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Physicians' Role in Kuwait's Health-care Supply Management⁽¹⁾

ABSTRACT

Aim of the paper: The physician's role in medical supplies selection in the healthcare context, driven primarily by clinical expertise, directly impacts hospital cost performance and efficiency. The primary purpose of this study was to assess the perceived importance and attention that physicians give to the costs of medical supplies in a public healthcare system.

Study Design: Physicians working in Kuwait's public health sector were asked to estimate the cost of 18 common pharmaceutical products and medical devices. A regression model identified factors associated with a higher rate of accurate estimates provided.

Sample and Data: A sample of 104 physicians working in Kuwait's public health sector responded to the survey. The sample represented a wide range of experience levels, work locations, and clinical specialties.

Results: Physicians showed limited awareness regarding the costs of medical supplies. On average, physicians accurately estimated only 22 percent of pharmaceutical products and 14 percent of medical devices. Most physicians indicated having limited accessibility to pricing information for the products they prescribe even though they perceived cost to be an essential criterion in the selection of clinically-equivalent products.

Conclusion: Education about supply management and cost containment may hold value for both physicians and the healthcare system. Hospital administrators should consider increasing accessibility to cost information and involving physician leaders in procurement to improve hospital cost efficiency.

Keywords: Health Care, Supply Chain Management, Supply Selection, Physicians, Kuwait.

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INTRODUCTION

Healthcare delivery requires many components to be effective and efficient. A critical component is the supply chain of medical products and equipment. Supply chain management is the discipline that manages the procurement, production, and logistics functions involved in delivering goods and services to customers. The health sector supply chains form particularly complex networks with many players involved. A combination of several characteristics found in the health sector supply chains distinguishes them from other supply chains, viz. a high degree of intermediation, high level of regulation, the range of healthcare supplies, and the mission of health care organizations (McKone-Sweet *et al.*, 2005).

A significant portion of healthcare spending goes towards pharmaceuticals and medical devices. Hospital supply expenses account for the second largest cost category at hospitals after salary expenses. Even after excluding non-medical supplies (food, equipment, linens, maintenance supplies, etc.) pharmaceuticals and medical devices generally make up approximately 15 percent of total hospital expenditures (Abdulsalam *et al.*, 2018). Many studies identify ample opportunities to improve healthcare's supply chain performance, but many challenges hinder this pursuit (Bhakoo and Choi, 2013; McKone-Sweet *et al.*, 2005). The healthcare supply environment is a complex one with many players involved, a wide range of products and alternatives, limited price transparency, and product complexity in terms of development, approval, and use (McKone-Sweet *et al.*, 2005).

Supply expenses vary drastically between different patients and different treatment needs. What is surprising is that even for similar patients with identical diagnoses, significantly different supply costs may be incurred in each case depending on who their physician is and where they receive treatment. Significant price variations in supplies have also been observed across hospitals within the same city (Robinson *et al.*, 2012; Abelson, 2006). This is particularly true in supply-intensive specialties such as cardiology and orthopedics, where the cost of supplies forms a significant portion of the total cost of patient treatment (Okike *et al.*, 2014). Even with relatively low-cost pharmaceuticals, differences between branded drugs and generic drugs over a patient's treatment cycle may translate to thousands of dollars (Shrank *et al.*, 2011).

A major player in the healthcare supply chain is the physician, who selects the supplies on behalf of the patient and sometimes directly administers them (Eckler and Schneller, 2015). Estimates suggest that physicians have direct influence over 60 percent of hospital supply expenditure (Lerner *et al.*, 2008). While they hold a

significant amount of knowledge about the properties and applications of medical supplies, physicians generally pay little attention to their costs and sourcing implications (Allan *et al.*, 2007). It is unclear how much physicians are aware about the costs of devices and pharmaceuticals they commonly select for use, which raises the following two research questions: (1) how accurate are physician perceptions of the costs of medical supplies that they often use or prescribe? And (2) What factors - physician rank, years of experience, specialty, education, etc.- are associated with more accurate physician perceptions of supply costs?

This study developed and administered a survey for physicians asking them to estimate the costs of medical products that are highly recognized. Specifically, the study focused on physicians serving in Kuwait's public health sector. While physicians showed strong familiarity with the medical items presented, they indicated limited cost knowledge, often overestimating the actual cost of drugs and underestimating the actual cost of medical devices. Regarding drug costs, physicians who perceived costs to be an important selection criterion and those who were familiar with information resources to search drug costs provided accurate cost estimates more often than their peers.

The next section provides a brief review of the literature that examines physicians' role in the supply chain as well as an overview of Kuwait's healthcare supply sector. The methods section then describes survey development, data collection, and analysis approach. The collected data is then analyzed and presented in the results section. Finally, the findings are discussed, highlighting the managerial and policy implications.

