Original Article

Factors Influencing Civil Servants Medical Benefit Scheme Revenues at Ramathibodi Hospital, Fiscal Year 2016 to 2017

Umaporn Udomsubpayakul MSc[1], Ronnachai Kongsakon MD[2], Oraluck Pattanaprateep PhD[1]

[1] Section for Clinical Epidemiology and Biostatistics, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand
[2] Department of Psychiatry, Faculty of Medicine Ramathibodi Hospital, Mahidol University, Bangkok, Thailand

Objective: To examine factors that influenced the revenues from Civil Servants Medical Benefit Scheme [CSMBS] of a Thai teaching hospital.

Materials and Methods: Retrospective invoice data were retrieved from the hospital's database to analyze changes between first half of fiscal year 2016 and 2017 by the Laspeyres index. Effects of price and quantity of existing item, exiting item, and new item were calculated for top six expense types and for total.

Results: CSMBS revenues were about two fifths of total hospital revenues. The revenues were from drug (22.3%) and from inpatient [IP] and outpatient [OP] services (77.1%). The price, quantity, exiting item, new item, and cross effects in IP service were 0.09, 0.88, -2.61, 2.77, and -0.13, while in OP service they were at -0.22, 1.66, -1.07, 0.69, and -0.05, respectively.

Conclusion: By splitting revenues into factors using Laspeyres index, each factor will reflect the increase or decrease of total revenue and allow the administrative team to monitor hospital revenues.

Keywords: Factors, Laspeyres index, Revenues, Hospital

At Ramathibodi Hospital, a 1,000-bed government teaching facility in Bangkok, total hospital revenues increased every year, but at a decreasing rate, which were 11.43%, 8.89%, and 4.86% in 2015, 2016, and 2017, respectively. Among these revenues, two fifth was from patients under Civil Servants Medical Benefit Scheme [CSMBS]. Identifying the factors that affected the CSMBS revenues will assist the management team to introduce more suitable strategies for the hospital.

To examine the factors, a mathematical model with Lasperyes index[1,2] was applied as follows: Lasperyes index = (total revenue where one factor changed to a selected period while holding other factors to its previous period) / (total revenue in previous period)

Index greater than one indicates that the considered factor has a positive impact on total revenue, and less than one means a negative impact. The present study aimed to examine factors that influenced the revenues from CSMBS from first half of fiscal year 2016 to 2017.

Materials and Methods

Retrospective invoice data were retrieved from hospital's database, which included 1) invoice date, 2) patient's dummy identification number, 3) health scheme, 4) service type, 5) service identifier, 6) unit price, and 7) ordered quantity. The data were split into two periods, which were first half of fiscal year 2016 (October 1, 2015 to March 31, 2016) and 2017 (October 1, 2016 to March 31, 2017).

Number of patients for each service type, outpatient [OP] and inpatient [IP], were counted in total, and by health schemes (i.e., universal coverage [UC], social security scheme [SSS], CSMBS, and self-pay). OP and IP revenues were calculated as a summation of each transaction's unit price multiplied by its ordered quantity, by Microsoft® Excel 2013. Revenue per OP patient and IP patient were then calculated and compared between two fiscal years by Quantile Regression (Stata®/SE 14.2).

CSMBS revenue was grouped by expense types, based on the announcement of Ministry of Finance, which are drug (DRUG), medical supply (SUPPLY), general (GEN), procedure (PROC), laboratory (LAB), X-ray (XRAY), anesthesia (ANES), diagnosis (DIAG), re-habitation (REHAB), dietary (DIET), dentistry

Correspondence to:

Pattanaprateep O. Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok 10400, Thailand.
Phone: +66-2-2011269
Email: oraluck.pat@mahidol.ac.th

(DENT), acupuncture (ACCUP). Percentages of each expense type to total revenue were calculated.

For factors affecting revenue analysis, total and each expense type revenue were decomposed and analyzed by Laspeyres index. The decomposed five factors were 1) price effect, 2) quantity effect, 3) exiting item effect, 4) new item effect, and 5) cross effect.

The price effect measures the impact of changes in price, while holding quantity constant. The quantity effect measures the impact of changes in quantity, while holding price constant. The cross effect measures the impact of the interaction between price and quantity changes. The price, quantity, and cross effects can be positive or negative and were calculated for existing items. The new and exiting item effects measure the changes in revenue affected from new and exiting items. Summation of all effects will be 1.0.

