV, hepatitis B.
4. Staff who have not taken vaccination against hepatitis.

Tools

I. Module on Chemotherapy related to intravenous site complications in relation to chemotherapy and prevention of

complications was prepared by the investigator.

II. Indigenously developed tool for assessment of knowledge

III. Indigenously developed checklist for assessment of competency

The module and tools on knowledge and competency were developed by the investigator. It was reviewed by 13 reviewers. Consisted of 3 medical oncologists and 10 nursing experts.

Knowledge Tool

Tool prepared by the investigator consisted questionnaire of 25 items. Scoring ranged from

Poor 1-8

Good 9-16

Excellent 17-25.

Demonstration Tool

Tool evaluated by 13 reviewers. Modifications were done as per the reviewer's response. Scoring of the tool was as this Prevention of phlebitis had total of 5 points, prevention of chemotherapy errors was 8 points, prevention of air embolism had 2 points, Prevention of hematoma had 2 points, prevention of hemorrhage had 1 point, prevention of chemotherapy drug induced complications had 7 points. prevention of infiltration had 1 point, prevention of thrombosis had 1 point, prevention of complications in relation to IV cannulation had 11 points, dilution, osmolarity, ph. had 2 points and prevention of extravasation had 10 points. The total was 50 points. Evaluation of the tool was Needed improvement ranged from 0-12 points, Good ranged from 13-25 points, Excellent ranged from 26-38 and Outstanding ranged from 39 - 50 points

Sample Size Calculation

$$n_A = Kn_B$$

$$n_b = \left[\frac{\pi_A(1-\pi_A)}{K} + \pi_B(1-\pi_B)\right] = \left[\frac{Z_1 - \alpha/2 - Z_1 - \beta}{\delta}\right]^2$$

where, $Z_1 - \alpha/2 = 1.96$ for 95% level of confidence

$$n_B = \left[\frac{0.5(1-0.5)}{1} + 0.4(1-0.4)\right]\left[\frac{1.96-0.8}{0.10}\right]^2$$

$n_B = 140$ then $n_A = 1x140 = 140$

Total Sample Size, $n_A + n_B = 280$

Considering a 10% iteration rate, the total sample size was n =280 / 0.9 = 308.

Statistical Analysis Plan

The collected data was analyzed using SPSS 25.0 and R Studio Software. Normality of distribution of scores on knowledge and competency level of nurses obtained at different time points in control and experimental arm was assessed using One-Sample Kolmogorov-Smirnov test and one-way ANCOVA was used to compare the scores on knowledge and level of competence at different time points in between the control and treatment arms between pre, post demonstration 7th and 30th day. Trend in change of mean scores was assessed with 95% CI. The scores on knowledge and skill competence were compared using Unpaired t-test or Mann-Whitney test depending upon the normality of the data [3-9].

Age is similar in both groups with females being higher. GNM and B.sc qualification was common. Medical and surgical were more common work areas and Chemotherapy certification and IV cannulation received in both groups almost equally.

(Table 2) - There was no statistical significance of both groups in knowledge on baseline data with regard to the various domains.

(Table 2 A) -On the second assessment conducted on Day 7, the knowledge domain scores for both the control and experimental groups were compared. The results revealed that the experimental group demonstrated statistically significant improvement across multiple domains. Specifically, knowledge related to cannulation ($p < 0.001$), chemotherapy drugs and IV site complications ($p < 0.001$), chemotherapy and dilution ($p < 0.001$), osmolarity, pH, and administration ($p < 0.001$) and IV administration systems ($p < 0.001$) showed significant enhancement. Additionally, knowledge regarding prevention of IV therapy–related complications ($p < 0.001$) and prevention of phlebitis and extravasation ($p < 0.001$) was also significantly higher in the experimental group. These findings indicate a marked improvement in knowledge among participants in the experimental group following the intervention.

(Table 2 B) - Assessment of knowledge domain on third assessment of day 30 had a statistically significant effect on cannulation with p <0. 0001318, chemo drugs and IV site complication was p<0.001, chemotherapy and dilution was p<0.001, Osmolarity, pH and administration system was p<0.001, IV administration system was p<0.001, Prevention of IV therapy related complications was p<0.001, Chemotherapy related complications was p<0.001, Prevention of phlebitis was p<0.001 and Prevention of extravasation was p<0.001 in the experimental group proving good improvement post the intervention.

