


# The Economic Outcomes of Pharmacist Interventions in Total Parenteral Nutrition Services in Saudi Arabia

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## ABSTRACT

**Objectives:** There are several problems and complications related to the Total Parenteral Nutrition (TPN) services. The pharmacist plays a crucial role in preventing these problems. Therefore, in this study, we aimed to assess the economic outcomes of pharmacist intervention in cost avoidance related to TPN services at a public hospital in Riyadh city, Saudi Arabia. **Methods:** Cohort prospective analysis of data collected regarding pharmacist intervention in TPN services provided to neonates, pediatrics and adult patients was performed. TPN services were provided 8 hr in a day and 7 days in a week. The study site was a 300-bed public hospital at the Ministry of Health (MOH) in Riyadh city, Saudi Arabia. The pharmacist reviews and prepares TPN and he pharmacist documents any or all TPN-related problems before the preparation of TPN or after dispensing it. The pharmacist uses an International Study Model to measure level of activity and provides rational of clinical intervention, recommendation, patient outcome, impact of pharmacoeconomics and related cost analysis. **Results:** The pharmacist identified a total of 402 TPN-related problems. The total number of TPN services provided was 394 prescribed to 82 patients. Of these, 209 (51.99%) and 193 (48.01%) interventions were provided to males and females, respectively. The total cost avoidance from pharmacist intervention in 1 year was 578,926.89 USD. The highest cost avoidance of TPN interventions was recorded for potentially significant (54.90%; 100,040.91 USD) and potentially serious problems (33.33%; 244,696.83 USD). The maximum cost avoidance in the case of rational clinical activities was recorded for TPN consultations (325,695.76 USD) followed by incompatibility (275,802.66) and inappropriate route (189,912.34 USD). The maximum cost avoidance related to patient outcome was recorded for patient condition improved (489,830.93 USD) and laboratory value improved (89,095.96). The maximum pharmacoeconomic cost avoidance impact was the patient duration of hospital stay decreased (226; 332,220.70 USD) and reduction in the drug therapy monitoring (246,227.15 USD). **Conclusion:** The clinical pharmacist responsible for TPN services plays an essential role in preventing TPN-related problems and avoid the unnecessary economic burden on the healthcare system. Expanding the role TPN clinical pharmacist is highly recommended for all TPN services to reduce the economic burden on healthcare system in Saudi Arabia.

**Key words:** Economic outcome, Pharmacist intervention, Total parenteral nutrition, Ministry of Health, Saudi Arabia.

## INTRODUCTION

The strategic plan on pharmacy was released in 2012 with several general goals and initiatives.<sup>1</sup> The new and updated version of this plan along with the current evaluation and inclusion of New Saudi Vision 2030 was released in 2018.<sup>2</sup> This version states several tools for monitoring the plan, implementation and outcomes of the pharmacy practice programs.<sup>1</sup> The cost avoidance or cost impact was one of the current application tools.<sup>3</sup> Several international publications have explored the impact of cost avoidance on the pharmacist performance in different clinical pharmacy programs including nutrition support pharmacy.<sup>4-6</sup> In addition, several local investigations used the tool and showed the high-cost impact of some pharmacy programs.<sup>7-10</sup> However, to the best of our knowledge, there are no studies conducted on the nutrition support services and their economic impact and cost avoidance in the KSA, Gulf and Middle Eastern countries. Therefore, in this study, we aimed to explore the economic impact of pharmacist interventions with nutrition support services at a public hospital located in Riyadh city, KSA.

## METHODS

This is a cohort prospective analysis of 12-month data of 2015 regarding pharmacist intervention by providing TPN services to neonates, pediatrics and adult patients. TPN services are provided at the public hospital belonging to the MOH; it provides services for 8 hr in a day and 7 days in a week and has 300 beds. The hospital has following specialties: adult's endocrinology, adult's nephrology pediatrics, adult's cardiology, adults internal medicine, adults surgery, adults critical care, NICU, PICU and obstetrics and gynecology. The hospital has ambulatory care services and emergency services with above specialties. In addition, the hospital had comprehensive pharmaceutical services including inpatient pharmacy and ambulatory care pharmacy. Furthermore, the TPN services, drug information services and computerized physician order entry system is available at both inpatient and outpatient units. In 2009s, the pharmacy services established TPN services starting from physician prescribing it to pharmacist reviewing, preparing and dispensing it; the nurse administers the preparation to the patients. After 5 years, the pharmacy improved the services by in-

stalling the automated compounding system techniques. TPN-related problems were documented before preparation and after dispensing the TPN order. The pharmacist intervention used an International Study Model, which measures the level of activity and provides rational of clinical intervention, recommendation, patient outcome impact of pharmacoeconomics and related cost analysis.<sup>11,12</sup> The data were gathered and analyzed by using the Survey Monkey system.

