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ABC-VEN Matrix Analysis on the Cardiovascular Medicines Used at the Cardiovascular Center in Mongolia

Dulmaa Lkhagvasuren[1],Yerkyebulan Mukhtar[2], Enkhjargal Dorjbal[3]

Graduate School, Mongolian National University of Medical Sciences[1]
School of Public Health, Mongolian National University of Medical Sciences[2]
School of Pharmacy, Mongolian National University of Medical Sciences[3]

Abstract— This study focused on the management of cardiovascular medicines (CVMs), as cardiovascular diseases (CVDs) are the great public health problem globally and in Mongolia. The ABC (Always, Better and Control) and VEN (Vital, Essential and Non-essential) analyses were emphasized in the comprehensive manual for Drug and Therapeutic Committees which has been developed by the World Health Organization (WHO).These are the analyses involve aggregate data such as annual consumption and cost as well as clinical importance of the medicines. We aimed to identify the cardiovascular medicines needing strict management control, used at the Cardiovascular Center (CVC) in Mongolia by conducting ABC, VEN and ABC-VEN matrix analyses.
The Category I (AV, AE, AN, BV and CV),which requires strict management control contains the vast majority (70.97%, 81.25% and 78.8%) of the total cardiovascular medicines analyzed and constituted the biggest amount of the total expenditures at 87.3% (116890484 MNT - Mongolian tugrik – the official currency of Mongolia), 89.53% (95107593 MNT) and 87.56% (129608248 MNT) in 2016, 2017 and 2018 respectively.ABC, VEN and ABC-VEN analyses should be carried out routinely in order to manage medicines effectively and properly at the Cardiovascular Center.

Keywords— ABC analysis, VEN analysis, management of medicines

1. Introduction

Cardiovascular diseases (CVDs) are the leading cause of mortality globally and in Mongolia. [1,2] About one third of mortality reported at the global level were caused by CVDs in 2016 and over 75% of these deaths take place in low- and middle-income countries. [1] In Mongolia, CVDs had been the number one cause of mortality since 1995 and 34.4% of all deaths were due to CVDs in 2018. Also CVDs were the second reason for hospitalization in the same year.[2]There are several number of tertiary care hospitals in Ulaanbaatar. But the only one “Cardiovascular Center” (CVC) is available and located at the Third State Central hospital and provides health care nationwide. Therefore the attention should be placed on rational use and proper management of cardiovascular medicines (CVMs) in this center.
The World Health Organization (WHO) developed the first WHO Model List of Essential Drugs since 1977 andthe 21st Model List of Essential Medicines was published in 2019.Nowadays more than 150 countries had adopted this list. [4] Currently, the 8thEssential Medicines List (EML) is being used in Mongolia.
Essential medicines constitute 20-40% of health care budgets in many developing countries including Mongolia, and considered as an important tool to reduce morbidity and mortality.[3,5] The previous studies claimed that the annual purchase of medicines and medical devices consumed almost one third of annual budget of the governmental hospitals.[6,7,11,16] Therefore, the budget allocated to the medicines needs to be expedient and cost effective for the quality of patient care, especially in the developing countries.[8,9,22] It can be achieved through the number of factors, including proper management and rational use of medicines. [11,21]ABC and VEN analyses were emphasized in the comprehensive manual for Drug and Therapeutic Committees which has been developed by the WHO in collaboration with Management Sciences for Health to address irrational use and management of medicines.[3] By using ABC, VEN and ABC-VEN matrix analyses it is possible to identify the medicines’ categories that require strict management control.[7]

The previous studies were carried out to determine the medicine categories of hospital formulary drugs and a few studies were aimed to reveal the categories of specific therapeutic class medicines such as respiratory tract agents and anti-cancer medicines.[5-23]
Consequently, the aim of this study was to identify the category of CVMs, which requires strict management control and used at the CVC in three years of 2016, 2017 and 2018.

2. Materials and Methods

ABC and VEN analyses: retrospective cross sectional and descriptive retrospective designs, as well as ABC-VEN matrix analysis were used to carry out this study.
The ABC analysis is well known analysis for managing inventory and it is broadly recognised as "Pareto analysis".The annual consumption of and expenditure for the CVMs, included in the EMLwere collected for the year 2016-2018 to conduct ABC analysis. The data were collected from the computer program named "B-Pharmacy" which was being used at the CVC and transferred into MS Excel program to be analysed. We classified the CVMs, used in this center into three categories – A, B and C, based on the cumulative cost percentage of 70%, 20% and 10% respectively by using MS Excel statistical functions. [16,22]
For the VEN analysis, all used CVMs were classified into three categories, which are well defined in the literatures as: Vital (V) medicines – Potentially lifesaving or crucial to providing basic health services, Essential (E) medicines – Effective against less severe, but significant forms of disease but not absolutely vital to providing basic health care and Non-essential (N) medicines – Used for minor illnesses, are of questionable efficacy, or have a comparatively high cost for a marginal therapeutic advantage, and are the least important items stocked. [3,4] The VEN status of each CVM was defined according to their clinical significance by the consultation with cardiologists of the CVC.
Subsequently the ABC-VEN matrix analysis was performed by cross tabulating the results of the ABC and VEN analysis to extract the three categories (Category I, II and III) and nine subcategories (AV, AE, AN, BV, BE, BN, CV, CE and CN). While Category I is comprised of AV, AE, AN, BV and CV subcategories, Category II is consisted of BE, CE and BN subcategories. Only CN subcategory is belonged to the Category III. [11,16,21]

Ethics

Ethical approval was sought from the Institutional Review Board at the Mongolian National University of Medical Sciences to conduct this study. Approval №2019/3-02.

