

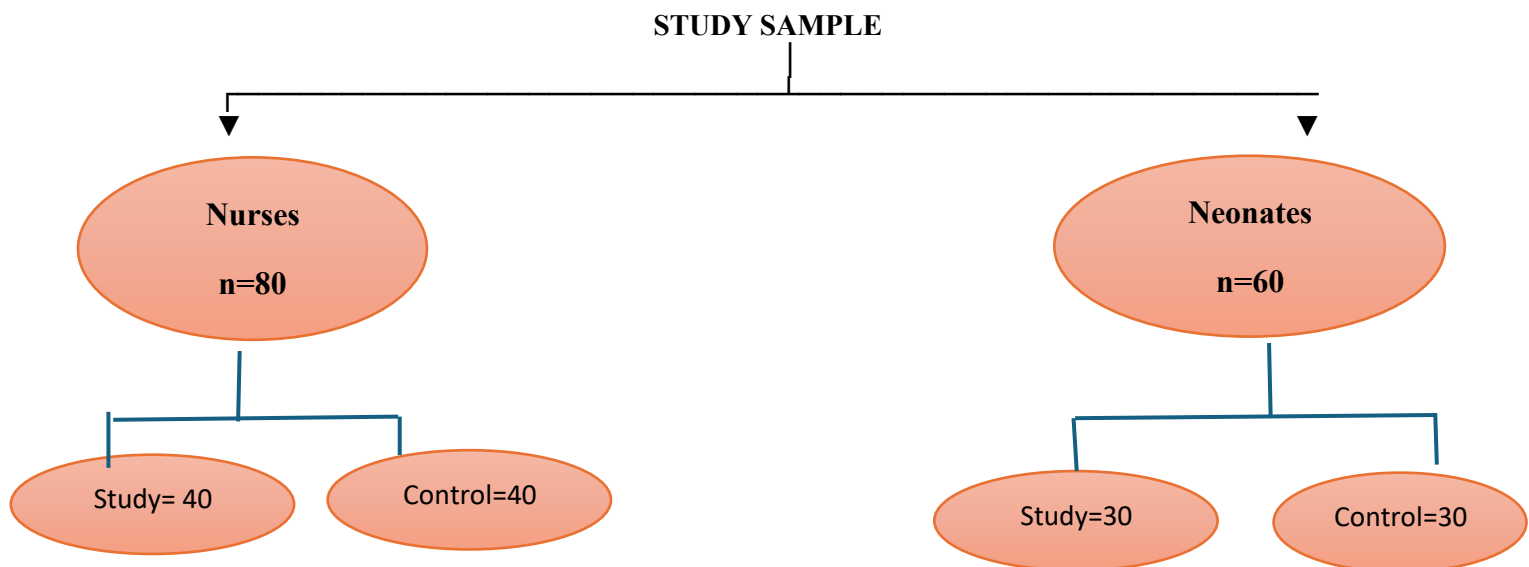
Section 1: Participant Flow & Sample Description

Subjects: The subjects consisted of two types of samples.

1-Regarding nurses: Nurses were recruited using a convenience sampling technique according to their availability during clinical shifts (80). Eligible nurses were assigned to either the study or control group. Nurses in the study group (40) received training on the nurse-led postoperative care bundle, whereas nurses in the control group (40) received the usual care procedures, to avoid data contamination cluster allocation was performed based on distinct nursing shifts/units.

2- Regarding neonates: Neonates who met the predefined eligibility criteria were recruited using a convenience sampling technique (60), after fulfilling the following criteria: neonates undergoing tracheoesophageal fistula repair who were admitted to the previously mentioned NICU and whose parents agreed to participate in the study. The exclusion criteria included neonates with other types of congenital anomalies or life-threatening conditions. Neonates cared for by nurses in the study group were included in the study group (30), whereas neonates cared for by nurses in the control group were included in the control group (30). Thus, the allocation of neonates was linked to the group allocation of the nurses providing their postoperative care.

The required sample size was calculated using G*Power software (version 3.1.9.7). Based on an effect size of $d = 0.50$, a significance level (α) of 0.05, and a statistical power ($1 - \beta$) of 80% for a two-tailed independent t-test, the initial required sample size was determined to be 54 neonates (27 per group). To account for a anticipated 10% drop-out rate, the sample size was increased to 60 neonates using the formula $N_{\text{adjusted}} = \frac{N}{1 - \text{attrition rate}} = \frac{54}{1 - 0.10} = 60$. Consequently, 60 neonates were randomly and equally allocated into two groups: the study group ($n = 30$) and the control group ($n = 30$).