## RESULTS

The pharmacist identified a total of 402 TPN-related problems. A total of 394 TPN orders were prescribed to 82 patients. The rate of intervention was 4.9 per patient. Of those, 209 (51.99%) and 193 (48.01%) were provided to males and females, respectively. The majority of patients were Saudi (266 (66.2%)) patients (non-Saudi patients were 136 (33.8%) in number). The majority of patients were neonates (303 (75.56%)) followed by pediatrics (97 (24.19%)) (1). The total cost avoidance from pharmacist intervention for 1 year was 578,926.89 USD. The maximum cost avoidance in female patients was 47.06% (299,630.67 USD), whereas the maximum cost avoidance in males was 52.94% (279,296.22 USD). The maximum nationality-related cost avoidance was 59.61% (354,036.65 USD) in Saudi patients, whereas it was 40.39% (224,890.24 USD) in non-Saudi patients. The maximum cost avoidance in neonates was 76.47% (403,762.96 USD) and in pediatrics, it was 23.53% (175,163.93 USD) (Tables 2–4). The maximum cost avoidance was recorded for senior registrar prescriber (67.84%; 319,488.32 USD) and consultant prescriber (27.06%; 209,323.17 USD). The maximum cost avoidance in terms of TPN interventions was recorded for potentially significant (54.90%; 100,040.91 USD) and potentially serious (33.33%; 244,696.83 USD) problems (Tables 5 and 6). The maximum rational cost avoidance in terms of clinical activities was recorded for TPN consultations

**Table 1: Patient demographic information.**

Age		
Answer Options	Response Count	Response Percent
0-30 days	303	75.6%
1 month- 6 years	97	24.2%
6-12 years	1	0.2%
12-18 years	0	0.0%
18-40 years	0	0.0%
40-65 years	0	0.0%
65 or older	0	0.0%
answered question		401
skipped question		1
Sex		
Answer Options	Response Count	Response Percent
Female	193	48.0%
Male	209	52.0%
answered question		402
skipped question		0
Nationality		
Answer Options	Response Count	Response Percent
Saudi	266	66.2%
Non-Saudi	136	33.8%
answered question		402
skipped question		0

**Table 2: Gender distribution versus cost avoidance.**

Sex	Female				Male			Total			
	No	Cost	No	%	Cost avoidance	No	%	Cost avoidance	No	%	Cost avoidance
1a		26.17	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
1b		54.89	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2a		30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2b		30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2c		30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2d		30.35	3	60.00%	91.05	2	40.00%	60.70	5	1.96%	151.75
2e		30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2f		34.31	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
3a		260.46	6	46.15%	1,562.76	7	53.85%	1,823.22	13	5.10%	3,385.98
3b		109.00	8	66.67%	872.00	4	33.33%	436.00	12	4.71%	1,308.00
3c		320.70	1	14.29%	320.70	6	85.71%	1,924.20	7	2.75%	2,244.90
4a		370.04	62	44.29%	22,942.48	78	55.71%	28,863.12	140	54.90%	51,805.60
4b		581.75	1	25.00%	581.75	3	75.00%	1,745.25	4	1.57%	2,327.00
4c		3,562.79	9	60.00%	32,065.11	6	40.00%	21,376.74	15	5.88%	53,441.85
4d		6,437.13	10	58.82%	64,371.30	7	41.18%	45,059.91	17	6.67%	109,431.21
5a		6,592.03	6	31.58%	39,552.18	13	68.42%	85,696.39	19	7.45%	125,248.57
5b		9,466.36	12	66.67%	113,596.32	6	33.33%	56,798.16	18	7.06%	170,394.48
5c		11,837.51	2	40.00%	23,675.02	3	60.00%	35,512.53	5	1.96%	59,187.55
6		100,000.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
Total			120	47.06%	299,630.67	135	52.94%	279,296.22	255	100.00%	578,926.89