The decomposition formulae are as follows:

$$R_{2017} - R_{2016} = \sum E \left[(P^i_{2017} - P^i_{2016}) * Q^i_{2016} \right] \text{ :Price effect}$$
$$= \sum E \left[P^i_{2016} * (Q^i_{2017} - Q^i_{2016}) \right] \text{ :Quantity effect}$$
$$= \sum E \left[(P^i_{2017} - P^i_{2016}) * (Q^i_{2017} - Q^i_{2016}) \right] \text{ :Cross effect}$$
$$= \sum N \left[(P^i_{2017} * Q^i_{2017}) \right] \text{ :New item effect}$$
$$= -\sum X \left[(P^i_{2017} * Q^i_{2016}) \right] \text{ :Exiting item effect}$$

Where

R_{2017} = Revenues in first half of fiscal year 2017
R_{2016} = Revenues in first half of fiscal year 2016
P^i_{2017} = Price per item in first half of fiscal year 2017
P^i_{2016} = Price per item in first half of fiscal year 2016
Q^i_{2017} = Number of quantity in first half of fiscal year 2017
Q^i_{2016} = Number of quantity in first half of fiscal year 2016
$\sum E$ = Summation for all existing items
$\sum N$ = Summation for all new items
$\sum X$ = Summation for all exiting items

Total change in revenues = Price effect + Quantity effect + Exiting item effect + New item effect + Cross effect / Total change in revenues from first half fiscal year 2016 to 2017

Results

Among the two first half fiscal years, total hospital revenue increased 5.30% from 6,785.0 to 7,144.5 million Baht, as a result of the increase of both quantity (number of visits) and price (revenue per visit). In terms of quantity, the total number of patients with at least one visit at OP service was 361,977 and 367,436 (1.51% increase) in 2016 and 2017, respectively. At IP service patients were 20,972 in 2016 and 21,427 (2.17% increase) in 2017. By health scheme, only number of IP patients under UC decreased from 5,015 to 4,948 per year (Table 1).

In terms of price, the total revenue per OP patient and IP patient (Baht/patient) was significantly higher in 2017 than 2016 fiscal year, respectively. However, by health scheme, IP revenue per patient decreased in SSS (i.e., from 88,874.7 in 2016 to 86,095.0 in 2017) and in CSMBS (i.e., from 87,085.6 to 85,642.9). In addition, the increases of OP revenue in these two health schemes were not significant.

For CSMBS (Table 2), drug was the major component of expense in both IP and OP service, 22.3 and 77.1%, respectively. The next five ranks in IP service were medical supply (20.7%), general (20.3%), procedure (15.7%), laboratory (10.7%), and X-ray (5.4%). In OP service were X-ray (9.0%), laboratory (6.5%), procedure (2.8%), general (1.7%), and medical supply (1.7%).

Table 1 showed change in total CSMBS revenue from 2,885.0 in 2016 to 2,981.7 million Baht in 2017, which resulted in a 3.35% increase. To decompose each factor affected price, quantity, exiting and new item, and cross effect, and Laspeyres index was applied to total and top six expense types for both service types in CSMBS. In total, new item was the main factor of the increase in IP service with the index of 2.77, while quantity was the main in OP service at 1.66 (Table 3). Change in price in 2017, while holding other factors

Table 1. Number of visits and revenues at outpatient [OP] and inpatient [IP] services by health schemes

	UC		SSS		CSMBS		Self-pay		Total	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
No. of OP patients	34,349	35,272	16,888	17,578	124,769	129,314	306,435	313,287	361,977	367,436
No. of IP patients	5,015	4,948	907	911	7,149	7,433	20,545	21,099	20,972	21,427
OP revenues (million Baht)	390.0	412.4	160.2	168.3	2,262.4	2,345.1	1,886.1	1,983.6	4,698.7	4,909.4
IP revenues (million Baht)	433.3	443.7	80.6	78.4	622.6	636.6	949.8	1,076.4	2,086.3	2,235.1
Total revenues (million Baht)	823.3	856.1	240.8	246.7	2,885.0	2,981.7	2,835.9	3,060.0	6,785.0	7,144.5
Baht/OP patient	11,354.2	11,692.9*	9,484.3	9,571.3	18,133.0	18,134.8	6,155.1	6,331.6*	12,980.8	13,361.2*
Baht/IP patient	86,400.7	89,663.4*	88,874.7	86,095.0	87,085.6	85,642.9	46,229.9	51,018.6*	99,479.1	104,312.5*

UC = universal coverage; SSS = social security scheme; CSMBS = civil servants medical benefit scheme
* Significantly different from 2016

constant to 2016, impacted the price index by -0.70, -0.02, 0.21, 0.11, 0.14, and 0.00 for each IP expense type and -0.39, -0.02, 0.04, 0.18, 0.33, and 1.18 for each OP expense type, respectively. With the same concept, quantity index was -4.95, 2.13, 0.99, 1.12, -1.04, and 0.66 for each IP expense types and 2.00, 0.75, 0.96, 1.09, 0.74, and -2.98 for each OP expense types. Price and quantity effect explained the change of any item that appeared in both fiscal years. For item that appeared only in 2016, the effect showed by exiting item index while new items in 2017 showed in new item index. In total, these two indices had more effect in IP service (i.e., -2.61 and 2.77) than in OP service (i.e., -1.07 and 0.69).