(Table 3) - The median (iqr) of knowledge score at baseline in control arm was 12 [10-14] which increased to 10.5 [7,13.8] at 2nd assessment with p = <0.001. The score at third assessment showed a significant reduction to 9[7,12-17] from baseline with p=<0.001. Whereas the median(iqr) of knowledge score at baseline in experimental group was 11 [10, 13] and in the second assessment was 19 [17-22] and with the retention of median score with 19 [16, 21] at the third assessment with p values of <0.0001 at both post assessments indicating the excellent learning .

(Table 4) There was no statistical significance of control and experimental groups of competency domains at baseline day of day 0.

(Table 4 B) Assessment of Competency domains scores on second assessment on day 7 - There was a good statistical significance in competency domains in the experimental group on second assessment of day 7 on Prevention of Phlebitis with a p value of 0.02482 , Prevention of chemotherapy errors with a p value of < 0.001, prevention of air embolism 0.044448, Chemotherapy drugs induced complication with a p value of < 0.001, PH drugs Competency with a p value of < 0.001, Prevention of extravasation with a p value of < 0.001 indicating a good learning of competency.

(Table 4 C) Assessment of competency domain scores on third assessment of day 30 in the experimental group has scored in Prevention of chemotherapy errors with a p value <0.001, Chemotherapy drugs induced complication with a p value < 0.001, ph of drugs as p < 0.001 and prevention of extravasation as p < 0.001 and other domains as non – significant. This may indicate as on the third assessment there is a less retention by day 30.

(Table 5) Change in total competency scores from baseline to First assessment to second assessment in control and experimental arm. There was no significant change from baseline to 2nd but statistically significant increase by 3rd assessment (p-0.037) though median remains unchanged and minimal competency improvement in the control group. Whereas in the experimental group there was a highly significant improvement at both 2nd and 3rd assessments (p <0.001). Median score shows a large and sustained gain from 29.5 to 45 to 43. The improvement from baseline is strong indicating good teaching practice.

(Table 6) A comparison of knowledge and competence at 2nd and 3rd assessments - The correlation coefficients of 0 .630 and 0.613 indicate a strong positive correlation between knowledge scores and competency scores. p < 0.001 means this correlation is highly statistically significant. As knowledge increases, competency tends to increase as well, which is expected and supports the idea that better understanding leads to better practical skills.

Faith Gibson ([2]), in his study, reported that oncology nurses had limited knowledge. However, in the present study, a significant difference in knowledge was observed among participants with a B.Sc. Nursing qualification in the control group (p = 0.001). Additionally, a statistically significant association was found in the control group among those who had obtained Chemotherapy (CT) certification (p < 0.001).

Furthermore, significant differences were noted in the baseline competency scores (p = 0.001) across various professional qualifications. Participants with B.Sc. Nursing, Diploma in Oncology Nursing, and M.Sc. Nursing qualifications scored higher compared to those with GNM and Post Basic B.Sc. Nursing.

Similarly, significant differences were found in competency-related scores—baseline total score (p = 0.000), second assessment (p = 0.000), and third assessment (p = 0.000). The Diploma in Oncology Nursing group consistently achieved the highest scores, followed by B.Sc. Nursing and M.Sc. Nursing, whereas GNM and Post Basic B.Sc. Nursing scored lower.

These findings indicate that professional qualifications have a significant impact on competency levels, with those holding a specialized Diploma in Oncology Nursing demonstrating superior performance. Faith Gibson ([2]) also reported that nurses with oncology qualifications exhibited a lack of worry-related knowledge (p = 0.05).

(Table 7) Association between knowledge and demographic factors of both groups - there was an association between age (p value0.05 in experimental), qualification (p value in control is <0.001 and experimental is <0.014) and CT certification received is (p value 0.001 in control and 0.010 in experimental) were statistically significant.

(Table 7 B) Competency was significantly influenced by age, gender, work experience, and professional qualification, while chemotherapy certification and IV cannulation training did not show a significant effect in either arm.

Results

Table 1: Demographic details.

Variable	Level	Control (n=154)	Experiment (n=154)	Total (n=308)
Age	median [or]	34.5 [30, 42]	36 [31, 43]	35 [31, 43]
Gender	Male	15 (9.7)	8 (5.2)	23 (7.5)
	Female	139 (90.3)	146 (94.8)	285 (92.5)
ProfessionalQualification_Rec	Diploma in Onco.	45 (29.2)	42 (27.3)	87 (28.2)
	Bsc Nursing	76 (49.4)	58 (37.7)	134 (43.5)
	GNM	19 (12.3)	34 (22.1)	53 (17.2)
	Msc Nursing	8 (5.2)	10 (6.5)	18 (5.8)
	Post Bsc Nursing	6 (3.9)	10 (6.5)	16 (5.2)