LITERATURE REVIEW

Kuwait's Healthcare System and Supply Chain

Kuwait's public health sector accounts for 80 percent of patient discharges, with six general hospitals and eleven specialty care hospitals (IMS Health, 2016). The availability of funding, access to human resources, and abundance of hospital bed capacity in the country allow such a health system to focus strategic development of the health sector on areas such as the supply chain management, rather than scurry to meet basic healthcare demand.

Kuwait's demand for healthcare services has been increasing rapidly, driven by an increase in population, life expectancy, and lower infant mortality. Despite a highly affluent population that enjoys a high per-capita GDP, the population suffers from high rates of non-communicable diseases, such as diabetes, cardio-

vascular diseases, and cerebrovascular diseases (Kuwait Ministry of Health, 2015). These factors, among others, have placed a heavy burden on Kuwait's healthcare system, with government expenditure at USD 5 billion in 2015 (Kuwait Ministry of Health, 2017).

In Kuwait, government expenditure on pharmaceuticals and medical devices in 2015 was estimated to be USD 800 million, up from USD 580 million in 2012 (Kuwait Ministry of Health, 2017). Kuwait's hospital supply expenditure made + -- up approximately 16 percent of total hospital expenses (Kuwait Ministry of Health, 2017). Over the past five years, supply expenses have witnessed a compounded annual growth rate of 11 percent. The Ministry of Health's Department of Purchases (in conjunction with the Central Medical Stores Administration) is responsible for the procurement of medical supplies for public health institutions, aggregating procurement requests from them and negotiating contracts with international suppliers for pharmaceuticals, consumables, capital goods, and medical devices.

Citizens of Kuwait (approximately 65 percent of the population) are covered by a public health plan, meaning that they receive free healthcare, while expatriates pay subsidized fees for non-emergency health services (IMS Health, 2016). An unintended consequence is a limited attention to the costs of the prescribed pharmaceuticals and medical devices. Physicians feel little incentive or pressure to factor costs in their decision-making, even when considering clinically-equivalent alternatives as it impacts neither their clinical work nor their compensation. An indication of this is the low market penetration of generic drugs in the country, where generic products account for only 21.6 percent of the total volume of prescribed drugs (IMS Health, 2016). In contrast, generic drugs in other countries with universal health coverage are much lower. For example, generic drugs accounted for 80 percent of prescriptions in Germany (Wouters *et al.*, 2017) and 81 percent in the United Kingdom (NHS Business Services Authority, 2018). The medical devices industry poses a greater challenge with even less transparency about pricing and brand alternatives relative to the pharmaceuticals industry, even in mature health systems (Pauly and Burns, 2008).

The Physician's Role in Healthcare Supply Management

Physicians are the gatekeepers of hospital supplies, particularly medical devices and pharmaceutical products, being the ones who select the supplies to use or prescribe to patients (Young *et al.*, 2016). Despite physicians' important role in supply selection and subsequently hospital costs, they receive limited education in healthcare supply management (Eckler and Schneller, 2015). Substitutable

supply options (i.e. different brands of the same medical item) vary significantly in terms of their costs. Between two clinically-equivalent medical items, physicians generally select one based on their personal experience, training, and relationship with supplier representatives rather than based on cost (Okike *et al.*, 2014).

Previous studies have demonstrated a lack of awareness that physicians hold with regards to drug costs (Allan *et al.*, 2007). Our study extends this line of inquiry further by assessing physician cost perceptions of both pharmaceuticals and medical devices and attempts to determine the factors that provide physicians with more knowledge about supply costs. Specifically, we consider physicians in Kuwait, a country with an affluent population that offers universal health coverage, but whose relative spending on medical supplies exceeds its neighboring peers (BMI, 2017).

DATA AND SAMPLE

A survey instrument was developed to measure physician cost perceptions. In total, the survey was confined to 30 questions to ensure that the time required to complete it did not exceed ten minutes. It was presented in an electronic format and made accessible online. The first section of the survey asked physicians to estimate the cost of 18 medical items (eight drugs and ten medical devices), described in more detail below. The second section asked respondents to answer 12 general and demographic questions.

The medical products were selected in such a way as to ensure that the majority of physicians, regardless of their specialty, would recognize them. Several steps were taken to ensure this outcome. First, we reviewed the literature for similar studies to aggregate a list of drugs used in similar studies (Allan *et al.*, 2007; Allan and Innes, 2004; Korn *et al.*, 2003). Subsequently, a focus group, composed of four physicians from various specialties, was consulted to refine the list and identify common drugs in Kuwait's hospital environment. Finally, the filtered list was cross-referenced with the World Health Organization's List of Essential Medicines (World Health Organization, 2017). The final list consisted of eight drugs commonly prescribed to hospital patients. A picture of each drug's packaging was displayed in the survey.