Discussion

Applying mathematic model in health care has been introduced in the 1970s[3], but rarely being applied in any health care industry in Asia. In China, Zhang et al, applied the Laspeyres index to analyze the factors driving the changes of the relationships between economic growth and environmental pressure in Gansu Province from 1990 to 2005[4]. Chen et al, also applied the index to investigate the use of drugs for the digestive system in Hangzhou area from 2005 to 2007[5]. In Thailand, Kaojerern et al, explained the factors influencing the use and expenditure of oral coxibs in a Thai teaching hospital between 2007 and 2009 by using the Laspeyres index[6]. In Canada, National Prescription Drug Utilization Information System [NPDUIS] has routinely reported pharmaceutical trend by each territory with this index since 2006[7]. Other economic indices in mathematic model were Paasche and Fisher indices[1]. All index numbers measure the changes in the level of factors between base and current periods. The Laspeyres index uses the base period as weights, while the Paasche index uses the current period. The Fisher index is the geometric mean of these two indices. In health care industry, these indices were discussed in improving Medical Care price indices in

Table 2. CSMBS revenues by service and expense type, 2016 and 2017

	IP (Baht)		% total (average)	OP (Baht)		% total (average)
	2016	2017		2016	2017	
Drug	140,120,551	140,385,458	22.3	1,746,799,347	1,806,552,657	77.1
Medical supply	128,881,574	132,183,411	20.7	37,361,967	40,997,266	1.7
General	126,223,514	128,885,909	20.3	38,257,894	41,599,745	1.7
Procedure	94,074,089	104,197,701	15.7	63,471,723	67,211,587	2.8
Laboratory	69,386,160	65,562,929	10.7	144,335,444	154,112,415	6.5
X-ray	34,614,034	33,789,311	5.4	207,418,028	206,931,444	9.0
Anesthesia	24,652,924	26,369,661	4.1	1,361,000	1,354,356	0.1
Diagnosis	2,743,543	3,092,510	0.5	17,714,707	19,631,891	0.8
Rehabitation	1,474,100	1,770,257	0.3	2,250,217	2,654,178	0.1
Dietary	351,740	290,690	0.1	-	-	
Dentistry	51,256	55,468	0.0	3,254,566	3,673,071	0.2
Acupuncture	1,686	446	0.0	207,642	367,503	0.0
Total	622,575,169	636,583,750		2,262,432,534	2,345,086,113	

Table 3. CSMBS Laspeyres indices, total and by expense types, fiscal years 2016 and 2017

	Drug	Medical supply	General	Procedure	Laboratory	X-ray	Total
IP service							
Price effect	-0.70	-0.02	0.21	0.11	0.14	0.00	0.09
Quantity effect	-4.95	2.13	0.99	1.12	-1.04	0.66	0.88
Exiting item effect	-3.00	-8.43	-0.22	-0.18	-0.20	-2.51	-2.61
New item effect	9.37	7.37	0.01	0.20	0.10	3.17	2.77
Cross effect	0.27	-0.05	0.00	-0.25	0.00	-0.32	-0.13
OP service							
Price effect	-0.39	-0.02	0.04	0.18	0.33	1.18	-0.22
Quantity effect	2.00	0.75	0.96	1.09	0.74	-2.98	1.66
Exiting item effect	-1.32	-1.23	0.00	-0.59	-0.17	-2.13	-1.07
New item effect	0.77	1.53	0.00	0.41	0.08	3.18	0.69
Cross effect	-0.07	-0.03	0.00	-0.09	0.02	-0.25	-0.05

the US[8] and other indices such as Service Price Index [SPI] and Medical Care Expenditure Index [MCE][9,10]. Fisher index was used to analyze drivers of prescription drug spending in Canada between 1998 and 2007 by measuring price, volume, and mix effects of changes[11]. Another method used Lorenz distribution curves and expenditure variance analysis to determine the impact of price and volume on total expenditure variation in Brazil between 2006 and 2013[12].

In the present study, the 5.30% increase of total hospital revenue between 2016 and 2017 was the result of two main factors, which were the number of patient visits and the revenue per patient in IP and OP services. Since our study site is a public hospital where services are always at full capacity, the increase was mainly from revenue per patient, which is shown in Table 1. Revenue per patient both in OP and IP services were significantly increased in total and by two health schemes (UC and self-pay).

The present study, however, focused on CSMBS revenue where the revenues did not significantly differ between the two study periods. By expense type, drug was the highest proportion revenue at 22.3% and 77.1% in IP and OP service, respectively. This was also at the same ratio in the report of Thailand health system in 2016 that 83% of total OP service expenditure was for drug[13].