Answered questions 255, Skipped 0

**Table 3: Nationality versus cost avoidance.**

Sex	Saudi			Non-Saudi			Total			
	No	Cost	%	No	Cost avoidance	%	Cost avoidance	No	%	Cost avoidance
1a	26.17	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
1b	54.89	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2a	30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2b	30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2c	30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2d	30.35	5	100.00%	151.75	0	0.00%	0.00	5	1.96%	151.75
2e	30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2f	34.31	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
3a	260.46	7	53.85%	1,823.22	6	46.15%	1,562.76	13	5.10%	3,385.98
3b	109	7	58.33%	763.00	5	41.67%	545.00	12	4.71%	1,308.00
3c	320.7	3	42.86%	962.10	4	57.14%	1,282.80	7	2.75%	2,244.90
4a	370.04	79	56.43%	29,233.16	61	43.57%	22,572.44	140	54.90%	51,805.60
4b	581.75	4	100.00%	2,327.00	0	0.00%	0.00	4	1.57%	2,327.00
4c	3,562.79	12	80.00%	42,753.48	3	20.00%	10,688.37	15	5.88%	53,441.85
4d	6,437.13	10	58.82%	64,371.30	7	41.18%	45,059.91	17	6.67%	109,431.21
5a	6,592.03	12	63.16%	79,104.36	7	36.84%	46,144.21	19	7.45%	125,248.57
5b	9,466.36	9	50.00%	85,197.24	9	50.00%	85,197.24	18	7.06%	170,394.48
5c	11,837.51	4	80.00%	47,350.04	1	20.00%	11,837.51	5	1.96%	59,187.55
6	100,000.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
Total		152	59.61%	354,036.65	103	40.39%	224,890.24	255	100.00%	578,926.89

Answered questions 255, Skipped 0

**Table 4: Age distribution versus cost avoidance.**

Sex	0-30 days			1 month- 6 years			Total			
	No	Cost	%	No	Cost avoidance	%	Cost avoidance	No	%	Cost avoidance
1a	26.17	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
1b	54.89	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2a	30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2b	30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2c	30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2d	30.35	4	80.00%	121.40	1	20.00%	30.35	5	1.96%	151.75
2e	30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2f	34.31	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
3a	260.46	9	69.23%	2,344.14	4	30.77%	1,041.84	13	5.10%	3,385.98
3b	109	11	91.67%	1,199.00	1	8.33%	109.00	12	4.71%	1,308.00
3c	320.7	4	57.14%	1,282.80	3	42.86%	962.10	7	2.75%	2,244.90
4a	370.04	111	79.29%	41,074.44	29	20.71%	10,731.16	140	54.90%	51,805.60
4b	581.75	3	75.00%	1,745.25	1	25.00%	581.75	4	1.57%	2,327.00
4c	3,562.79	12	80.00%	42,753.48	3	20.00%	10,688.37	15	5.88%	53,441.85
4d	6,437.13	13	76.47%	83,682.69	4	23.53%	25,748.52	17	6.67%	109,431.21
5a	6,592.03	14	73.68%	92,288.42	5	26.32%	32,960.15	19	7.45%	125,248.57
5b	9,466.36	12	66.67%	113,596.32	6	33.33%	56,798.16	18	7.06%	170,394.48
5c	11,837.51	2	40.00%	23,675.02	3	60.00%	35,512.53	5	1.96%	59,187.55
6	100,000.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
Total		195	76.47%	403,762.96	60	23.53%	175,163.93	255	100.00%	578,926.89

Answered questions 255, Skipped 0

Table 5: Prescriber qualification versus cost avoidance.