Ten medical supplies were selected after discussion with the focus group, ensuring high recognizability of products and a wide price range. To avoid random guessing, respondents could skip products they did not recognize. A picture of each medical product was displayed in the survey. Physicians were then asked to respond to questions about: (1) their overall knowledge of the listed items, (2) their

confidence in the estimates they provided, (3) their accessibility of cost information at their institution, and (4) their perceived importance of costs. Finally, demographic information about the physicians was collected. The survey instrument is presented in Appendix A.

Data Collection

The target respondents were physicians working in Kuwait's public health sector. Our inquiry was not confined to a specific clinical specialty or physician rank.

The researchers disseminated survey links with a concise explanation of the study to their physician contacts (mainly via WhatsApp), who were then asked to relay the message to their colleagues in turn and report the number of people the message was forwarded to. Physicians in Kuwait commonly use this messaging application in the professional setting to receive information and instructions regarding their duties. Hence, a snowball sampling approach was taken to maximize potential respondents. The data collection period occurred in October 2018 for a period of three weeks with reminder messages sent ten days after the initial request. Approximately 50 percent of the responses were received within the first four days of data collection.

For the medical items included in the survey, the actual cost data were obtained from several sources. Drug prices are regulated by the Ministry of Health's Pharmaceuticals and Herbal Medicines Registration & Control Administration. Wholesale and retail drug prices are regulated by the Ministry of Health and published on their website (State of Kuwait Ministry of Health, 2018). For medical devices, the prices that apply to public hospitals were obtained from a prominent medical products distributor in Kuwait. The provided pricing data was cross-checked with a hospital's procurement representative and found to be reliable.

METHODOLOGY

We have compared the estimates that physicians provided for the medical items included in the survey with their actual costs to determine the rate of accuracy in estimating medical products. This is done by first calculating the absolute value of the difference between the estimate and actual cost and then dividing that by the actual cost for each physician-item observation. A binary variable is then assigned to indicate whether the estimate is accurate within a 25 percent margin of error. In other words, if a provided estimate is within plus or minus 25 percent of the actual

cost, it is considered correct. This range is selected so that results can be compared to prior studies that have involved medical cost estimations (Allan *et al.*, 2007). As a sensitivity analysis, the average accuracy rates and regression models are recalculated with a 35 percent margin of error and findings from the statistical results remain consistent.

A paired two-sample t-test is used to compare the accuracy rate between pharmaceutical items and medical devices. Two-sample t-tests are employed to check for significant differences in mean accuracy of physicians based on education, specialty, hospital affiliation.

Regression analysis has been conducted to determine the factors that influence the overall accuracy of physician estimates. The unit level of analysis is the physician, and the dependent variable is the number of products that the physician accurately estimates. A generalized linear model is applied with a logarithm link function to account for the count data, also referred to as Poisson regression. A separate model has been estimated for pharmaceutical items and medical devices. The independent variables in the model includes years of clinical experience, gender, whether the physician is familiar with MOH's drug lookup eService (1 = Yes, 0 = No), and the four cost perception measures: clinical knowledge of items, confidence in cost estimates provided, perceived importance of cost, and perceived accessibility of cost information.

RESULTS

The survey has been submitted to 348 physicians, of whom 104 completed the survey, at a response rate of 29.8 percent. Table 1 summarizes demographic information gathered from the survey. Four responses missing data on some demographic variables are included in the univariate statistics but excluded from the regression analysis. Only four respondents have indicated a lack of familiarity with at least one item, and their rate of correct responses has been adjusted accordingly.

The years of professional clinical experience among participants vary between one year to 45 years, with an average of 7.2 years and a standard deviation of 7.3. Approximately 60 percent of the respondents hold the title of Resident, Assistant Registrar, or Registrar. The remaining 40 percent hold more senior positions. The most common specialization among respondents is Internal Medicine, which is expected since Internal Medicine departments are the largest in Kuwait's general public hospitals (Kuwait Ministry of Health, 2017).

Table 1

Sample Descriptive Statistics (N = 104)	n	%
<i>Gender</i>		
Male	63	61.0
Female	41	39.0
<i>Education</i>		
Kuwait University	54	51.9
Royal College of Surgeons in Ireland	13	12.5
Other	33	31.7
Undisclosed	4	3.8
<i>Years of Experience*</i>		
0-5	55	52.9
6-10	25	24.0
11-15	12	11.5
16-20	3	2.9
Over 20 years	5	4.8
Undisclosed	4	3.8
<i>Institution Type</i>		
General Hospital	79	76.0
Specialized	8	7.7
Primary Care or Other	9	8.7
Undisclosed	8	7.7