Section 2: Baseline Characteristics

Table 1 demonstrates that the participating nurses in the study and control groups were comparable with respect to all baseline personal and professional characteristics ($p>0.05$), and none of the participating nurses had previously attended any training course related to postoperative care bundles for tracheoesophageal fistula repair. This finding indicates a uniform baseline level of exposure to the postoperative care bundle for tracheoesophageal fistula repair among participants.

Table 2 Baseline personal characteristics and medical data and demonstrates that there are no statistically significant differences regarding neonatal age at admission, gestational age, sex, admission weight, presenting symptoms, and type of tracheoesophageal fistula (all $p>0.05$). majority of participating neonates were admitted within the first day of life and were born at 37- 39 weeks of gestation and had type C tracheoesophageal fistula. Regarding main presenting symptoms in both groups, the majority of them had excessive salivation, respiratory distress, cyanosis, and inability to pass a nasogastric tube. The similarity between participating groups indicates successful baseline comparability, supporting the validity of subsequent comparisons of postoperative outcomes.

Table (1): Characteristics of the participating nurses (n= 80)

Items	Control group (n= 40)	Study group (n= 40)	Test	P value
Age/ years				
20-< 30	14(35.0)	13(32.5)	χ^2 .510	.775
30- <40	15(37.5)	18(45.0)		
≥ 40	11(27.5)	9(22.5)		
Mean $\pm$ SD/ years	33.17 $\pm$ 6.06	33.20 $\pm$ 6.03	t.018	.985
Gender				
Female	30(75.0)	28(70.0)	FET	.401
Male	10(25.0)	12(30.0)		
Educational level				
Secondary School Nursing	5(12.5)	4(10.0)	χ^2 .593	.898
Technical Nursing Institute	18(45.0)	17(42.5)		
Bachelor's degree in nursing.	13(32.5)	16(40.0)		
Postgraduate Education	4(10.0)	3(7.5)		
Job title				
Staff Nurse	36(90.0)	37(92.5)	FET	.500
Nursing Supervisor	4(10.0)	3(7.5)		
Years of experience in neonatal intensive care units				
<5 years	6(15.0)	7(17.5)	χ^2 .211	.900
5 <10 years	23(57.5)	21(52.5)		
≥ 10 years	11(27.5)	12(30.0)		
Mean $\pm$ SD/ years	8.15 $\pm$ 3.75	8.27 $\pm$ 4.21	t,.140	.889

χ^2 : Chi-square test FET: Fisher Exact Test t: independent sample t test *: Statistically significant at $p\leq 0.05$

Table (2): Percentage distribution of the participating neonates according to their personal characteristics and medical data (n= 60)

Variable	Participating neonates (n=60)			
	Study group (n=30)	Control group (n=30)	Test	P-value
Age on admission /day				
< 1	24(80.0)	25(83.3)	χ^2 .111	.739
1- <3	6(20.0)	5(16.7)		
Mean $\pm$ SD	1.20 $\pm$.40 day	1.16 $\pm$.37 day	t,.328	.744
Gestational Age/ week				
35- <37	8(26.7)	5(16.7)	χ^2 .884	.347
37- 39	22(73.3)	25(83.3)		
Gender				
Girl	17(56.7)	14(46.7)	χ^2 .601	.438
Boy	13(43.3)	16(53.3)		
Weight on admission				
Mean $\pm$ SD	2354 $\pm$ 218.4	2355 $\pm$ 250.9	t,.328	.744
Medical history				
Main presenting symptoms (Multiple responses were allowed)				
Excessive salivation/frothing from the mouth	28(93.3)	27(90.0)	FET	1.000
Choking during feeding	27(90.0)	24(80.0)	FET	.472
Coughing during feeding	26(86.7)	26(86.7)	FET	1.000
Cyanosis	27(90.0)	28(93.3)	FET	1.000
Respiratory distress tachypnea/retractions	27(90.0)	28(93.3)	FET	1.000
Abdominal distension	23(76.7)	25(83.3)	χ^2 , .417	.519
Inability to pass a nasogastric tube	30(100.0)	30(100.0)	-	-
Type of Tracheoesophageal Fistula (TEF)				
Type A (Pure esophageal atresia without fistula)	5(16.7)	4(13.3)	FET	1.000
Type C (Esophageal atresia with distal fistula)	25(83.3)	26(86.7)		