WorkExp_Rec	0-5 Years	60 (39.0)	55 (35.7)	115 (37.3)
	6-10 Years	33 (21.4)	29 (18.8)	62 (20.1)
	11-15 Years	28 (18.2)	31 (20.1)	59 (19.2)
	>=16 Years	33 (21.4)	39 (25.3)	72 (23.4)
Work_Area_Rec				
	Medical Onco.	60 (39.0)	54 (44.0)	114 (37.0)
	OT	22 (14.3)	21 (13.6)	43 (14.0)
	Surgical	27 (17.5)	36 (23.4)	63 (20.5)
	OPD	12 (7.8)	20 (13.0)	32 (10.4)
	ICU	27 (17.5)	21 (13.6)	48 (15.6)
	Radiation	6 (3.9)	2 (1.3)	8 (2.6)
CTCert_Rec	No	136 (88.3)	136 (88.3)	272 (88.3)
	Yes	18 (11.7)	18 (11.7)	36 (11.7)
IVCanu	No	120 (77.9)	118 (76.6)	238 (77.3)
	Yes	34 (22.1)	36 (23.4)	70 (22.7)

Table 2: Knowledge domains at Baseline on day 1 for control and experimental groups.

Knowledge Score for Day-1 for Control and Experimental Groups					
Variable	Level	Control (n=154)	Experiment (n=154)	Total (n=308)	p-value
Cannulation	0	4 (2.6)	4 (2.6)	8 (2.6)	
	1	34 (22.1)	29 (18.8)	63 (20.5)	
	2	80 (51.9)	99 (64.3)	179 (58.1)	
	3	36 (23.4)	22 (14.3)	58 (18.8)	0.1221328*
Chemo drugs and IV site complications	0	51 (33.1)	65 (42.2)	116 (37.7)	
	1	86 (55.8)	79 (51.3)	165 (53.6)	
	2	17 (11.0)	10 (6.5)	27 (8.8)	0.149461*
Chemotherapy and dilution	0	4 (2.6)	10 (6.5)	14 (4.5)	
	1	92 (59.7)	93 (60.4)	185 (60.1)	
	2	58 (37.7)	51 (33.1)	109 (35.4)	0.2202069*
Osmolarity, pH and administration system	0	53 (34.4)	61 (39.6)	114 (37.0)	
	1	55 (35.7)	64 (41.6)	119 (38.6)	
	2	38 (24.7)	26 (16.9)	64 (20.8)	
	3	8 (5.2)	3 (1.9)	11 (3.6)	0.1236309*
IV administration system	0	22 (14.3)	20 (13.0)	42 (13.6)	
	2	46 (29.9)	49 (31.8)	95 (30.8)	
	1	86 (55.8)	85 (55.2)	171 (55.5)	0.9067292*
Prevention of IV therapy related complications	0	2 (1.3)	3 (1.9)	5 (1.6)	
	1	13 (8.4)	25 (16.2)	38 (12.3)	
	2	139 (90.3)	126 (81.8)	265 (86.0)	0.0989041*
Chemotherapy related complications	0	3 (1.9)	7 (4.5)	10 (3.2)	
	1	29 (18.8)	25 (16.2)	54 (17.5)	
	2	55 (35.7)	47 (30.5)	102 (33.1)	
	3	41 (26.6)	50 (32.5)	91 (29.5)	
	4	22 (14.3)	20 (13.0)	42 (13.6)	

	5	4 (2.6)	5 (3.2)	9 (2.9)	0.605282*
Prevention of phlebitis	1	17 (11.0)	23 (14.9)	40 (13.0)	
	0	137 (89.0)	131 (85.1)	268 (87.0)	0.3967075*
Prevention of extravasation	0	37 (24.0)	32 (20.8)	69 (22.4)	
	1	58 (37.7)	65 (42.2)	123 (39.9)	
	2	49 (31.8)	46 (29.9)	95 (30.8)	

Table 2A: second assessment conducted on Day 7, knowledge domain scores for both the control and experimental groups.