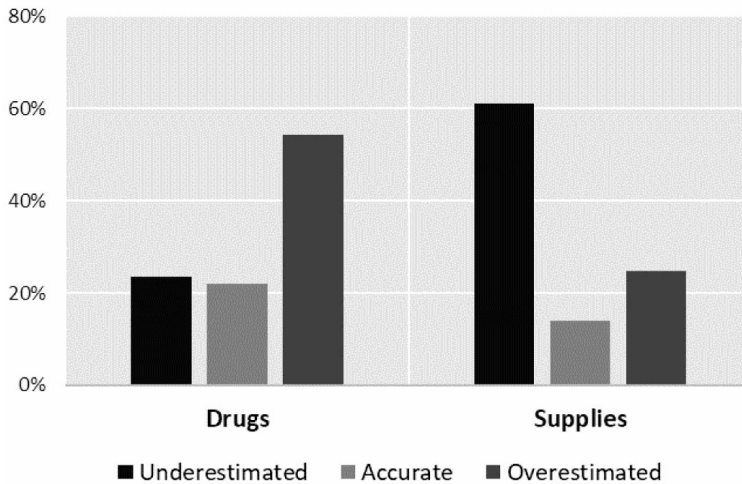
Physician Estimation Accuracy

With accuracy defined at a 25 percent error threshold, physicians have given an accurate cost estimate for 3.1 out of the 18 items on average (17.9 percent of the time) with a standard deviation of 1.90. With a 35 percent margin of error, physician estimates are accurate 24 percent of the time on average. In terms of the magnitude of estimation error, the median physician deviation from actual costs is 75 percent on average. Appendix B provides details about average physician cost estimates for each item in the survey.

Physicians have overestimated the cost of drugs with an actual price of less than 5 KWD (16 USD) and underestimated the cost of drugs more expensive than 5 KWD. Physician cost estimates are most inaccurate for the two cheapest drugs on the list. In terms of medical supplies, physicians have underestimated the cost of supplies included in the survey, with the exception of the two cheapest devices. Figure 1

illustrates the frequency at which physicians have underestimated or overestimated the costs of medical items.

Figure 1
The Frequency of Physician Cost Estimations (n = 104), Grouped with Item Category

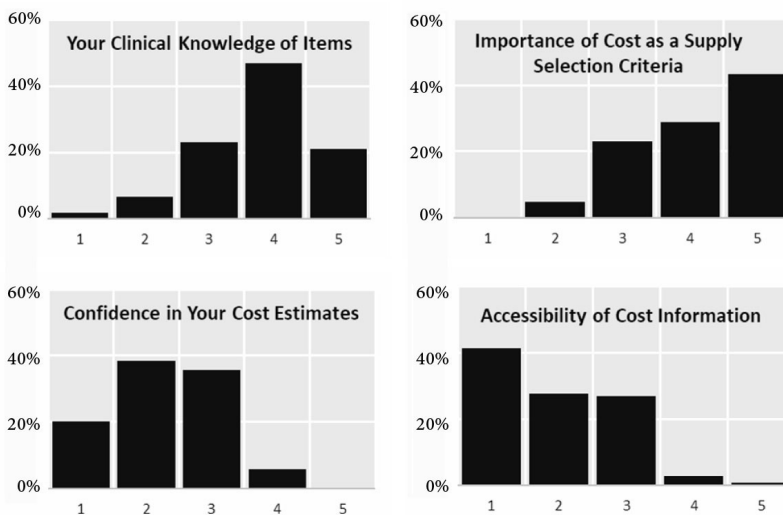


As observable in Figure 1, physicians have provided accurate estimates of drug prices ($\mu = 0.22$ $\sigma = 0.032$) more often than they have for medical supplies ($\mu = 0.14$ $\sigma = 0.018$). The difference is statistically tested via a paired two-sample t-test ($t = 3.77$, $df = 103$, $p < 0.01$) and found to be significant considering an α of 0.05. The median deviation of the estimates from actual costs for drugs and medical supplies is 85 and 81 percent, respectively. The difference between these means is not statistically significant. Furthermore, a two-sample t-test shows no statistical significance between the accuracy rates of locally-trained versus internationally-trained physicians ($t = -1.58$, $df = 102$, $p = 0.12$). The mean accuracy of Internal Medicine physicians has been compared with the mean accuracy of all other specialties. Internal Medicine is the most common specialty in Kuwait's physician population and in our sample. Other specialties cannot be isolated due to limited observations in each group. In terms of drug cost accuracy, Internal Medicine physicians, on average, have 4.7 accurate drug cost estimates compared to 3.9 accurate estimates by physicians of other specialties, a statistically significant difference ($t = -2.61$, $df = 102$, $p = 0.01$). There is no significant difference between the average accuracy rates of Internal Medicine versus other specialties. A comparison across physicians from different hospitals also shows no significant differences in mean accuracy rates.

Physician Perceptions of Medical Supply Costs

Figure 2 provides histograms of the four general survey questions related to supply costs. The specific questions asked and the definitions of their 1 to 5 scales are included in Appendix A. Generally, “1” indicates low agreement to the survey item and “5” indicates high agreement.

