


The Economic Outcomes of Pharmacist Interventions at Critical Care Services of Private Hospital in Riyadh City, Saudi Arabia

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ABSTRACT

Objectives: The study aims to explore the economic outcomes of the clinical pharmacist at critical care units at a private hospital in Riyadh city, Saudi Arabia in a 6 month study and prevent additional medication costs. **Methods:** It was a 6-months cross-sectional study from January to June 2016 in adults critical care unit. It was a thirty-bed critical care bed consisting of trauma, medical, surgical and maternity critical care cases. The pharmacist monitored all patients through daily medical round and documents any pharmacist intervention. The pharmacist intervention system used an international study model, measure level of activity, rational of clinical intervention, recommendation, patient outcome and pharmacoeconomic impact related estimated cost avoidance. **Results:** The total number of pharmacist interventions were (1,222) provided to (1,124) patients. The complete cost avoidance from pharmacist intervention over the study period was (220,882.10 USD) while over one year was (441,764.2 USD). The highest cost avoidance of critical care interventions was from potentially significant 51.00% (102,581.78 USD) and potentially serious 32.28% (99,162.29 USD). The majority of cost avoidance came from anti-infective agents (73,408.95 USD) followed by nutrition and blood agents (61,182.97 USD) and cardiovascular medications (27,584.52 USD). The most rational clinical activities cost avoidance was from others type (102,168.44 USD) followed by inappropriate dose (30,504.16 USD) and TPN consultations (25,313.99 USD). The most patient outcome related to cost avoidance was patient condition improved (120,036.38 USD) followed by unknown outcomes (47,067.85 USD) and laboratory values improved (21,661.55 USD). The most pharmacoeconomic cost avoidance impact was a reduction in the cost drug therapy 79.94% (163,747.96 USD) and the patient length of hospital stay decreased 1.15% (32,846.49 USD). **Conclusion:** The critical care clinical pharmacist prevent the additional cost of drug-related problems occurrences and economic burden on the healthcare system at a private hospital in the Kingdom of Saudi Arabia. Expanding clinical pharmacist at critical care services is highly recommended to all private hospitals in Saudi Arabia.

Key words: Economic outcomes, Pharmacist, Interventions, Critical care services, Private hospital, Riyadh, Saudi Arabia.

INTRODUCTION

In the past several years during pharmacy strategic plan at the Ministry of Health (MOH) in Saudi Arabia.¹ There were several pharmacy practice programs established.² There were several measures tools to follow up the programs and measure clinical outcomes and cost avoidance in pharmacy and healthcare system.¹ Several previous studies across the world showed the reduction of the economic burden and save cost through pharmacist interventions with an emphasis on critical care services.³⁻⁷ The pharmacist can prevent medications errors and reduce adverse drug reactions and consequences the cost avoidance.^{5,6} Besides, the current site country conducted several investigations about the economic impact of the pharmacist at clinical services. They showed with drug information services, total parental nutrition services, critical care services, poisoning services.⁸⁻¹¹ The majority of the studies done at the governmental hospital. It is hard to find a study conducted at private institutions.¹² The aim of the study is to explore the economic outcome of pharmacist interventions at critical care department at the most prominent private hospital in Riyadh city, Saudi Arabia.

METHODS

It was a prospective cohort analysis from January to June 2016 in adults critical care unit. It was a thirty-bed critical care unit that consisted of trauma, medical, surgical and maternity critical care cases. Dr. Sulaiman Al-Habib Medical Group (HMG) is one of the largest healthcare providers in the Gulf Cooperation Council (GCC) Countries; currently there are 14 medical which are located in Saudi Arabia (Riyadh and Qassim) and in the UAE (Dubai). HMG is also developing one of the largest private medical cities in Saudi Arabia. In 1995, the core of the Medical Group of Dr. Sulaiman Al Habib was built in Olya area in the Saudi capital, Riyadh, with accordance to an advanced vision that applies the highest international healthcare standards; in providing fully integrated premium health services with a capacity of 241 beds. Furthermore, the complex comprises premium hospitals and clinics of fully integrated maternity hospital, bone, joint and spine surgery hospital, dermatology and plastic surgery centre, ophthalmology and laser/vision correction surgical centre, specialized infertility treatment and reproduction assistance centre. The pharmacies of HMG apply the new technological methods at all work

phases. HMC Pharmacies have 4 in-patient pharmacy satellites and 3 out-patient pharmacies including the main. Pharmacies work 24/7 with an integrated team of 97 pharmacists with multiple specialities. The pharmacy's work depends on the patient's medical record system as it helps the pharmacist to provide greater care and protection against the conflict between medicines, especially concerning chronic diseases. The pharmacist monitored all patients through daily medical round and documents any pharmacist intervention. The pharmacist intervention system used an international study model, measure level of activity, rational of clinical intervention, recommendation, patient outcome and pharmacoeconomic impact. The estimated cost avoidance of prevents drug-related problems.^{13,14} The data was gathered and analyzed using the Monkey survey system.