2nd Assessment on Day-7 As per Domains					
Variable	Level	Control (n=154)	Experiment (n=154)	Total (n=308)	p-value
Cannulation	0	22 (14.3)	2 (1.3)	24 (7.8)	
	1	44 (28.6)	33 (21.4)	77 (25.0)	
	2	55 (35.7)	50 (32.5)	105 (34.1)	
	3	33 -21.4	69 (44.8)	102 (33.1)	<0.001*
Chemo drugs and IV site complications	0	62 (40.3)	8 (5.2)	70 (22.7)	
	1	68 (44.2)	29 (18.8)	97 (31.5)	
	2	24 (15.6)	117 (76.0)	141 (45.8)	<0.001*
Chemotherapy and dilution	0	33 (21.4)	2 (1.3)	35 (11.4)	
	1	68 (44.2)	48 (31.2)	116 (37.7)	
	2	53 (34.4)	104 (67.5)	157 (51.0)	<0.001*
Osmolarity, pH and administration system	0	72 (46.8)	32 (20.8)	104 (33.8)	
	1	50 (32.5)	19 (12.3)	69 (22.4)	
	2	25 (16.2)	58 (37.7)	83 (26.9)	
	3	7 (4.5)	45 (29.2)	52 (16.9)	<0.001*
IV administration system	0	46 (29.9)	1 (0.6)	47 (15.3)	
	1	74 (48.1)	19 (12.3)	93 (30.2)	
	2	34 (22.1)	134 (87.0)	168 (54.5)	<0.001*
Prevention of IV therapy related complications	0	37 (24.0)	15 (9.7)	52 (16.9)	
	1	26 (16.9)	10 (6.5)	36 (11.7)	
	2	91 (59.1)	129 (83.8)	220 (71.4)	<0.001*
Chemotherapy related complications	0	14 (9.1)	1 (0.6)	15 (4.9)	
	1	39 (25.3)	1 (0.6)	40 (13.0)	
	2	36 (23.4)	6 (3.9)	42 (13.6)	
	3	30 (19.5)	41 (26.6)	71 (23.1)	
	4	18 (11.7)	25 (16.2)	43 (14.0)	
	5	16 (10.4)	48 (31.2)	64 (20.8)	
Prevention of phlebitis	6	1 (0.6)	32 (20.8)	33 (10.7)	<0.001*
	0	129 (83.8)	55 (35.7)	184 (59.7)	
Prevention of extravasation	1	25 (16.2)	99 (64.3)	124 (40.3)	<0.001*
	0	33 (21.4)	2 (1.3)	35 (11.4)	
	1	40 (26.0)	2 (1.3)	42 (13.6)	
†=Mann Whitney U test P-value; *=Chi-Square test P-value					

*Note: †=Mann Whitney U test P-value; *=Chi-Square test P-value.

Table 2 B: Assessment on Knowledge domains at third assessment on day-30.

Assessment on day-30 as Per Domains					
Variable	Level	Control (n=154)	Experiment (n=154)	Total (n=308)	p-value
Cannulation	0	34 (22.1)	25 (16.2)	59 (19.2)	
	1	73 (47.4)	44 (28.6)	117 (38.0)	
	2	47 (30.5)	83 (53.9)	130 (42.2)	
	3	0 (0.0)	2 (1.3)	2 (0.6)	0.0001318*
Chemo drugs and IV site complications	0	73 (47.4)	7 (4.5)	80 (26.0)	
	1	60 (39.0)	29 (18.8)	89 (28.9)	
	2	21 (13.6)	118 (76.6)	139 (45.1)	<0.001*
Chemotherapy and dilution	0	36 (23.4)	1 (0.6)	37 (12.0)	
	1	69 (44.8)	49 (31.8)	118 (38.3)	
	2	49 (31.8)	104 (67.5)	153 (49.7)	<0.001*
Osmolarity, pH and administration system	0	75 (48.7)	33 (21.4)	108 (35.1)	
	1	50 (32.5)	18 (11.7)	68 (22.1)	
	2	22 (14.3)	58 (37.7)	80 (26.0)	
	3	7 (4.5)	45 (29.2)	52 (16.9)	<0.001*
IV administration system	0	55 (35.7)	3 (1.9)	58 (18.8)	
	1	62 (40.3)	16 (10.4)	78 (25.3)	
	2	37 (24.0)	135 (87.7)	172 (55.8)	<0.001*
Prevention of IV therapy related complications	0	40 (26.0)	14 (9.1)	54 (17.5)	
	1	29 (18.8)	13 (8.4)	42 (13.6)	
	2	85 (55.2)	127 (82.5)	212 (68.8)	<0.001*
Chemotherapy related complications	0	12 (7.8)	0 (0.0)	12 (3.9)	
	1	32 (20.8)	1 (0.6)	33 (10.7)	
	2	44 (28.6)	22 (14.3)	66 (21.4)	
	3	40 (26.0)	21 (13.6)	61 (19.8)	
	4	14 (9.1)	43 (27.9)	57 (18.5)	
	5	10 (6.5)	49 (31.8)	59 (19.2)	
Prevention of phlebitis	6	2 (1.3)	18 (11.7)	20 (6.5)	<0.001*
	0	130 (84.4)	49 (31.8)	179 (58.1)	
Prevention of extravasation	1	24 (15.6)	105 (68.2)	129 (41.9)	<0.001*
	0	35 (22.7)	1 (0.6)	36 (11.7)	
	1	45 (29.2)	3 (1.9)	48 (15.6)	
	2	40 (26.0)	34 (22.1)	74 (24.0)	
	3	31 (20.1)	59 (38.3)	90 (29.2) p<0.001	
Baseline Score	4	3 (1.9)	57 (37.0)	60 (19.5)	<0.001*
Cannulation	median [iqr]	9 [7, 12]	19 [16, 21]	14 [9, 19]	<0.001†