Figure 2
Physician Perceptions of Supply Costs (N = 104)



Physicians in this study believe that cost is an important supply selection criterion for clinically-equivalent items but they indicate a low level of accessibility to cost information at their institutions. Physicians have also reported that their clinical knowledge of the medical items presented in the survey is relatively high while their cost knowledge is low.

Factors Influencing Physicians' Accuracy of Cost Estimations

The correlation matrix of the independent variables included in the Poisson regression model is presented in Table 2. The regression results are provided in Table 3. The exponentiated beta coefficients, which reflect the incidence rate ratios, are provided for easier interpretation of the results. By increasing an independent variable by one unit, the count of accurate estimates (dependent variable) is expected to increase by a factor of the incidence rate ratio. For example, when the physician indicates familiarity with MOH's online drug prices search system, the accuracy rate is expected to be higher than the average by a factor of 1.65, holding all else constant.

Table 2
Correlation Matrix of Independent Variables

	Mean (SD)	1	2	3	4	5	6	7
1 Experience	7.24 (7.34)	1						
2 Gender (binary)	0.61 (0.49)	0.14	1					
3 eService (binary)	0.22 (0.42)	0.25 ^b	0.10	1				
4 Knowledge	3.79 (0.92)	-0.14	-0.01	-0.16	1			
5 Confidence	2.27 (0.85)	0.27 ^a	0.19	-0.03	0.21 ^b	1		
6 Importance	4.11 (0.92)	-0.01	0.03	-0.04	0.19	0.06	1	
7 Accessibility	1.94 (0.94)	-0.18	-0.01	-0.04	0.18	0.06	-0.06	1

Notes: Pearson correlation with pairwise deletion (N = 104).

^a $p < 0.05$.

^b $p < 0.01$.

Table 3
Poisson Regression Predicting the Count of Accurate Cost Estimates by a Physician

Independent Variables	Model 1 DV: Count of Accurate Drugs Estimates					Model 2 DV: Count of Accurate Devices Estimates				
	exp(β)	β	SE β	t	p	exp(β)	β	SE β	t	P
(Intercept)	0.52	-0.65	0.49	-1.32	0.185	1.06	0.06	0.55	0.11	0.912
Years of Experience	0.99	-0.01	0.01	-0.87	0.386	1.00	0.00	0.01	0.06	0.955
Gender	1.08	0.08	0.16	0.49	0.626	1.16	0.15	0.18	0.81	0.419
eService	1.65	0.50	0.17	2.94	0.003	1.20	0.18	0.20	0.89	0.374
Confidence in Estimates	1.36	0.31	0.10	3.08	0.002	1.04	0.04	0.11	0.33	0.745
Clinical Knowledge	0.87	-0.14	0.09	-1.58	0.115	0.99	-0.01	0.10	-0.10	0.922
Access to Cost Info	1.01	0.01	0.08	0.17	0.865	0.90	-0.10	0.10	-1.05	0.293
Importance of Costs	1.24	0.22	0.09	2.38	0.017	1.07	0.07	0.10	0.70	0.486
Model Fit Statistics:										
N	100					100				
Null Deviance (df)	121.8 (99)					127.8 (99)				
Residual Deviance (df)	96.5 (92)					123.8 (92)				

In Model 1, where the accuracy rate of drug costs is the dependent variable, physician awareness of the Ministry of Health's online prices search system is positively and significantly associated with higher physician cost estimation accuracy. Confidence in the cost estimates provided is associated with a higher

accuracy rate such that for each additional unit in the confidence scale, the number of accurately estimated items is predicted to increase by 1.36. The perceived importance of supply costs is also significantly associated with more accurate cost perceptions. Years of experience and clinical knowledge are not significantly associated with better cost estimates by physicians. Accessibility to cost information and physician gender are not significant predictors of cost awareness, either.

No factors are significantly associated with the accuracy rate of cost estimates for medical devices (Model 2). As a robustness check, the models are re-estimated after recalculating the accuracy rate of physicians, given a 35 percent margin of error instead of 25 percent. For both models, the results remain consistent in terms of significant predictors of cost accuracy.

Discussion

Previous studies have examined physician cost perceptions, and most of them have concluded that physicians have limited knowledge of medical care costs (Allan *et al.*, 2007). This study extends this line of inquiry by widening the scope of supplies to include both pharmaceutical drugs and medical devices and considers the factors associated with higher physician awareness. The distinction between drugs and devices is important because drugs are well-classified, with regulated pricing, and a high level of price transparency and product substitutability. Medical devices, on the other hand, do not share any of these characteristics, posing a challenge for both hospital materials managers and physicians in selection and pricing (Wenzl and Mossialos, 2018; Walker, 2016). Furthermore, this study examines factors that are associated with more accurate physician perceptions, providing some guidance about how to increase awareness, and ultimately improve cost efficiency in the healthcare system.