Section 3: Primary Outcome Measures

Table 3 presents that there is no statistically significant difference was observed between participating nurses' total knowledge scores in the pretest phase with mean score (16.07 ± 4.05 vs. 16.00 ± 3.91 , $t=0.084$, $p=0.933$), indicating comparable baseline knowledge. Following implementation of the postoperative care bundle, the posttest total knowledge score of the study group (24.82 ± 2.01) was significantly higher than that of the control group (16.15 ± 4.19) ($t=11.78$, $p<0.001$). The between-group effect size at posttest was very large (Cohen's $d = 2.64$), indicating that implementation of the postoperative care bundle produced a substantial improvement in nurses' knowledge regarding postoperative care following tracheoesophageal fistula repair.

Table 4 clarifies that at baseline, there is no statistically significant difference in the overall practice score between the study and control groups (17.70 ± 5.30 vs. 18.45 ± 5.34 , $t=0.630$, $p=0.531$), confirming baseline comparability. Following implementation of the postoperative care bundle, the nurses in the study group exhibited significant improvements across all evaluated domains of the postoperative care bundle, including airway and respiratory management, positioning and anastomosis protection, hemodynamic monitoring, nutritional support, pain management, infection prevention, postoperative complication monitoring, and family education (all $p<0.001$). Moreover, the mean posttest practice score was significantly higher among nurses in the study group than in the control group (36.07 ± 4.00 vs. 20.25 ± 5.23 , $t=15.18$, $p<0.001$). The between-group effect size was extremely large (Cohen's $d = 3.39$), indicating that implementation of the postoperative care bundle produced a substantial improvement in nurses' clinical practice beyond routine care.

Table 5 shows that neonates receiving the nurse-led postoperative care bundle achieved significantly greater physiological stability than those receiving routine care. Significant improvements were observed across cardiovascular stability, respiratory stability, thermoregulation, and fluid-perfusion status ($p \leq 0.012$), resulting in a significantly higher total physiological stability score in the study group ($p<0.001$). Regarding early recovery outcomes; neonates in the study group required fewer days of mechanical ventilation, initiated enteral feeding earlier, achieved full oral feeding sooner, experienced shorter post-operative NICU stays, and demonstrated lower postoperative pain scores compared with controls ($p<0.05$). Regarding postoperative complications, sepsis occurred significantly less frequently among intervention neonates (6.7% vs 26.7%; $p=0.038$). Although reductions were also observed for aspiration pneumonia, atelectasis, wound infection, and anastomotic leakage, these differences did not reach statistical significance. Collectively, these findings indicate that implementation of the nurse-led postoperative care bundle was associated with enhanced physiological stability and accelerated postoperative recovery among neonates undergoing tracheoesophageal fistula repair.

Table (3): Comparison of nurses' knowledge level regarding postoperative care bundle within and between study and control groups (n=80)

Knowledge Level	Study group (n= 40)		Test	P– valu e	Control group (n= 40)		Test	P– valu e
	Pretest	Post test			Pretest	Post test		
Adequate knowledge (≥80 %)	3(7.5)	35(87.5)	χ^2 51.3 2	.001 *	2(5.0)	4(10.0)	FET	.675
Inadequate knowledge (< 80%)	37(92.5)	5(12.5)			38(95.0)	36(90.0)		
Between-group comparison Test; independent sample t test								
Pretest phase Between study and control group	Total mean score of study group 16.07±4.05		Total mean score of control group 16.00±3.91		t, .084		P–value .933	
Post test phase Between study and control group	Total mean score of study group 24.82±2.01		Total mean score of control group 16.15±4.19		t, 11.78		P–value < .001*	

χ^2 : Chi-square test FET: Fisher Exact Test t: independent sample t test *: Statistically significant at $p \leq 0.05$

Table (4): Comparison of nurses' practice level regarding postoperative care bundle within and between study and control groups (n=80)