RESULTS

The total number of pharmacist interventions were (1,222) provided to (1,124) patients. Of those 682 (44.19%) was male, 682 (55.81%) was female, the majority of patients were Saudi 956 (78.23%) The most patients in aged 65 years and above was 459 (37.59%) followed by age (18-40) was 368 (30.14%) and age (40-65) 263 (21.54%) (Table 1). The total cost avoidance from pharmacist intervention over the study period was (220,882.10 UD) while over one year was (441,764.2 USD). The cost avoidance during the study period was from female related was 44.41% (99,236.14 USD) while male avoidance cost was 55.59% (121,645.96 USD). Nationality related cost avoidance was 79.27% (195,711.07 USD) of Saudi patients while 20.73% (25,171.03 USD) of non-saudi patients. The highest cost avoidance age was age over 65 years was 37.38% (90,630.48 USD), followed by age (16-40) was 30.59% (41,693.28 USD) and age (40-65 years) was 20.46% (28,607.03 USD) (Table 2-4). The most cost avoidance came from senior registrar prescriber 32.09% (273,796.51

Table 1: Patient demographic information.

Age		
Answer Options	Response Count	Response Percent
0-30 days	36	2.95%
1 month- 6 years	56	4.59%
6-12 years	17	1.39%
12-18 years	22	1.80%
18-40 years	368	30.14%
40-65 years	263	21.54%
65 or older	459	37.59%
answered question		1221
skipped question		1
Sex		
Answer Options	Response Count	Response Percent
Female	540	44.19%
Male	682	55.81%
answered question		1222
skipped question		0
Nationality		
Answer Options	Response Count	Response Percent
Saudi	956	78.23%
Non-Saudi	266	21.77%
answered question		1222
skipped question		0

Table 2: Gender VS cost avoidance.

Sex	Female				Male			Total			
	No	Cost	No	%	Cost avoidance	No	%	Cost avoidance	No	%	Cost avoidance
1a	26.17		5	62.50%	130.85	3	37.50%	78.51	8	0.00%	209.36
1b	54.89		9	28.13%	494.01	23	71.88%	1,262.47	32	0.00%	1,756.48
2a	30.35		0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2b	30.35		67	53.60%	2,033.45	58	46.40%	1,760.30	125	0.00%	3,793.75
2c	30.35		0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2d	30.35		175	50.43%	5,311.25	172	49.57%	5,220.20	347	1.96%	10,531.45
2e	30.35		21	46.67%	637.35	24	53.33%	728.40	45	0.00%	1,365.75
2f	34.31		2	66.67%	68.62	1	33.33%	34.31	3	0.00%	102.93
3a	260.46		159	36.72%	41,413.14	274	63.28%	71,366.04	433	5.10%	112,779.18
3b	109		9	37.50%	981.00	15	62.50%	1,635.00	24	4.71%	2,616.00
3c	320.7		0	0.00%	0.00	0	0.00%	0.00	0	2.75%	0.00
4a	370.04		5	83.33%	1,850.20	1	16.67%	370.04	6	54.90%	2,220.24
4b	581.75		0	0.00%	0.00	0	0.00%	0.00	0	1.57%	0.00
4c	3,562.79		13	54.17%	46,316.27	11	45.83%	39,190.69	24	5.88%	85,506.96
4d	6,437.13		0	0.00%	0.00	0	0.00%	0.00	0	6.67%	0.00
5a	6,592.03		0	0.00%	0.00	0	0.00%	0.00	0	7.45%	0.00
5b	9,466.36		0	0.00%	0.00	0	0.00%	0.00	0	7.06%	0.00
5c	11,837.51		0	0.00%	0.00	0	0.00%	0.00	0	1.96%	0.00
6	100,000.00		0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
Total			465	44.41%	99,236.14	582	55.59%	121,645.96	1047	100.00%	220,882.10

Answered 1047, Skipped 175

Table 3: Nationalities VS cost avoidance.