*Note: †=Mann Whitney U test P-value; *=Chi-Square test P-value

Table 3: Change in total knowledge scores from baseline to second assessment to third assessment in control and experimental arm.

Variable	Control (n=154)	P for change in Control	Experiment (n=154)	P for change in Experimental	Total (n=308)
Baseline Score	12 [10, 14]		11 [10, 13]		12 [10, 13]
2nd assessment score on day 7	10.5 [7.0, 13.8]	<0.001	19 [17, 22]	<0.0001	15 [10, 19]
3rd assessment score on day 30	9 [7, 12]	<0.001	19 [16, 21]	<0.0001	14 [9, 19]

Table 4 A: Assessment of Competency domains scores at Baseline on day 1.

Competency Score for Day-1					
Variable	Level	Control (n=154)	Experiment (n=154)	Total (n=308)	p-value (Mann-Whitney U test)
Prevention of Phlebitis	median [iqr]	4 [4, 5]	4 [4, 5]	4 [4, 5]	0.292186
Prevention of chemotherapy errors	median [iqr]	5 [4, 6]	5 [4, 6]	5 [4, 6]	0.067525
Prevention of air embolism	median [iqr]	2 [2, 2]	2 [2, 2]	2 [2, 2]	0.474418
Prevention of hematoma	median [iqr]	2 [2, 2]	2 [2, 2]	2 [2, 2]	0.320489
Prevention of hemorrhage	median [iqr]	1 [1, 1]	1 [1, 1]	1 [1, 1]	0.314934
Chemotherapy drugs induced complication	median [iqr]	0 [0, 3]	0.5 [0, 3]	0 [0, 3]	0.122518
Prevention infiltration Competency	median [iqr]	0 [0, 1]	0 [0, 1]	0 [0, 1]	0.908861
Prevention of thrombosis	median [iqr]	0 [0, 1]	0 [0, 1]	0 [0, 1]	0.358631
IV Cannulation Competency	median [iqr]	10 [10, 10]	10 [10, 10]	10 [10, 10]	0.288441
PH drugs Competency	median [iqr]	0 [0, 0]	0 [0, 1]	0 [0, 0]	0.365321
Prevention of extravasation	median [iqr]	2 [2, 3]	3 [2, 4]	2 [2, 3]	0.139161

Table 4 B: Assessment of Competency domains scores on second assessment on day 7.

Day-7					
Variable	Level	Control (n=154)	Experiment (n=154)	Total (n=308)	p-value (Mann-Whitney U test)
Prevention of Phlebitis	median [iqr]	4 [4, 4]	4 [4, 5]	4 [4.0, 4.2]	0.024282
Prevention of chemotherapy errors	median [iqr]	5 [4, 6]	7 [7, 8]	6.5 [5, 8]	<0.001
Prevention of airembolism	median [iqr]	2 [2, 2]	2 [2, 2]	2 [2, 2]	0.044448
Prevention of haematoma	median [iqr]	2 [2, 2]	2 [2, 2]	2 [2, 2]	0.562427
Prevention of hemorrhage	median [iqr]	1 [1, 1]	1 [1, 1]	1 [1, 1]	0.156623
Chemotherapy drugs induced complication	median [iqr]	0 [0, 2]	7 [6.2, 7.0]	4 [0, 7]	<0.001
Prevention infiltration Competency	median [iqr]	0 [0, 1]	0 [0, 1]	0 [0, 1]	0.642654
Prevention of thrombosis	median [iqr]	0 [0, 1]	0 [0, 1]	0 [0, 1]	0.90604
IVCannulation Competency	median [iqr]	10 [10, 10]	10 [10, 10]	10 [10, 10]	0.633759
PH drugs Competency	median [iqr]	0 [0, 0]	2 [2, 2]	2 [0, 2]	<0.001
Prevention of extravasation	median [iqr]	2 [2, 4]	9 [9, 9]	5 [2, 9]	<0.001

Table 4C: Assessment of Competency on domain scores at third assessment on day 30.