Physician cost perceptions of pharmaceutical supplies in this study are consistent with results from previous studies summarized in a systematic review by Allan *et al.* (2007). Across 12 studies applied the same margin of error (± 25 percent), the median accuracy rate is 29 percent. The median accuracy rate of drugs in this study is 25 percent. This study further adds that cost perceptions of medical devices are significantly less accurate than perceptions of drugs. One reason may be that the price variation of drugs is lower than that of devices. The middle 80 percent price range of all drugs registered in Kuwait is between 0.820 KWD and 19.500 KWD (State of Kuwait Ministry of Health, 2018). While we do not have data about the range of medical device prices, it is safe to assume that they would exhibit a much wider price range.

Consistent with previous studies, physicians in this study generally overestimate the cost of drugs. Our findings add that medical devices are much more likely to be underestimated than overestimated (Figure 1). An underestimation of supply costs can lead to a significant amount of waste. For example, a recent study conducted at the University of California in San Francisco estimates that \$968 worth of unused supplies (about 13 percent of the total procedure cost) goes to waste in each neurosurgery operation (Zygourakis *et al.*, 2017). The authors also indicate that the surgeon is a predictor of the amount of waste per surgery. This observation provides an indication that changing surgeon behavior (through education, incentives, or directives) can, in fact, improve cost efficiency.

The results reveal a contrast between clinical knowledge and cost knowledge of medical items. The limited cost perception accuracy is observed equally across different education backgrounds, physician ranks, and institutions. Internal Medicine physicians appear to have an advantage in drug cost awareness, perhaps due to their higher familiarity with drugs listed in the survey. Medical programs do not typically provide courses or training in hospital administration or healthcare operations management. Two-thirds of the respondents have graduated from either Kuwait University or the Royal College of Surgeons in Ireland, and after reviewing the curriculums of both programs, no business-oriented training is identified.

Physicians believe that cost is an important factor in supply selection. However, they also indicate minimal access to cost information at their institutions. This contrast is illustrated in Figure 2 and reflects the low level of generic drugs substitution in Kuwait (IMS Health, 2016). Making supply cost information more accessible may be a practical approach to motivating the prescription of generic drugs. Accessibility of cost information can be an effective cost reduction mechanism (Goetz *et al.*, 2015). Results also indicate that familiarity with the Ministry of Health's drug price look-up services is associated with higher cost awareness. This service that the Ministry publicly offers can be further enhanced to allow searching by the chemical name of the drug (i.e., the "generic name") and linking it to additional drug information and equivalency research. In addition, the Ministry may bring cost information supported by comparative effectiveness research into electronic health records with a decision support system technology as a reference for physicians (Tilburt J. C., *et al.* 2013).

Study Limitations and Future Research

Convenience sampling provides an efficient method for collecting an acceptable sample size in a relatively short time frame. The drawback of convenience

sampling is the risk of sampling bias. This bias may have manifested in our sample as the sample over-represents physicians working at general hospitals, which are easier to locate and invite to participate. It appears that our sample is skewed towards younger physicians, but this cannot be confirmed since we do not know the age distribution of Kuwait's physician population. When inviting physicians to participate, higher-ranked physicians are less readily available at the hospitals.

Future research should consider a more refined sample to answer questions pertaining to specific physician groups. For example, comparing physicians in private hospitals, public hospitals, primary care clinics, and specialized private practices may reveal more differences in cost awareness and attention.

Another track of research should also examine the effects of physician perceptions on costs. Are supply resources utilized more strategically when there is a higher cost awareness among physicians? Previous studies indicate that displaying the cost of medications and laboratory tests on the computerized physician order entry screens can influence physician prescribing behaviors and reduce overall costs without adversely impacting the quality of health care (Korn *et al.*, 2003; Lin and Miller, 1998). While such studies are encouraging, research should be conducted in the Kuwait context, in order to answer questions about how to best display the medical supply costs, and how to track overall physician prescription patterns.

CONCLUSION AND RECOMMENDATIONS

The results of this research provide some guidance to policymakers for improving hospital operational efficiency by reducing supply costs without compromising service quality. To become benevolent stewards of the healthcare supply chain physicians would require three elements: information, incentives, and education. These elements are elaborated upon below.

Increasing Availability of Medical Supply Information

Information useful to improve supply selection decision-making includes product characteristics and pricing, potential product alternatives, efficacy studies, etc. Conducting product equivalency studies between device alternatives is much more complicated than pharmaceuticals, but can prove to be rewarding given more pronounced price variations across product alternatives (Wenzl and Mossialos, 2018).

When information is not readily available, it should be created. Physician leaders in each specialty can form value analysis teams that study and consider all

aspects of product alternatives commonly used in common diagnoses or procedures in that discipline (Lang and Eaton, 2009). They can then recommend best practices and steer the product choice for less experienced physicians, without compromising their primary responsibility to decide on what is best for their patients (Tilburt *et al.*, 2013).