Sex		Saudi			Non-Saudi			Total		
No	Cost	No	%	Cost avoidance	No	%	Cost avoidance	No	%	Cost avoidance
1a	26.17	7	87.50%	183.19	1	12.50%	26.17	8	0.00%	209.36
1b	54.89	30	93.75%	1,646.70	2	6.25%	109.78	32	0.00%	1,756.48
2a	30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2b	30.35	85	68.00%	2,579.75	40	32.00%	1,214.00	125	0.00%	3,793.75
2c	30.35	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2d	30.35	240	69.16%	7,284.00	107	30.84%	3,247.45	347	1.96%	10,531.45
2e	30.35	34	75.56%	1,031.90	11	24.44%	333.85	45	0.00%	1,365.75
2f	34.31	3	100.00%	102.93	0	0.00%	0.00	3	0.00%	102.93
3a	260.46	387	89.38%	100,798.02	46	10.62%	11,981.16	433	5.10%	112,779.18
3b	109	17	70.83%	1,853.00	7	29.17%	763.00	24	4.71%	2,616.00
3c	320.7	0	0.00%	0.00	0	0.00%	0.00	0	2.75%	0.00
4a	370.04	5	83.33%	1,850.20	1	16.67%	370.04	6	54.90%	2,220.24
4b	581.75	0	0.00%	0.00	0	0.00%	0.00	0	1.57%	0.00
4c	3,562.79	22	91.67%	78,381.38	2	8.33%	7,125.58	24	5.88%	85,506.96
4d	6,437.13	0	0.00%	0.00	0	0.00%	0.00	0	6.67%	0.00
5a	6,592.03	0	0.00%	0.00	0	0.00%	0.00	0	7.45%	0.00
5b	9,466.36	0	0.00%	0.00	0	0.00%	0.00	0	7.06%	0.00
5c	11,837.51	0	0.00%	0.00	0	0.00%	0.00	0	1.96%	0.00
6	100,000.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
Total		830	79.27%	195,711.07	217	20.73%	25,171.03	255	100.00%	220,882.10
Answered 1047, Skipped 175										

USD) and consultant prescriber 63.61% (180,463.62USD). The highest cost avoidance of critical care interventions was from potentially significant 51.00% (102,581.78 USD) and potentially serious 32.28% (99,162.29 USD) (Table 5 and 6). The majority of cost avoidance came from anti-infective agents (73,408.95 USD) followed by nutrition and blood agents (61,182.97 USD) and cardiovascular medications (27,584.52 USD) (Table 7). The most rational clinical activities cost avoidance was from others type (102,168.44 USD) followed by inappropriate dose (30,504.16 USD) and TPN consultations (25,313.99 USD). While the most pharmacist recommendations type related to cost avoidance was change dose (65,599.18 USD) followed by other recommendations (43,624.15 USD) and the drug discontinued (37,896.28 USD) (Table 8 and 9). The most patient outcome related to cost avoidance was patient condition improved (120,036.38 USD) followed by unknown outcomes (47,067.85 USD) and laboratory values improved (21,661.55 USD). The most Pharmacoeconomic cost avoidance impact was a reduction in the cost of drug therapy 79.94% (163,747.96 USD) and the patient length of hospital stay decreased 1.15% (32,846.49 USD) (Table 10 and 11). The most type cost avoidance of intervention used was type [3a-additional treatment - 260.46\$] 433 (41.36%) followed by type [2d - dosage adjustments (no potential for harm - 30.35\$] 347 (33.14%) and type (2b - therapeutic duplication - 30.35\$) 125 (11.94%) (Table 12).

DISCUSSION

Many pharmacy practice programs founded during Pharmacy strategic plan.^{1,15} That has included drug information services, medication safety

program, pain management program, stewardship antimicrobial program and critical care program programs.¹⁶⁻¹⁹ All those programs need to measure the impact and validate the cost requirement. The pharmacy administration at the ministry of health released key performance indicators to follow up and measure the clinical and economic impact of the program. The pharmacy strategic plan started implementation at private hospitals. Authors working at the most prominent private hospital in Riyadh city wish to measure the economic outcome of critical care pharmacy services. The findings should very high cost avoidance as the impact of pharmacist intervention at critical care services. That almost similar what report by Aljbouri TM¹² and MacLaren, R *et al.* in reduction infection-related problems,³ but higher than what reported by Schumock GT *et al.* that's related newly established of clinical pharmacy services at current site and the different times between two studies with incremental cost.⁷ However, it is lower cost avoidance what reported by MacLaren R *et al.* with cardiologic diseases.⁴ There are not any differences in the cost avoidance among gender because both of them received the same service without differences in the numbers. The majority of cost avoidance related to Saudi patient because most of the patients were Saudi. The findings showed high-cost avoidance from elderly patients that's would be excepted because the geriatrics had several diseases and needed medications and may be exposed to several mistakes and demand for close monitoring for prevention of them. Most of the cost avoidance as results from senior registrar prescriber more than consultant one. That is related to lower level of credential need more education and training related drug therapy. The highest cost avoidance of medications was from anti-infective agent, nutrition product and cardiovascular medications.

Table 4: Age distribution vs cost avoidance.