Day-30					
Variable	Level	Control (n=154)	Experiment (n=154)	Total (n=308)	p-value (Mann-Whitney U test)
Prevention of Phlebitis	median [iqr]	4 [4, 4]	4 [4, 4]	4 [4, 4]	0.076362
Prevention of chemotherapy errors	median [iqr]	5 [4, 6]	8 [7, 8]	7 [5, 8]	<0.001
Prevention of air embolism	median [iqr]	2 [2, 2]	2 [2, 2]	2 [2, 2]	0.08226
Prevention of hematoma	median [iqr]	2 [2, 2]	2 [2, 2]	2 [2, 2]	1
Prevention of hemorrhage	median [iqr]	1 [1, 1]	1 [1, 1]	1 [1, 1]	0.317311
Chemotherapy drugs induced complication	median [iqr]	0 [0, 2]	7 [6, 7]	4 [0, 7]	<0.001
Prevention infiltration	median [iqr]	0 [0, 1]	0 [0, 1]	0 [0, 1]	0.907997
Prevention of thrombosis	median [iqr]	0 [0, 1]	0 [0, 1]	0 [0, 1]	0.812309
IV cannulation	median [iqr]	10 [10, 10]	10 [10, 10]	10 [10, 10]	0.735504
PH drugs	median [iqr]	0 [0, 0]	2 [2, 2]	2 [0, 2]	<0.001
Prevention of extravasation	median [iqr]	2 [2, 4]	9 [7, 9]	5 [2, 9]	<0.001

Table 5: Change in total competency scores from baseline to First assessment to second assessment in control and experimental arm.

Variable	Control (n=154)	P for change in Control	Experiment (n=154)	P for change in Experimental	Total (n=308)
Competency_- Baseline Total Score	28 [26, 31]		29.5 [26.2, 33.0]		28 [26.0, 32.2]
Competency second assessment	28 [26, 32]	0.542	45 [43, 46]	<0.001	38 [28, 45]
Competency third assessment	28 [26, 32]	0.037	43 [41, 44]	<0.001	37 [28, 43]

Table 6: Correlation of scores on knowledge and competency assessed at second and third assessment for both groups.

Knowledge and Competency at second	Correlation Coefficient	.630**
	Sig. (2-tailed)	<.001
	N	308
Knowledge and Competency at third	Correlation Coefficient	.613**
	Sig. (2-tailed)	<.001
	N	308

Table 7: Association between the knowledge and demographic factors in both arms.

Variable	Category	Control Arm		Experimental Arm	
		Median (IQR)	Pvalue	Median (IQR)	Pvalue
Age	<35	12(10-14)	0.348	11(9-13)	0.05
	>=35	12(19-14)		12(10-13)	
Gender	Male	12(10-13)	0.609	11.5(10.25-13)	0.737
	Female	12(9-14)		11(10-13)	
Work Experience	0-5 Years	12(10-14)	0.111	11(9-13)	0.09
	6-10 Years	13(10-14.5)		12(10.5-13)	
	11-15 Years	12(10-14)		12(10-13)	
	>=16 Years	11(8-13)		11(9-14)	
Professional Qualification_Rec	Bsc Nursing	12(10-15)	0.001	11(9-13)	0.014
	Diploma in Onco.	12(10-14)		12(11-14)	
	GNM	8(9-11)		10(9-13)	
	Msc Nursing	12(10.5-16)		12.5(10-14.25)	
	Post Bsc Nursing	11(10.5-12.75)		10(8.75-11.25)	
CTCert_Rec	No	12 (9-13)	<0.001	11 (10-13)	0.01
	Yes	15 (12.75-15.25)		13 (11.75-15)	
IVCanu_Rec	No	12 (9-14)	0.21	11 (10-13)	0.716
	Yes	12 (10-14.25)		12 (9-13)	

Table 7B: Association between the competency and demographic factors in control and experimental arms.