By Laspeyres index, price effect for drug was negative, which was lower when we compared to Thailand month-on-month consumer price index in June 2017 at 0.04[14]. This may be the result from the regulation of the Comptroller General Department of the Ministry of Finance announcement since 2012 that created a national mechanism to negotiate prices of drug and develop a central financial audit system for CSMBS patients[13]. The highest impact on drug revenue was from new drug, especially in IP at 9.37. This implied that new technology cost much more than current drug. In addition, physicians prescribed new drug more than existing one since quantity index was negative (-4.95) and exiting index was also negative (-3.00). However, in OP service, each factor had less effect than in IP service since its indices' magnitude was lower.

Conclusion

Total hospital revenues of Ramathibodi Hospital increased 5.30% between 2016 and 2017 as a result of the increase of both quantity (number of visits) and price (revenue per visit). However, by health scheme, number of IP patients under UC was decreased from

5,015 to 4,948 per year, and IP revenue per patient decreased in SSS and CSMBS. In addition, the increases of OP revenue in these two health schemes were not significant.

The present study analyzed more on CSMBS revenue since it was about two fifth of total hospital revenues. By decomposing each factor, drug was the major part of revenue (22.3% in IP service and 77.1% in OP service). In IP service, price, quantity, and exiting item had negative indices that drove the revenue per patient down in total of -8.65 and the high magnitude index was on new item at 9.37. While in OP service, the magnitude of indices was lower than IP service. It moved between -1.32 to 2.00 and the new item impacted only 0.77.

With the Lasperyes index, the findings can help the administrative teams to understand the factors that affected the increase of revenue and provide the appropriate policy to maintain their net income.

What is already known on this topic?

CSMBS revenues of a Thai teaching hospital increased every year. However, the administrative team does not know the factor or reason of the increase.

What this study adds?

By applying Lasperyes index to hospital data, the analyst can monitor and report which factors affect the increase or decrease of total revenue. As a result, the administrative team will be able to design suitable strategies to control the hospital's margin.

Potential conflicts of interest

The authors declare no conflict of interest.

References

1. Triplett JE. Economic theory and BEA's alternative quantity and price indexes. Surv Curr Bus. 1992; 72:49-52.
2. Diewert WE. The early history of price index research. In: Diewert WE, Nakamura AO, editors. Essays in index number theory. Amsterdam, North-Holland: Elsevier Science; 1993.p.33-65.
3. Navarro V, Parker R, White KL. A stochastic and deterministic model of medical care utilization. Health Serv Res 1970;5:342-57.
4. Zhang ZL, Chen XP, Yang J, Xue B, Li YJ. Dynamic changes of the relationships between economic growth and environmental pressure in Gansu Province: a structural decomposition analysis.

Ying Yong Sheng Tai Xue Bao 2010;21:429-33.

5. Chen XY, Zhang CQ, Zhang H, Liu W, Wang JY. Analysis on the current use and trend of drugs for digestive system through comprehensive statistics index, in Hangzhou. Zhonghua Liu Xing Bing Xue Za Zhi 2010;31:572-5.

6. Kaojarern S, Masaya-Anon N, Pongchareonsuk P, Pattanaprateep O. Factors influencing oral coxibs utilization and expenditure at a Thai teaching hospital, fiscal year 2007 to 2009. Value Health Reg Issues 2012;1:3-6.

7. National Prescription Drug Utilization Information System (NPDUIS) Database Privacy Impact Assessment (PIA). Pharmaceutical trend overview report. Ottawa, Ontario: Canadian Institute for Health Information; 2006.

8. National Research Council (US) Panel to Advance a Research Program on the Design of National Health Accounts. Accounting for health and health care: Approaches to measuring the sources and costs of their improvement. Washington, DC: National Academies Press (US); 2010.

9. Dunn A, Liebman E, Pack S, Shapiro AH. Medical care price indexes for patients with employer-provided insurance: nationally representative estimates from MarketScan Data. Health Serv Res 2013;48:1173-90.

10. Aizcorbe A, Nestoriak N. Changing mix of medical care services: stylized facts and implications for price indexes. J Health Econ 2011;30:568-74.

11. Canadian Institute for Health Information (CIHI). Drivers of prescription drug spending in Canada. Ottawa, Ontario: CIHI; 2012.

12. Chama Borges LT, Garcia Serpa Osorio-de-Castro, Magarinos-Torres R, Wettermark B. Trends in medicines procurement by the Brazilian federal government from 2006 to 2013. PLoS One 2017; 12:e0174616.

13. World Health Organization, Regional Office for the Western Pacific. The Kingdom of Thailand health system review. Health systems in transition vol.5, no.5. Manila: WHO Regional Office for the Western Pacific; 2015.

14. Bank of Thailand. Consumer price index [Internet]. 2016 [cited 2017 Sep 8]. Available from: https://www.bot.or.th.