Sex	0-30 days			1 month- 6 years			6-12 years			12-18 years			18-40 years			40-65 years			65 or older			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%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	3	37.50%	78.51	0	0.00%	0.00	5	62.50%	130.85	8	0.76%	209.36
1b	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	9	28.13%	494.01	1	3.13%	54.89	22	68.75%	1,207.58	32	3.06%	1,756.48	0	0.00%	0.00
2a	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	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2b	4	3.20%	121.40	6	4.80%	182.10	4	3.20%	121.40	46	36.80%	1,396.10	39	31.20%	1,183.65	20	16.00%	607.00	125	11.95%	3,793.75	0	0.00%	0.00
2c	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	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
2d	3	0.87%	91.05	33	9.54%	1,001.55	7	2.02%	212.45	8	2.31%	242.80	120	34.68%	3,642.00	80	23.12%	2,428.00	95	27.46%	2,883.25	346	33.08%	10,501.10
2e	2	4.44%	60.70	0	0.00%	0.00	1	2.22%	30.35	0	0.00%	0.00	14	31.11%	424.90	12	26.67%	364.20	16	35.56%	485.60	45	4.30%	1,365.75
2f	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	1	33.33%	34.31	0	0.00%	0.00	2	66.67%	68.62	3	0.29%	102.93
3a	12	2.77%	3,125.52	6	1.39%	1,562.76	1	0.23%	260.46	7	1.62%	1,823.22	121	27.94%	31,515.66	77	17.78%	20,055.42	209	48.27%	54,436.14	433	41.40%	112,779.18
3b	1	4.17%	109.00	3	12.50%	327.00	2	8.33%	218.00	0	0.00%	0.00	5	20.83%	545.00	2	8.33%	218.00	11	45.83%	1,199.00	24	2.29%	2,616.00
3c	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	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
4a	0	0.00%	0.00	1	16.67%	370.04	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	2	33.33%	740.08	3	50.00%	1,110.12	6	0.57%	2,220.24
4b	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	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
4c	13	54.17%	46,316.27	1	4.17%	3,562.79	0	0.00%	0.00	0	0.00%	0.00	1	4.17%	3,562.79	1	4.17%	3,562.79	8	33.33%	28,502.32	24	2.29%	85,506.96
4d	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	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
5a	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	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
5b	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	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
5c	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	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
6	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	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00
Total	35	3.35%	49,823.94	50	4.78%	7,006.24	15	1.43%	842.66	21	2.01%	2,248.12	320	30.59%	41,693.28	214	20.46%	28,607.03	391	37.38%	90,630.48	1046	100.00%	220,851.75

Answered questions 1047, Skipped questions 175

Table 5: Prescriber qualifications VS cost avoidance.

Sex	Consultant			Serier registrar			Registrar			Intern			Total		
	No	Cost	%	No	Cost avoidance	%	No	Cost avoidance	%	No	Cost avoidance	%	No	Cost avoidance	%
1a	8	26.17	100.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	8	209.36	0.76%
1b	26	54.89	81.25%	0	1,427.14	0.00%	6	0.00	18.75%	0	0.00	0.00%	32	1,756.48	3.06%
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	43	30.35	34.40%	9	1,305.05	7.20%	73	273.15	58.40%	0	19,939.95	0.00%	125	3,793.75	11.94%
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	170	30.35	48.99%	21	5,159.50	6.05%	156	637.35	44.96%	0	99,426.60	0.00%	347	10,531.45	33.14%
2e	16	30.35	35.56%	5	485.60	11.11%	24	151.75	53.33%	0	3,642.00	0.00%	45	1,365.75	4.30%
2f	2	34.31	66.67%	0	68.62	0.00%	1	0.00	33.33%	0	0.00	0.00%	3	102.93	0.29%
3a	360	260.46	83.14%	9	93,765.60	2.08%	64	2,344.14	14.78%	0	150,024.96	0.00%	433	112,779.18	41.36%
3b	16	109	66.67%	1	1,744.00	4.17%	7	109.00	29.17%	0	763.00	0.00%	24	2,616.00	2.29%
3c	0	320.7	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
4a	4	370.04	66.67%	0	1,480.16	0.00%	2	0.00	33.33%	0	0.00	0.00%	6	2,220.24	0.57%
4b	0	581.75	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
4c	21	3,562.79	87.50%	0	74,818.59	0.00%	3	0.00	12.50%	0	0.00	0.00%	24	85,506.96	2.29%
4d	0	6,437.13	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
5a	0	6,592.03	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
5b	0	9,466.36	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
5c	0	11,837.51	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
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	666		63.61%	45	180,463.62	4.30%	336	3,515.39	32.09%	0	273,796.51	0.00%	1047	220,882.10	100.00%