Variable	Category	Control Arm		Experimental Arm	
		Median (IQR)	Pvalue	Median (IQR)	Pvalue
Age	<35	27(25-29)	0.004	27(26-31)	0.001
	>=35	29(43-35)		31(27-34.75)	
Gender	Male	27(25-28)	0.049	26.5(26-27.75)	0.017
	Female	28(26-32)		30(27-33)	

Work Experience	0-5 Years	27(25-29)	<0.001	28(26-31)	<0.001
	6-10 Years	29(26-34)		28(26-32.5)	
	11-15 Years	31(28-37.75)		33(31-36)	
	>=16 Years	27(25-31.5)		29(26-32)	
Professional Qualification Rec	Bsc Nursing	27(26-29.75)	<0.001	28(26-31)	0.001
	Diploma in Onco.	33(29-37)		32(29.75-37)	
	GNM	24(26-27)		30(26-33)	
	Msc Nursing	28(23.5-35.25)		27.5(26-31)	
	Post Bsc Nursing	24.5(24-27)		27.5(25.5-29)	
CTCert_Rec	No	27 (26-31)		29 (26-33)	
	Yes	29.50 (26.50-34.25)	0.215	30 (27-32)	0.966
IVCanu_Rec	No	30.75 (27-37)		29 (26-32.25)	
	Yes	30 (26-35)	0.052	31 (26.25-35.75)	0.213

Discussion

Faith Gibson [2] in his study mentioned that those with qualification in oncology nursing had limited knowledge. However, in the present study, a significant difference in knowledge was observed among participants with a B.Sc. Nursing qualification in the control group ($p = 0.001$). Additionally, a statistically significant association was found in the control group among those who had obtained Chemo Therapy (CT) certification ($p < 0.001$). Furthermore, significant differences were noted in baseline competency scores ($p = 0.001$) across various professional qualifications. Participants with B.Sc. Nursing, Diploma in Oncology Nursing, and M.Sc. Nursing qualifications scored higher compared to those with GNM and Post Basic B.Sc. Nursing.

Similarly, significant differences were found in competency-related scores—baseline total score ($p = 0.000$), second assessment ($p = 0.000$) and third assessment ($p = 0.000$). Diploma in Oncology Nursing group consistently achieved the highest scores, followed by B.Sc. Nursing and M.Sc. Nursing, whereas GNM and Post Basic B.Sc. Nursing scored lower. These findings indicate professional qualifications have a significant impact on competency levels, with those holding a specialized Diploma in Oncology Nursing demonstrating superior performance. Faith Gibson ([2]) also reported that nurses with oncology qualifications exhibited a lack of worry-related knowledge ($p = 0.05$).

Knowledge

during baseline assessment of knowledge was not statistically significant in both groups. This meant both groups were alike in understanding and interpreting the questions. Both groups were equal in their knowledge without the intervention was evident. Loai Abu has said that nurse's knowledge of chemotherapy was not satisfactory [23-39] and needed continuous education. Hence, we align with the findings of Loai Abu. When the domains of knowledge were assessed on the third assessment, there was high statistical significance found in these areas. Cannulation (<0.001), chemotherapy and dilution (<0.001), osmolarity (<0.001), pH and administering system (<0.001), IV administration system (<0.001), prevention of IV therapy related complications (<0.001), chemotherapy related complications (<0.001), prevention of phlebitis (<0.001), in the experimental group prevention of extravasation (<0.001). This showed intervention was highly successful in the development of knowledge and the retention was seen on the 30th day and states that the change in the experimental group has not occurred by chance.

Cannulation

Assessment of cannulation at baseline level showed no statistical significance between the two groups. They were equal in nature with equal distribution. *Loai Abu* [39] has shared that there was deficit of knowledge regarding site of insertion, and characteristics. Same is seen in our baseline study too that lack of education has yielded decreased knowledge and competency. Assessment of cannulation at the second assessment between both the groups show statistical significance in the experimental group. They were –Double checking with the second nurse (0.005092), checking laboratory values (<0.001), use of PPE (<0.001), withdrawal using sterile gauze (<0.001), documentation (<0.001). Leucovorin and MTX (<0.001), in case of irritants and vesicants (<0.001) , flushing post vincristine (<0.001), taxol and polyethylene (<0.001) , taxol and codan (<0.001), photosensitive (<0.001), no movements by patients (<0.001), patients to report in case of pain (<0.001), chooses right cannula and right location (<0.001) , marks outline (<0.03), photograph the site (<0.001), elevation of arm (<0.001) , warm compresses in vinca and taxanes (<0.001), cold compress in anthracycline and mitomycin(<0.001), hyaluronidase in vinca

and taxanes (<0.001) and dexrazoxane in anthracycline(<0.001) are all found much statistically significant in experimental group. This shows that the interventions done in the group has shown specific learning with regard to chemotherapy complication prevention and it has shown a significant differentiation from the control group. Pertaining to the same discussion, the following 3 authors have opined in the same line. *Abu L* [39] also said that the more percentages of participants having information regarding the procedure domain post education. *Hui Yunaiyu* [33] has said that nurse's knowledge on chemotherapy was less than 70%. Hence he has emphasized the need for higher education in chemotherapy to increase the level of skill. *Mohammed alauadine* [33] has also said nurses specially students need to be taught on chemotherapy [40-54].