Sex	Consultant			Senior registrar			Registrar			Intern			Total		
	No	Cost	%	No	Cost avoidance	%	No	Cost avoidance	%	No	Cost avoidance	%	No	Cost avoidance	%
1a	0	26.17	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
1b	0	54.89	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
2a	0	30.35	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
2b	0	30.35	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
2c	0	30.35	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
2d	0	30.35	0.00%	5	151.75	100.00%	0	0.00	0.00%	0	0.00	0.00%	5	151.75	1.96%
2e	0	30.35	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
2f	0	34.31	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
3a	2	260.46	15.38%	11	520.92	84.62%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
3b	0	109	0.00%	11	0.00	91.67%	0	1,199.00	0.00%	1	109.00	8.33%	12	1,308.00	4.71%
3c	1	320.7	14.29%	5	320.70	71.43%	0	1,603.50	0.00%	1	320.70	14.29%	7	2,244.90	2.75%
4a	40	370.04	28.57%	96	14,801.60	68.57%	0	35,523.84	0.00%	4	1,480.16	2.86%	140	51,805.60	54.90%
4b	2	581.75	50.00%	2	1,163.50	50.00%	0	1,163.50	0.00%	0	0.00	0.00%	4	2,327.00	1.57%
4c	2	3,562.79	13.33%	11	7,125.58	73.33%	0	39,190.69	0.00%	2	7,125.58	13.33%	15	53,441.85	5.88%
4d	8	6,437.13	47.06%	9	51,497.04	52.94%	0	57,934.17	0.00%	0	0.00	0.00%	17	109,431.21	6.67%
5a	2	6,592.03	10.53%	14	13,184.06	73.68%	0	92,288.42	0.00%	3	19,776.09	15.79%	19	125,248.57	7.45%
5b	9	9,466.36	50.00%	8	85,197.24	44.44%	0	75,730.88	0.00%	1	9,466.36	5.56%	18	170,394.48	7.06%
5c	3	11,837.51	60.00%	1	35,512.53	20.00%	0	11,837.51	0.00%	1	11,837.51	20.00%	5	59,187.55	1.96%
6	0	100,000.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
Total	69	209,323.17	27.06%	173	319,488.32	67.84%	0	319,488.32	0.00%	13	50,115.40	5.10%	255	578,926.89	100.00%
Answered questions 255, Skipped 0															

Table 6: Intervention severity versus cost avoidance.

Sex	Potentially Fatal			Potentially Serious			Potentially Significant			Neutral			Total		
	No	Cost	%	No	Cost avoidance	%	No	Cost avoidance	%	No	Cost avoidance	%	No	Cost avoidance	%
1a	0	26.17	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
1b	0	54.89	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
2a	0	30.35	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
2b	0	30.35	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
2c	0	30.35	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
2d	0	30.35	0.00%	1	30.35	20.00%	4	121.40	80.00%	0	0.00	0.00%	5	151.75	1.96%
2e	0	30.35	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
2f	0	34.31	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
3a	0	260.46	0.00%	7	1,823.22	53.85%	6	1,562.76	46.15%	0	0.00	0.00%	13	3,385.98	5.10%
3b	0	109	0.00%	3	327.00	25.00%	9	981.00	75.00%	0	0.00	0.00%	12	1,308.00	4.71%
3c	0	320.7	0.00%	2	641.40	28.57%	5	1,603.50	71.43%	0	0.00	0.00%	7	2,244.90	2.75%
4a	1	370.04	0.71%	36	13,321.44	25.71%	103	38,114.12	73.57%	0	0.00	0.00%	140	51,805.60	54.90%
4b	0	581.75	0.00%	0	0.00	0.00%	4	2,327.00	100.00%	0	0.00	0.00%	4	2,327.00	1.57%
4c	1	3,562.79	6.67%	11	39,190.69	73.33%	3	10,688.37	20.00%	0	0.00	0.00%	15	53,441.85	5.88%
4d	2	6,437.13	11.76%	14	90,119.82	82.35%	1	6,437.13	5.88%	0	0.00	0.00%	17	109,431.21	6.67%
5a	10	6,592.03	52.63%	5	32,960.15	26.32%	4	26,368.12	21.05%	0	0.00	0.00%	19	125,248.57	7.45%
5b	16	9,466.36	88.89%	2	18,932.72	11.11%	0	0.00	0.00%	0	0.00	0.00%	18	170,394.48	7.06%
5c	0	11,837.51	0.00%	4	47,350.04	80.00%	1	11,837.51	20.00%	0	0.00	0.00%	5	59,187.55	1.96%
6	0	100,000.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
Total	30	234,189.15	11.76%	85	244,696.83	33.33%	140	100,040.91	54.90%	0	0.00	0.00%	255	578,926.89	100.00%