Answered 1047, Skipped 175

Table 6: Intervention servirty VS 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%	8	209.36	100.00%	0	0.00	0.00%	8	0.00	0.00%
1b	0	54.89	0.00%	4	219.56	12.50%	28	1,536.92	87.50%	0	0.00	0.00%	32	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%	7	212.45	5.60%	106	3,217.10	84.80%	12	364.20	9.60%	125	3,793.75	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%	24	728.40	6.92%	212	6,434.20	61.10%	111	3,368.85	31.99%	347	10,531.45	1.96%
2e	0	30.35	0.00%	0	0.00	0.00%	12	364.20	26.67%	33	1,001.55	73.33%	45	1,365.75	0.00%
2f	0	34.31	0.00%	0	0.00	0.00%	1	34.31	33.33%	2	68.62	66.67%	3	102.93	0.00%
3a	2	260.46	0.46%	287	74,752.02	66.28%	132	34,380.72	30.48%	12	3,125.52	2.77%	433	112,779.18	5.10%
3b	0	109	0.00%	7	763.00	29.17%	17	1,853.00	70.83%	0	0.00	0.00%	24	2,616.00	4.71%
3c	0	320.7	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
4a	0	370.04	0.00%	3	1,110.12	50.00%	3	1,110.12	50.00%	0	0.00	0.00%	6	2,220.24	54.90%
4b	0	581.75	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
4c	1	3,562.79	4.17%	6	3,562.79	25.00%	15	21,376.74	62.50%	2	7,125.58	8.33%	24	85,506.96	5.88%
4d	0	6,437.13	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
5a	0	6,592.03	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
5b	0	9,466.36	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
5c	0	11,837.51	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%	0	0.00	0.00%
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	3	4,083.71	0.29%	338	99,162.29	32.28%	534	102,581.78	51.00%	172	15,054.32	16.43%	1047	220,882.10	100.00%

Answered 1047, Skipped 175

Table 7: Pharmacological groups of interventions vs cost avoidance.

Sex	Gastro-intestinal system	Cardiovascular system	Respiratory system	Central nervous system	Infections	Endocrine system	Gynaecology disorder	Urinary-tract disorder	Immunosuppression	Nutrition and blood	Musculoskeletal and joint diseases	Eye disorder	Ear,Nose and Oropharynx	Skin disorders	Anaesthesia	Other	Total
1a	0	0	0	0	52.34	0	0	0	0	26.17	0	0	0	0	0	130.85	209.36
1b	109.78	109.78	0	0	658.68	0	0	0	0	164.67	0	0	0	0	0	713.57	1,756.48
2a	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2b	485.6	212.45	91.05	0	789.1	303.5	30.35	0	0	242.8	30.35	30.35	91.05	30.35	60.7	1,396.10	3,793.75
2c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2d	789.1	1,274.70	91.05	455.25	2,974.30	333.85	60.7	60.7	30.35	485.6	60.7	30.35	91.05	0	121.4	3,672.35	10,531.45
2e	880.15	0	0	91.05	60.7	121.4	0	0	0	60.7	0	0	0	0	0	151.75	1,365.75
2f	0	0	0	0	102.93	0	0	0	0	0	0	0	0	0	0	0	102.93
3a	8,855.64	21,357.72	2,083.68	2,604.60	38,808.54	3,385.98	520.92	2,083.68	0	20,576.34	260.46	1,041.84	0	781.38	0	10,418.40	112,779.18
3b	109	327	0	109	1,090.00	545	0	0	0	436	0	0	0	0	0	0	2,616.00
3c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4a	370.04	740.08	0	0	370.04	370.04	0	0	0	0	0	0	0	0	0	370.04	2,220.24
4b	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4c	7,125.58	3,562.79	0	3,562.79	28,502.32	0	0	0	0	39,190.69	0	0	0	0	0	3,562.79	85,506.96
4d	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5a	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5b	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	18,724.89	27,584.52	2,265.78	6,822.69	73,408.95	5,059.77	611.97	2,144.38	30.35	61,182.97	351.51	1,102.54	182.1	811.73	182.1	20,415.85	220,882.10

Answered questions 1047, Skipped questions 175

Table 8: Clinical activities VS cost avoidance.

Types	Pharmacokinetic consult	Adverse drug reaction	Therapeutic Duplication	Alternative Therapy	Dose Standardization	Contraindication	Dosage Calculation	Inappropriate Dose	Inappropriate Route	Inappropriate Schedule	Incompatibility	Drug-Drug Interaction	Abnormal Lab Test Result	Drug Therapy Omission	TPN Consultation	Other	Total
1a	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	209.36	209.36
1b	0	109.78	0	164.67	0	0	0	0	0	54.89	0	0	0	0	0	1,427.14	1,756.48
2a	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2b	0	0	3,672.35	30.35	30.35	0	0	30.35	0	0	0	0	0	0	0	30.35	3,793.75
2c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2d	0	0	151.75	30.35	1,972.75	0	394.55	5,887.90	60.7	1,547.85	0	0	0	0	30.35	455.25	10,531.45
2e	0	0	30.35	91.05	0	0	0	0	971.2	0	0	0	0	0	0	273.15	1,365.75
2f	0	0	0	0	0	0	0	0	102.93	0	0	0	0	0	0	0	102.93
3a	0	4,167.36	1,302.30	4,427.82	2,344.14	1,302.30	1,562.76	6,771.96	7,813.80	1,562.76	520.92	5,209.20	6,511.50	260.46	3,906.90	65,115.00	112,779.18
3b	0	0	0	109	0	109	0	0	0	109	0	218	218	0	0	1,853.00	2,616.00
3c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4a	0	0	740.08	0	0	0	0	0	0	0	0	740.08	0	0	0	740.08	2,220.24
4b	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4c	3,562.79	0	0	0	0	0	0	17,813.95	0	10,688.37	0	0	0	0	21,376.74	32,065.11	85,506.96
4d	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5a	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5b	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	3,562.79	4,277.14	5,896.83	4,853.24	4,347.24	1,411.30	1,957.31	30,504.16	8,948.63	13,962.87	520.92	6,167.28	6,729.50	260.46	25,313.99	102,168.44	220,882.10