Aligning Physician and Hospital Incentives

Incentivizing physicians towards more cost-effective healthcare delivery is also necessary to improve performance. However, one must caution against unintended consequences of incentive plans that may give rise to self-serving behaviors by physicians. Further research with underpinnings in agency theory and stewardship theory may help identify the right contract structures to set up successful incentive schemes (Abdulsalam *et al.*, 2018). The gain-sharing model is one incentive structure that motivates physicians to consider supply costs while also accounting for clinical outcomes (Ketcham and Furukawa, 2008). Bundled payment programs and patient classification systems can also push physicians and hospital administrators to manage costs better when planning for a treatment or procedure (Tsai *et al.*, 2015).

Educating Physicians About Supply Chain Management

Supply chain management education directed towards physicians is generally absent in most medical programs worldwide. Physicians represent a critical node in the supply chain of pharmaceuticals and medical devices, yet they are neither aware of the hospital's procurement process nor their significant role in it. An introductory-level course about hospital management that covers topics in operations management, finance, inventory management, strategy, human resource scheduling, etc. may shape physician behaviors and elevate their role to become stewards of the hospital and not just of the patient. Part of this duty falls upon the Kuwait Institute for Medical Specialties (KIMS) or the Kuwait Medical/Surgical Association. Seminars or short certification programs can be provided for physicians to improve their appreciation for the healthcare supply chain and provide them with opportunities to participate in improving it.

Healthcare institutions may also consider including supply chain and business topics as part of an orientation program upon recruitment. Combining clinical knowledge with an awareness of supply management, distribution channels, and costs have been shown to improve supply chain performance (Korn *et al.*, 2003).

Previous studies looking at increasing physician awareness of medical supply costs have noted significant reductions in hospital costs. Studies examining the impact of providing medical cost data to physicians have also noted a 10 to 25 percent reduction in costs, without a significant adverse effect on the quality of care due to the changes in medication choice (Goetz *et al.*, 2015). In Kuwait's health care system, we can assume that physician cost awareness can increase the dispensing of generic medications to 50 percent of total dispensed volume, which cost half their branded counterparts. Based on these relatively conservative estimates, the estimated savings would amount to approximately 100 million USD annually, representing a 15 percent saving opportunity.

Final Remarks

Opportunities to improve performance in the supply chains of the health sector remain plentiful. This paper considers one venue which involves the role of physicians in supply selection and their potential impact on hospital costs. This study shows that physicians have little awareness about the costs of supplies that they select and use in their service delivery. Medical device costs appear to be even more elusive to physicians than pharmaceutical items. While pharmaceutical costs at mature healthcare systems are relatively well managed, medical devices continue to pose a challenge (Wenzl and Mossialos, 2018).

Improving the efficiency of the healthcare system in Kuwait is the responsibility of multiple stakeholders in the healthcare supply chain. The Ministry of Health needs to tackle issues at the strategic level, considering population health, overall expenditure, and long-term planning. Institutions such as Kuwait University's Medical College and KIMS should incorporate education about healthcare planning and operations into their curriculums. Hospital administrators need to address tactical issues involving effective procurement and use of resources. Finally, physicians need to address the day-to-day operational supply chain issues such as being aware of their prescription behaviors and the general cost implications of their actions.

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Appendix A

Survey Instrument

Section 1. Pharmaceuticals and Medical Supply Costs

How much do you estimate the following medical items cost the hospital, in Kuwaiti Dinars?

Please provide an educated guess of the value (in KWD) for each of the following items.

Input "-1" if you do not recognize the medical item

Pharmaceutical Supply Costs

Plavix (Clopidogrel) - Tablet, 28 x 75 mg	[numerical input]
Gasec (Omeprazole) - Tablet, 28 x 20 mg	[numerical input]
Tramal (Tramadol) - Tablet, 10 x 100 mg	[numerical input]
Clexane (Enoxaparin) Syringe, 2 x 0.4mL	[numerical input]
Amoxil (Amoxicillin) - Tablet, 20 x 500 mg	[numerical input]
Rocephin (Ceftriaxone) - I.V. Vial, 1 g	[numerical input]
Klacid (Clarithromycin) - Tablet, 20 x 500 mg	[numerical input]
Augmentin (amoxicillin/clavulanate) - Tab, 14 x 1 g	[numerical input]

Medical Supplies & Devices Costs

Laprascope - Stryker IDEAL EYES Standard	[numerical input]
Arterial Blood Gas (ABG) Needle - Pack of 100	[numerical input]
Blood, 500 ml, (O, Rh Positive)	[numerical input]
Foley's Catheter (All-Silicone)	[numerical input]
Guidewire for PTCA procedure	[numerical input]
Diagnostic Catheter	[numerical input]
Cardiac Pacemaker - St. Jude Assurity	[numerical input]
Bare Metal Stent	[numerical input]
Drug-Eluting Stent	[numerical input]
Bio-Absorbable Stent	[numerical input]

Section 2. General and Demographic Questions

Please rate your overall familiarity with the medical items listed 1 to 5 scale (1 = "low, 5 = "high") in this survey.