Domain	Study group (n= 40)						Control group (n= 40)					
	Pretest		Post test		TES T	P- value	Pretest		Post test		TE ST	P- val ue
	Incom petent practic e	Comp etent practic e	Inco mpet ent practi ce	Compe tent practic e			Incom petent practic e	Comp etent practic e	Incom petent practic e	Comp etent practic e		
Airway and Respiratory Management	38(95.0)	2(5.0)	5(12.5)	35(87.5)	χ^2 54.75	.001*	35(87.5)	5(12.5)	33(82.5)	7(17.5)	χ^2 .392	.531
Positioning and Anastomosis Protection	39(97.5)	1(2.5)	3(7.5)	37(92.5)	χ^2 64.96	.001*	39(97.5)	1(2.5)	37(92.5)	3(7.5)	FET	.615
Hemodynamic Monitoring	37(92.5)	3(7.5)	4(10.0)	36(90.0)	χ^2 54.48	.001*	36(90.0)	4(10.0)	35(87.5)	5(12.5)	FET	1.00
Nutritional Support and Feeding Management	36(90.0)	4(10.0)	2(5.0)	38(95.0)	χ^2 57.94	.001*	37(92.5)	3(7.5)	36(90.0)	4(10.0)	FET	1.00
Pain Assessment and Management	36(90.0)	4(10.0)	5(12.5)	35(87.5)	χ^2 48.08	.001*	35(87.5)	5(12.5)	34(85.0)	6(15.0)	χ^2 .105	.745
Infection Prevention Measures	34(85.0)	6(15.0)	2(5.0)	38(95.0)	χ^2 51.71	.001*	33(82.5)	7(17.5)	32(80.0)	8(20.0)	χ^2 .082	.775
Monitoring for Postoperative Complications	38(95.0)	2(5.0)	5(12.5)	35(87.5)	χ^2 54.75	.001*	37(92.5)	3(7.5)	36(90.0)	4(10.0)	FET	1.00
Family Education and Discharge Preparation	34(85.0)	6(15.0)	3(7.5)	37(92.5)	χ^2 48.32	.001*	32(80.0)	8(20.0)	30(75.0)	10(25.0)	χ^2 .287	.592
Total level	38(95.0)	2(5.0)	8(20.0)	32(80.0)	χ^2 46.03	.001*	38(95.0)	2(5.0)	37(92.5)	3(7.5)	FET	1.00
Between-group comparison Test; independent sample t test												
Pretest phase Between study and control group	Total mean score of study group 17.70±5.30				Total mean score of control group 18.45±5.34			t, .630		P-value .531		
Post test phase Between study and control group	Total mean score of study group 36.07±4.00				Total mean score of control group 20.25±5.23			t,15.18		P-value .001*		

χ^2 : Chi-square test FET: Fisher Exact Test t: independent sample t test *: Statistically significant at $p \leq 0.05$

Table (5): Comparison of the mean scores for neonatal physiological stability and early recovery outcomes between the study and control groups after implementation of the postoperative care bundle (n=60)

Variable	Participating neonates (n=60)			
	Study group (n=30)	Control group (n=30)	Test	P-value
Neonate's physiological stability				
Cardiovascular stability	3.43±.678	2.73±1.31	t, 2.59	.012
Respiratory stability	5.86±.819	4.40±2.54	t,3.00	.004
Thermoregulation	1.83±.379	1.40±.498	t,3.79	.001
Fluid and Perfusion Status	3.10±.547	2.26±1.14	t, 3.60	.001
Total mean score	14.23±1.40	10.80±5.04	t,3.59	.001
Early recovery outcomes				
Duration of mechanical ventilation	2.90±.607	3.33±.922	t,2.14	.036
Time to initiation of enteral feeding postoperative/ day	6.86±.507	7.53±.507	t,5.08	.001
Time to full oral feeding/ day	13.00±.525	13.66±.758	t,3.95	.001
Length of NICU / day	15.53±1.45	16.93±1.87	t,3.23	.002
Postoperative pain assessment	2.60±.498	3.00±.525	t, 3.02	.004
Presence of postoperative complications:				
Anastomotic leak	2(6.7)	3(10.0)	FET	1.000
Aspiration pneumonia	1(3.3)	7(23.3)	FET	.052
Sepsis	2(6.7)	8(26.7)	χ^2 4.32	.038
Atelectasis	1(3.3)	7(23.3)	FET	.052
Wound infection	1(3.3)	6(20.0)	FET	.103

Independent Samples t-test χ^2 : Chi-square test FET: Fisher Exact * No statistically significant difference; P value >0.05

Section 4: Adverse Events

Adverse Events: No adverse events or safety concerns were reported among premature neonates or participating parents throughout the study duration and follow-up periods.