Answered questions 1047, Skipped questions 175

Table 9: Order changed based upon Pharmacists recommendation vs cost avoidance.

Sex	Drug Discontinued		Change Drug		Drug Added		Dose Changed		Schedule Changed		Route Changed		Additional Lab Test Ordered		Unknown		Others		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	No	Cost avoidance	No	Cost avoidance
1a	1	26.17	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	7	183.19	8	209.36
1b	9	494.01	4	219.56	1	54.89	1	54.89	1	54.89	0	0.00	0	0.00	0	0.00	16	878.24	32	1,756.48
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	0	0.00	0	0.00
2b	122	3,702.70	0	0.00	0	0.00	2	60.70	0	0.00	0	0.00	0	0.00	0	0.00	1	30.35	125	3,793.75
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	0	0.00	0	0.00
2d	8	242.80	2	60.70	4	121.40	261	7,921.35	51	1,547.85	2	60.70	0	0.00	0	0.00	19	576.65	347	10,531.45
2e	1	30.35	6	182.10	0	0.00	1	30.35	1	30.35	29	880.15	0	0.00	1	30.35	6	182.10	45	1,365.75
2f	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	3	102.93	0	0.00	0	0.00	0	0.00	3	102.93
3a	57	14,846.22	31	8,074.26	76	19,794.96	70	18,232.20	6	1,562.76	34	8,855.64	31	8,074.26	2	520.92	126	32,817.96	433	112,779.18
3b	0	0.00	2	218.00	3	327.00	1	109.00	1	109.00	0	0.00	7	763.00	0	0.00	10	1,090.00	24	2,616.00
3c	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
4a	2	740.08	0	0.00	1	370.04	0	0.00	0	0.00	0	0.00	1	370.04	0	0.00	2	740.08	6	2,220.24
4b	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
4c	5	17,813.95	0	0.00	3	10,688.37	11	39,190.69	3	10,688.37	0	0.00	0	0.00	0	0.00	2	7,125.58	24	85,506.96
4d	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
5a	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
5b	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
5c	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
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	0	0.00	0	0.00
Total	205	37,896.28	45	8,754.62	88	31,356.66	347	65,599.18	63	13,993.22	68	9,899.42	39	9,207.30	3	551.27	189	43,624.15	1047	220,882.10

Answered 1047, Skipped 175

Table 10: Patient outcome VS cost avoidance.

Sex	Therapeutic End Point Reached		Patient's Condition Improved		Patient's Condition Worse		Laboratory Value Improved		Laboratory Value Worse		Patient's Mental Status Worse		Infection Improved		Infection Worse		Unknown		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	No	Cost avoidance	No	Cost avoidance
1a	6	157.02	0	0.00	0	0.00	1	26.17	0	0.00	0	0.00	0	0.00	0	0.00	1	26.17	8	209.36
1b	16	878.24	9	494.01	0	0.00	0	0.00	0	0.00	0	0.00	6	329.34	0	0.00	1	54.89	32	1,756.48
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	0	0.00	0	0.00
2b	3	91.05	15	455.25	0	0.00	0	0.00	0	0.00	0	0.00	6	182.10	0	0.00	101	3,065.35	125	3,793.75
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	0	0.00	0	0.00
2d	17	515.95	89	2,701.15	0	0.00	8	242.80	0	0.00	1	30.35	35	1,062.25	0	0.00	197	5,978.95	347	10,531.45
2e	6	182.10	6	182.10	0	0.00	0	0.00	0	0.00	0	0.00	1	30.35	0	0.00	32	971.20	45	1,365.75
2f	0	0.00	1	34.31	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	68.62	3	102.93
3a	62	16,148.52	251	65,375.46	3	781.38	27	7,032.42	3	781.38	0	0.00	21	5,469.66	4	1,041.84	62	16,148.52	433	112,779.18
3b	4	436.00	5	545.00	0	0.00	1	109.00	1	109.00	0	0.00	2	218.00	1	109.00	10	1,090.00	24	2,616.00
3c	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
4a	0	0.00	1	370.04	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	5	1,850.20	6	2,220.24
4b	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
4c	0	0.00	14	49,879.06	0	0.00	4	14,251.16	0	0.00	0	0.00	1	3,562.79	0	0.00	5	17,813.95	24	85,506.96
4d	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
5a	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
5b	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
5c	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
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	0	0.00	0	0.00
Total	114	18,408.88	391	120,036.38	3	781.38	41	21,661.55	4	890.38	1	30.35	72	10,854.49	5	1,150.84	416	47,067.85	1047	220,882.10

Answered 1047, Skipped 175

Table 11: Pharmacoeconomic outcomes VS cost avoidance.