Answered questions 255, Skipped 0

**Table 7: Clinical activity rationale (clinical intervention activity) versus cost avoidance.**

Sex	Dosage Calculation		Inappropriate Dose		Inappropriate Route		Incompatibility		Drug Therapy Omission		TPN Consultation		Other		Total	
	No	Cost avoidance	No	Cost avoidance	No	Cost avoidance	No	Cost avoidance	No	Cost avoidance	No	Cost avoidance	No	Cost avoidance	No	Cost avoidance
1a	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
1b	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2a	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2b	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2c	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2d	1	30.35	2	60.70	0	0.00	0	0.00	0	0.00	2	60.70	0	0.00	5	151.75
2e	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2f	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
3a	0	0.00	5	1,302.30	4	1,041.84	0	0.00	1	260.46	0	0.00	3	3,906.90	13	3,385.98
3b	1	109.00	5	545.00	0	0.00	0	0.00	0	0.00	0	0.00	6	3,270.00	12	1,308.00
3c	0	0.00	0	0.00	1	320.70	0	0.00	0	0.00	0	0.00	6	0.00	7	2,244.90
4a	6	2,220.24	73	27,012.92	1	370.04	1	370.04	48	17,761.92	0	0.00	11	297,142.12	140	51,805.60
4b	0	0.00	0	0.00	1	581.75	0	0.00	0	0.00	1	0.00	2	0.00	4	2,327.00
4c	0	0.00	3	10,688.37	7	24,939.53	3	10,688.37	0	0.00	0	0.00	2	21,376.74	15	53,441.85
4d	0	0.00	0	0.00	15	96,556.95	2	12,874.26	0	0.00	0	0.00	0	0.00	17	109,431.21
5a	1	6,592.03	0	0.00	5	32,960.15	12	79,104.36	0	0.00	0	0.00	1	0.00	19	125,248.57
5b	0	0.00	0	0.00	1	9,466.36	17	160,928.12	0	0.00	0	0.00	0	0.00	18	170,394.48
5c	0	0.00	1	11,837.51	2	23,675.02	1	11,837.51	1	11,837.51	0	0.00	0	0.00	5	59,187.55
6	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	9	8,951.62	89	51,446.80	37	189,912.34	36	275,802.66	50	29,859.89	3	60.70	31	325,695.76	255	578,926.89

Answered questions 255, Skipped 0

Table 8: Recommendations versus cost.

Sex	Initiate Drug Order			Change Drug			Change Dose			Change Route			Other			Total		
	No	Cost	%	No	Cost avoidance	%	No	Cost avoidance	%	No	Cost avoidance	%	No	Cost avoidance	%	No	Cost avoidance	%
1a	0	26.17	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
1b	0	54.89	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
2a	0	30.35	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
2b	0	30.35	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
2c	0	30.35	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
2d	0	30.35	0.00%	0	0.00	0.00%	2	60.70	40.00%	0	0.00	0.00%	3	91.05	0.00%	5	151.75	1.96%
2e	0	30.35	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
2f	0	34.31	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
3a	1	260.46	7.69%	0	0.00	0.00%	5	1,302.30	38.46%	4	30.77%	0.00%	3	781.38	7.69%	13	3,385.98	5.10%
3b	0	109	0.00%	0	0.00	0.00%	5	545.00	41.67%	0	0.00%	0.00%	7	763.00	0.00%	12	1,308.00	4.71%
3c	0	320.7	0.00%	0	0.00	0.00%	0	0.00	0.00%	1	14.29%	0.00%	6	1,924.20	0.00%	7	2,244.90	2.75%
4a	48	370.04	34.29%	1	370.04	0.71%	73	27,012.92	52.14%	1	0.71%	0.00%	17	6,290.68	34.29%	140	51,805.60	54.90%
4b	0	581.75	0.00%	0	0.00	0.00%	0	0.00	0.00%	1	25.00%	0.00%	3	1,745.25	0.00%	4	2,327.00	1.57%
4c	0	3,562.79	0.00%	2	7,125.58	13.33%	4	14,251.16	26.67%	7	46.67%	0.00%	2	7,125.58	0.00%	15	53,441.85	5.88%
4d	0	6,437.13	0.00%	0	0.00	0.00%	2	12,874.26	11.76%	15	88.24%	0.00%	0	0.00	0.00%	17	109,431.21	6.67%
5a	0	6,592.03	0.00%	3	19,776.09	15.79%	9	59,328.27	47.37%	5	26.32%	0.00%	2	13,184.06	0.00%	19	125,248.57	7.45%
5b	0	9,466.36	0.00%	2	18,932.72	11.11%	15	141,995.40	83.33%	1	5.56%	0.00%	0	0.00	0.00%	18	170,394.48	7.06%
5c	0	11,837.51	0.00%	0	0.00	0.00%	2	23,675.02	40.00%	2	40.00%	0.00%	1	11,837.51	20.00%	5	59,187.55	1.96%
6	0	100,000.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00%	0.00%	0	0.00	0.00%	0	0.00	0.00%
Total	49		19.22%	8	18,022.38	3.14%	117	281,045.03	45.88%	37	14.51%	0.00%	44	43,742.71	19.61%	255	578,926.89	100.00%