Please rate your overall confidence in the cost estimates you 1 to 5 scale (1 = "low, 5 = "high") provided.

How important do you think cost is in selecting between two 1 to 5 scale (1 = "not important", clinically equivalent alternatives? 5 = "very important")

How accessible is supply cost information at your hospital? 1 to 5 scale (1 = "not at all accessible", 5 = "easily accessible")

Are you aware of the Kuwait Ministry of Health's drug prices [Yes] or [No] look-up e-service?

What is your gender?	[Male] or [Female]
What is your medical specialty?	[Text input]
Current Medical Level?	[Text input]
Where did you receive your medical education?	[Text input]
Which year did you graduate medical school?	[numerical input]
Do you work in a private institution or practice?	[Yes] or [No]
Which institution have you worked in the longest?	[Text input]

Appendix B

Summary Results of Physician Estimates of Medical Items.

	Actual Cost	Median Estimation	Percent of Physicians that:		
	(KWD)	(KWD)	Underestimated	Accurate ^a	Overestimated
<i>Pharmaceuticals</i>					
Tramal	1.9	11.5	2%	5%	94%
Clexane	2.82	15	4%	5%	91%
Amoxil	3.19	5	9%	13%	79%
Rocephin	4.84	10	13%	20%	66%
Augmentin	8.98	7	42%	43%	14%
Gasec	9.04	8	38%	32%	31%
Klacid	9.51	7	58%	22%	20%
Plavix	20.1	22	24%	38%	38%
<i>Medical Supplies</i>					
Foley's Catheter	12	10	38%	24%	39%
Diagnostic Catheter	42	95	24%	17%	62%
Blood	60	35	56%	27%	19%
ABG Needle	85	15	89%	5%	7%
Guidewire	100	50	63%	10%	31%
Bare Metal Stent	335	200	63%	20%	16%
Laparoscope	380	100	78%	7%	17%
Pacemaker	800	500	63%	4%	34%
Drug-Eluting Stent	840	300	75%	14%	11%
Bio-Absorbable Stent	1000	300	77%	11%	14%

Notes:

^a Estimates within $\pm$ 25 percent of the actual cost are "accurate." For example, with an item that costs 20 K.D., any estimate given between 15 K.D. and 25 K.D. is "accurate."

دور الطبيب في إدارة موارد الرعاية الصحية في الكويت

إيمان الجعفر

ضاري الحويل

يوسف عبدالسلام

جامعة الكويت

هدف الدراسة: تلعب الخبرة الإكلينيكية للأطباء دوراً كبيراً في اختيار وإدارة الموارد والموارد الطبية لتقديم الرعاية الصحية؛ مما يؤثر - بشكل مباشر - في أداء تكلفة المستشفى وكفاءته. الهدف الرئيسي لهذه الدراسة هو تقييم الإدراك والاهتمام الذي يوليه الأطباء لتكاليف الموارد والمستلزمات الطبية في نظام الرعاية الصحية العامة.

منهجية الدراسة: من خلال استبانة، طُلب من الأطباء العاملين في قطاع الصحة الحكومي في الكويت تقدير تكلفة 18 من المنتجات الدوائية والأجهزة الطبية الشائعة. باستخدام تحليل الارتباط.

تمت دراسة العوامل المرتبطة بارتفاع معدل التقديرات المقدمة من المشاركين ودقتها.

البيانات وعينة الدراسة: استجابت عينة من 104 أطباء يعملون في القطاع الصحي الحكومي في الكويت. العينة شملت الأطباء من الجنسين؛ بالإضافة إلى خبرات عملية وتخصصات سريرية متنوعة.

نتائج الدراسة: أظهر الأطباء وعياً محدوداً فيما يتعلق بتكاليف المستلزمات الطبية. في المتوسط، يقدر الأطباء بدقة 22 في المائة فقط من المنتجات الصيدلانية و14 في المائة من الأجهزة الطبية. علاوة على ذلك، أشار معظم الأطباء إلى محدودية إمكانية الوصول إلى معلومات تسعير المنتجات التي يتم وصفها، على الرغم من أنهم عدّوا التكلفة معياراً مهماً في اختيار المنتجات المكافئة سريرياً.

الخاتمة: التعليم حول إدارة موارد الرعاية واحتواء التكاليف قد يحمل قيمة لكل من الأطباء ونظام الرعاية الصحية. يجب على القائمين على إدارة المستشفيات التفكير في زيادة إمكانية الوصول إلى معلومات التكلفة وإشراك القادة من الأطباء في الشراء من أجل تحسين كفاءة تكاليف المستشفى.

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