Sex	Reduction in the Cost of Drug Therapy			Increase 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			No Change in Costs			Total		
	No	%	Cost avoidance	No	%	Cost avoidance	No	%	Cost avoidance	No	%	Cost avoidance	No	%	Cost avoidance	No	%	Cost avoidance	No	%	Cost avoidance
1a	7	87.50%	183.19	1	12.50%	26.17	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	8	0.00%	209.36
1b	24	75.00%	1,317.36	5	15.63%	274.45	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	3	0.00%	164.67	32	0.00%	1,756.48
2a	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	0	0.00%	0.00	0	0.00%	0.00
2b	121	96.80%	3,672.35	2	1.60%	60.70	2	1.60%	60.70	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	125	0.00%	3,793.75
2c	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	0	0.00%	0.00	0	0.00%	0.00
2d	261	75.22%	7,921.35	42	12.10%	1,274.70	3	0.86%	91.05	0	0.00%	0.00	0	0.00%	0.00	41	1.96%	1,244.35	347	1.96%	10,531.45
2e	36	80.00%	1,092.60	1	2.22%	30.35	2	4.44%	60.70	0	0.00%	0.00	0	0.00%	0.00	6	0.00%	182.10	45	0.00%	1,365.75
2f	2	66.67%	68.62	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	1	0.00%	34.31	3	0.00%	102.93
3a	362	83.60%	94,286.52	31	7.16%	8,074.26	10	2.31%	2,604.60	3	0.69%	781.38	0	0.00%	0.00	27	5.10%	7,032.42	433	5.10%	112,779.18
3b	6	25.00%	654.00	12	50.00%	1,308.00	0	0.00%	0.00	0	0.00%	0.00	2	8.33%	218.00	4	4.71%	436.00	24	4.71%	2,616.00
3c	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	0	2.75%	0.00	0	2.75%	0.00
4a	3	50.00%	1,110.12	3	50.00%	1,110.12	0	0.00%	0.00	0	0.00%	0.00	0	0.00%	0.00	0	54.90%	0.00	6	54.90%	2,220.24
4b	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	0	1.57%	0.00	0	1.57%	0.00
4c	15	62.50%	53,441.85	0	0.00%	0.00	0	0.00%	0.00	9	37.50%	32,065.11	0	0.00%	0.00	0	5.88%	0.00	24	5.88%	85,506.96
4d	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	0	6.67%	0.00	0	6.67%	0.00
5a	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	0	7.45%	0.00	0	7.45%	0.00
5b	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	0	7.06%	0.00	0	7.06%	0.00
5c	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	0	1.96%	0.00	0	1.96%	0.00
6	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	0	0.00%	0.00	0	0.00%	0.00
Total	837	79.94%	163,747.96	97	9.26%	12,158.75	17	1.62%	2,817.05	12	1.15%	32,846.49	2	0.19%	218.00	82	100.00%	9,093.85	1047	100.00%	220,882.10

Answered questions 1047, Skipped questions 175

Table 12: Type of cost avoidance used for pharmacist interventions.

Answer Options	Response Percent	Response Count	Total cost
1a	0.76%	8	209.36
1b	3.06%	32	1,756.48
2a	0.00%	0	0.00
2b	11.94%	125	3,793.75
2c	0.00%	0	0.00
2d	33.14%	347	10,531.45
2e	4.30%	45	1,365.75
2f	0.29%	3	102.93
3a	41.36%	433	112,779.18
3b	2.29%	24	2,616.00
3c	0.00%	0	0.00
4a	0.57%	6	2,220.24
4b	0.00%	0	0.00
4c	2.29%	24	85,506.96
4d	0.00%	0	0.00
5a	0.00%	0	0.00
5b	0.00%	0	0.00
5c	0.00%	0	0.00
6	0.00%	0	0.00
answered question		1047	220,882.10
skipped question		175	

That is similar what reported by Aljbouri TM.¹² Those medications highly interpreted by the pharmacist at critical care services with highly consequences problems and additional cost if they happened. The highest cost avoidance of type of interventions after other types was inappropriate dosing and TPN consultation. That is related to use of high-risk medications and expecting serious complications with the further incremental hospital of stay and high economic burden. The majority of cost avoidance leads to patients improved conditions that's a clear economic outcome of a pharmacist working at critical care services. The results showed that is most of the cost avoidance due to drug therapy cost related mistake prevention and reduced complications with the sequencing of reduction of hospital stay. The type of cost calculation used was dosing adjustments related cost because of interventions related change dose or therapy duplication. The critical care pharmacist had a high economic impact of from very simple of pharmacy work-related interventions. We expected higher cost if we include other services related setting guidelines, answering drug information inquiries and patients counseling services. The proving of a clinical pharmacist to critical care services at a private hospital is highly recommended in Riyadh city, Saudi Arabia.