Answered questions 255, Skipped 0

**Table 9: Patient outcome versus cost avoidance.**

Sex	Cost	Patient's Condition Improved			Laboratory Value Improved			Total		
		No	%	Cost avoidance	No	%	Cost avoidance	No	%	Cost avoidance
1a	26.17	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
1b	54.89	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2a	30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2b	30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2c	30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2d	30.35	3	60.00%	91.05	2	40.00%	60.70	5	1.96%	151.75
2e	30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2f	34.31	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
3a	260.46	5	38.46%	1,302.30	8	61.54%	2,083.68	13	5.10%	3,385.98
3b	109	4	33.33%	436.00	8	66.67%	872.00	12	4.71%	1,308.00
3c	320.7	7	100.00%	2,244.90	0	0.00%	0.00	7	2.75%	2,244.90
4a	370.04	10	7.14%	3,700.40	130	92.86%	48,105.20	140	54.90%	51,805.60
4b	581.75	3	75.00%	1,745.25	1	25.00%	581.75	4	1.57%	2,327.00
4c	3,562.79	13	86.67%	46,316.27	2	13.33%	7,125.58	15	5.88%	53,441.85
4d	6,437.13	17	100.00%	109,431.21	0	0.00%	0.00	17	6.67%	109,431.21
5a	6,592.03	18	94.74%	118,656.54	1	5.26%	6,592.03	19	7.45%	125,248.57
5b	9,466.36	18	100.00%	170,394.48	0	0.00%	0.00	18	7.06%	170,394.48
5c	11,837.51	3	60.00%	35,512.53	2	40.00%	23,675.02	5	1.96%	59,187.55
6	100,000.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
Total		101	39.61%	489,830.93	154	60.39%	89,095.96	255	100.00%	578,926.89
Answered questions 255, Skipped 0										

(325,695.76 USD) followed by incompatibility (275,802.66 USD) and inappropriate route (189,912.34 USD). The maximum cost avoidance in terms of pharmacist's recommendation type was recorded for change dose (281,045.03 USD) followed by change route (189,912.34 USD) (Tables 7 and 8). The maximum cost avoidance in terms of patient outcome related to was patient condition improved (489,830.93 USD) and laboratory value improved (89,095.96). The maximum cost avoidance in relation to pharmacoeconomic impact was the duration of hospital stay of patient (226; 332,220.70 USD) and reduction in the cost of drug therapy monitoring (246,227.15 USD) (Tables 9 and 10).

## DISCUSSION

The pharmacoeconomic program was established during pharmacy strategic planning at MOH in the KSA.<sup>1</sup> Some pharmacoeconomic tools were used as the indicators to follow the implementation of pharmacy strategic plan and measure the economic outcomes of the pharmacy practice program.<sup>3</sup> In the main public hospital in Riyadh city, the pharmacy staff implemented those tools. The authors explored the economic impact of pharmacist intervention with TPN services. The findings showed high-cost avoidance due to prevention of TPN-related problems. However, it is less than the reported value in a previous study.<sup>4</sup> That might be because, the TPN services have been newly established, TPN pharmacist newly trained and newly started TPN services at the hospital. There is not of much a difference in the gender and related cost avoidance because most of the TPN-related problems were similar. The results showed two-third of the problems were related to Saudi patients, whereas one-third of them were related to non-Saudi patients. This is