Jung taekum [55] has described the guidelines for extravasation. He said extravasation and its management includes intervention as well as thermal application. There was statistical significance in our study with extravasation when it came to patient reporting or pain (<0.001). Continuous education about extravasation was essential, said *Jung taeku* [55]. Importance of demonstration was seen in this study with statistical significance.

In our study, use of PPE (<0.001) was statistically significant whereas *Ramanand Choudhary* [36] has told that more than 92% of participants reported that they had worn hand protection gloves during chemotherapy; 6% had been using white coats as protective clothing. Use of face and respiratory protection was less than 5%. There should be a good supply of PPE for the nurses to protect themselves as otherwise they will risk themselves whereas in our study there was a good supply of PPE seen from the institutional level.

Assessment of domains of cannulation at second assessment between both the groups- high statistical significance was seen in –Prevention of phlebitis (0.024282), prevention of chemotherapy errors (<0.001), prevention of air embolism (0.044448), chemotherapy drugs induced complications (<0.001), pH drugs competency (<0.001), prevention of extravasation (<0.001). This value indicates that the most important and particular to chemotherapy competency domains was statistically significant when compared with the general competencies in the experimental group. It proves the importance of the integrated demonstration done by the researcher and the experimental group has outweighed the control group. Whereas Shivani [56-61] has said that 30.34% of hospitalized patients among whom 22.8% (33) were females followed by 7.6% were males was seen in phlebitis. In our study prevention of phlebitis was very significant.

Loai abuseour [39] explained oncology nurses knowledge on CT extravasations was unsatisfactory. Mona38 said that only 60% of nurses had knowledge on safe administration of chemotherapy. Comparison of total competency scores in this study between the baseline, second assessment and third assessment on extravasation shows (day 7 and day 30) that the experiment group consistently outperformed the control group in terms of median competency scores, with statistically significant differences (<0.001 and <0.001).

Change in total competency score in this study between both groups from baseline to first assessment to second assessment showed a highly significant statistical change with second assessment score (<0.001) and to the third assessment as (<0.001) showing a complete gradual increase and persistent retention of the interventional group in our study. Subin Shijin [62-68] has also proved that education with simulation demonstrated medium to large effect sizes. Kath weeks [69,70] has supported simulation learning along with technology and computer animation to healthcare students. Padilha [71,72] too has said, introduction of high simulation in the clinical nursing. In our study too a good demonstration has proved it right. The correlation between the total scores on knowledge and competency was assessed. The correlation at second assessment was 0.630 with p = <0.001. Correlation at third assessment was 0.613 which was slightly less with p = <0.001. Indicating a good correlation among the knowledge and competency. Investigator states that when there is a knowledge increase, the competency level of the nursing staff also increased. Hence education is very necessary to bring the desired changes in the organization. Derya [73,74] has reconfirmed the use of high simulation and said that, students of HS group better transferred whatever they learned in the clinical teaching practice. The results show creating an effective environment in simulation had a positive effect on the development of the clinical skills.

Conclusion

Knowledge is power, said Francis Bacon. No human being will work hard at anything unless they believe that they are working for competence, said Aja. Hence gaining knowledge and competence is quintessential. Keeping this in mind the investigator has tried to bridge the gap where many studies have documented that nurses lack in knowledge particularly chemotherapy., provide knowledge regarding the protocols, side effects arising due to IV therapy. In the same way competence is the ability to deal with IV therapy reducing complications causing extra days of hospitalization and incurring heavy financial burden to patient and his family. The areas which had good differences were seen in double checking with the second nurse , checking laboratory values, use of PPE, withdrawal using sterile gauze, documentation, Leucovorin and MTX , in case of irritants and vesicants , flushing post vincristine, taxol and polyethylene, taxol and codan, photosensitive, no movements by patients, patients to report in case of pain , chooses right cannula and right location , marks outline , photograph the site , elevation of arm , warm compresses in vinca and taxanes , cold compress in anthracycline and mitomycin, hyaluronidase in vinca and taxanes and dexrazoxane in anthracycline are all highly statistically significant in the experimental group. This shows that the interventions done in the group has shown specific learning with regard to chemotherapy complication prevention and it has shown a significant difference from the control group.

Hence with all the integrated demonstration program which consisted of impart of knowledge and competency, the nursing staff in the experimental group has outperformed the control group showing the necessity for continuing education program.

Recommendations

The module which has been used here can be used for 1. Development of a certification program which can obtain recognition from state and Indian nursing council and implement the course.

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Conflict of Interest

None.

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