CONCLUSION

The pharmacist plays a significant role at critical care services of the private hospital. The pharmacist condition improved, decrease drug therapy cost and patient length hospital stay. Expanding critical care pharmacist at a private hospital is highly recommended and appreciated in the Kingdom of Saudi Arabia.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

ABBREVIATIONS

MOH: Ministry of Health; **HMG:** Dr. Sulaiman Al-Habib Medical Group; **GCC:** Gulf Cooperation Council.

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REFERENCES

- Alomi YA, Alghamdi SJ, Alattyh RA. Strategic plan of general administration of pharmaceutical care at ministry of health in Saudi Arabia 2012-2022. *J Pharm Pharm Scien.* 2015;1(13):1-8.
- Ahmed Y, Pharm A, Pharm C. National pharmacy practice programs at ministry of health in Saudi Arabia. *Journal of Pharma and Pharmaceuical Sciences.* 2015;1(2):17-8.
- MacLaren R, Bond CA, Martin SJ, Fike D. Clinical and economic outcomes of involving pharmacists in the direct care of critically ill patients with infections. *Crit Care Med.* 2008;36(12):3184-9.
- MacLaren R, Bond CA. Effects of pharmacist participation in intensive care units on clinical and economic outcomes of critically ill patients with thromboembolic or infarction-related events. *Pharmacotherapy.* 2009;29(7):761-8.
- Leape LL, Cullen DJ, Clapp MD, Burdick E, Demonaco HJ, Erickson JI, *et al.* Pharmacist participation on physician rounds and adverse drug events in the intensive care unit. *J Am Med Assoc.* 1999;282(3):267-70.
- The Society of Critical Care Medicine and the American College of Clinical Pharmacy. *Pharmacotherapy.* 2000;20(11):1400-6.
- Schumock GT, Meek PD, Ploetz PA, Vermeulen LC. Economic evaluations of clinical pharmacy services 1988-1995. *Pharmacotherapy.* 1996;16(6):1188-208.
- Alomi YA. Cost-efficiency of clinical pharmacy services at ministry of health in Saudi Arabia application of American Model. *Value Heal.* 2016;19(7):A482-3.
- Alomi YA, Almudaiheem HY, Alarnous T, Alshurei S, Alsharafa A, Alzahrani T, *et al.* Cost-efficiency of national drug information center through ministry of health hotline calling services (937) in Saudi Arabia: application of a Merckian Model. *Value Heal J Int Soc Pharmacoeconomics Outcomes Res.* 2015;18(7):A735.
- Alomi YA, Alanazi AA, Alsallouk SA, Almaznai MM, Abu-Alnaja NI, Alduhailan M, *et al.* Cost-efficiency of medication safety program at pediatrics, obstetrics and gynecology hospital, East Province, Saudi Arabia. *Value Heal.* 2016;19(7):A464.
- Alomi YA, Fallatah AO. Cost avoidance of pharmacist running pediatrics total parenteral nutrition services at ministry of health In Saudi Arabia. *Value Heal.* 2016;19(7):A461.
- Aljbouri TM, Alkhalwaldeh MS, Abu-Rumman AK, Hasan TA, Khattar HM, Abu-Oliem AS. Impact of clinical pharmacist on cost of drug therapy in the ICU. *Saudi Pharm J.* 2013;21(4):371-4.
- Ling JM, Mike LA, Rubin J, Abraham P, Howe A, Patka J, *et al.* Documentation of pharmacist interventions in the emergency department. *Am J Heal Pharm.* 2005;62(17):1793-7.
- Mutnick AH, Sterba KJ, Peroutka JA, Sloan NE, Beltz EA, Sorenson MK. Cost savings and avoidance from clinical interventions. *Am J Heal Pharm.* 1997;54(4):392-6.
- Alomi YA. National pharmacy practice programs at ministry of health in Saudi Arabia. *J Pharm Pharm Scien.* 2015;1(2):17-8.
- Alomi YA. National drug information center program at Ministry of Health in Saudi Arabia. *Adv Pharmacoepidemiol Drug Saf.* 2016;5(1):1-2.
- Alomi YA. National medication safety program at ministry of health in Saudi Arabia. *J Pharmacovigil.* 2015;3(5):e145.
- Alomi YA. National pharmacy pain management program at ministry of health in Saudi Arabia. *J Pharmacol Clin Res.* 2017;3(2):1-7.
- Alomi YA. National antimicrobial stewardship program in Saudi Arabia; initiative and the future. *J Surg.* 2017;4(5):1-7.