expected because most of our patients were Saudi nationals. The majority of the cost avoidance were recorded for neonates and pediatrics as most of the TPN candidates were pediatric patients. Most of the cost avoidance was recorded by senior registrar physician because of most of them committed potential mistakes of total parenteral nutrition. The maximum cost avoidance was recorded for potentially severe or significant interventions because the complications would be dangerous and highly risky to the patient even with the low number of interventions.<sup>13</sup> The maximum cost implicated for TPN problems were general TPN consultations and TPN incompatibility; however, these problems lead to significant complications and great sequences of additional cost. Consequently, a great deal of cost is saved. The maximum cost avoidance was recorded for patient conditions improved. This might be related to the reduction of duration of hospital stay and drug therapy monitoring. That is expected with serious or significant TPN related problems. The economic impact of TPN pharmacist was very substantial. The economic impact documentation of prevention intervention with TPN services is highly recommended at MOH hospitals in the KSA.

## CONCLUSION

The economic outcomes of pharmacist intervention through TPN services is vital. In future, we should target to expand the TPN services managed by the pharmacist at all MOH healthcare institutions in the KSA.

## ACKNOWLEDGEMENT

None.



**Table 10: Pharmacoeconomic outcome versus cost avoidance.Sex**

No	Reduction in the Cost of Drug Therapy			Reduction in the Cost of Drug Therapy Monitoring			Patient's Length of Stay Decreased			Patient's Length of Stay Increased			Total			
	Cost	No	%	Cost avoidance	No	%	Cost avoidance	No	%	Cost avoidance	No	%	Cost avoidance	No	%	Cost avoidance
1a	26.17	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
1b	54.89	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2a	30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2b	30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2c	30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2d	30.35	0	0.00%	0.00	0	0.00%	0.00	5	100.00%	151.75	0	0.00%	0.00	5	1.96%	151.75
2e	30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2f	34.31	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
3a	260.46	0	0.00%	0.00	4	30.77%	1,041.84	9	69.23%	2,344.14	0	0.00%	0.00	13	5.10%	3,385.98
3b	109	1	8.33%	109.00	3	25.00%	327.00	8	66.67%	872.00	0	0.00%	0.00	12	4.71%	1,308.00
3c	320.7	0	0.00%	0.00	1	14.29%	320.70	6	85.71%	1,924.20	0	0.00%	0.00	7	2.75%	2,244.90
4a	370.04	0	0.00%	0.00	34	24.29%	12,581.36	105	75.00%	38,854.20	1	0.71%	370.04	140	54.90%	51,805.60
4b	581.75	0	0.00%	0.00	0	0.00%	0.00	4	100.00%	2,327.00	0	0.00%	0.00	4	1.57%	2,327.00
4c	3,562.79	0	0.00%	0.00	4	26.67%	14,251.16	11	73.33%	39,190.69	0	0.00%	0.00	15	5.88%	53,441.85
4d	6,437.13	0	0.00%	0.00	11	64.71%	70,808.43	6	35.29%	38,622.78	0	0.00%	0.00	17	6.67%	109,431.21
5a	6,592.03	0	0.00%	0.00	9	47.37%	59,328.27	10	52.63%	65,920.30	0	0.00%	0.00	19	7.45%	125,248.57
5b	9,466.36	0	0.00%	0.00	8	44.44%	75,730.88	10	55.56%	94,663.60	0	0.00%	0.00	18	7.06%	170,394.48
5c	11,837.51	0	0.00%	0.00	1	20.00%	11,837.51	4	80.00%	47,350.04	0	0.00%	0.00	5	1.96%	59,187.55
6	100,000.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
Total		1	0.39%	109.00	75	29.41%	246,227.15	178	69.80%	332,220.70	1	0.39%	370.04	255	100.00%	578,926.89

Answered questions 255, Skipped 0

## CONFLICT OF INTEREST

The authors declare that there are no conflict of interest.

## ABBREVIATIONS

**TPN:** Total parenteral nutrition; **ASPEN:** American Society of Parenteral Nutrition; **NICU:** Neonatal intensive care unit; **PICU:** Pediatric intensive care unit; **MOH:** Ministry of Health; **KSA:** Kingdom of Saudi Arabia; **ISMP:** Institute for Safe Medication Practices.

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