3. Results

Total 31 (2016), 32 (2017) and 33 (2018)CVMs, included in the EML of Mongolia were used at the CVC and consumed 133895307, 106224093 and 148024837 MNT (Mongolian tugrik – the official currency of Mongolia) respectively in 2016-2018.

ABC analysis

We found that the Class A medicines represented 16,13%, 21.88% and 15.2% of the total CVMs and consumed the largest proportion of the total budget at 71%, 70% and 69% for the years 2016, 2017 and 2018 respectively. Meanwhile, the Class B medicines constituted almost one fourth (an average of 21.88%) of the total CVMs and spent 27521202, 21258740 and 29656328 MNT in the years 2016, 2017 and 2018 respectively.The results of the ABC analysis are shown in the **Table 1 and Figure 1**.

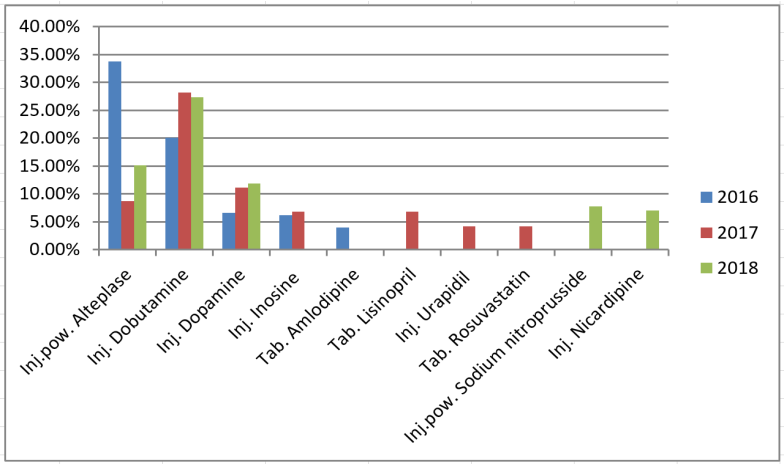
Table 1. ABC, VEN and ABC-VEN matrix analysis of the CVMs used at the CVC for the year 2016-2018.

Cat	2016		2017		2018	
	% of total CVMs	% of total CVMs expenditure (Cost - MNT)	% of total CVMs	% of total CVMs expenditure (Cost - MNT)	% of total CVMs	% of total CVMs expenditure (Cost - MNT)
ABC classification						
A	16.13	71 (94398700)	21.88	70 (74358063)	15.2	69 (102242476)
B	22.58	20 (27521202)	21.88	20 (21258740)	21.2	20 (29656328)
C	61.29	9 (11975405)	56.24	10 (10607290)	63.6	11 (16126033)
VEN classification						
V	64.52	51.03 (68323684)	71.88	69.86 (74205068)	70	57.6 (85318172)
E	29.03	48.57 (65027623)	21.88	21.91 (23274900)	24	34 (50224720)
N	6.45	0.4 (544000)	6.24	8.23 (8744125)	6	8.4 (12481945)
ABC-VEN matrix						
Cat I	**70.97**	**87.3 (116890484)**	**81.25**	**89.53 (95107593)**	**78.8**	**87.56(129608248)**
AV	9.68	30.57 (40935900)	12.5	50.32 (53455538)	6.1	39.15 (57952400)
AE	6.45	39.93 (53462800)	6.25	15.47 (16430400)	6.1	22.89 (33884576)
AN	0	0 (0)	3.13	4.21 (4472125)	3	7.03 (10405500)
BV	12.9	10.04 (13443152)	12.5	10.96 (11646240)	15.1	10.9 (16138208)
CV	41.93	6.76 (9048632)	46.87	8.57 (9103290)	48.5	7.58 (11227564)
Cat II	**25.8**	**11.92 (15964823)**	**18.75**	**10.47 (11116500)**	**18.2**	**11.04(16340144)**
BE	6.45	7.23 (9678050)	6.25	5.03 (5340500)	6.1	9.13 (13518120)
CE	16.13	1.41 (1886773)	9.37	1.42 (1504000)	12.1	1.91 (2822024)
BN	3.23	3.29 (4400000)	3.13	4.02 (4272000)	0	0 (0)
Cat III (CN)	**3.23**	**0.78 (1040000)**	**0**	**0 (0)**	**3**	**1.4(2076445)**

**** Cat – Category***

Expectedly, the majority of the CVMs were classified as Class C medicines at 61.29%, 56.24% and 63.6% of the total CVMs for the years 2016, 2017 and 2018 respectively. But they accounted for a minor percentage (an average of 10%) of total CVMs budget over the 3 years.

From the **Figure 1**, it can be seen that only 3 medicines: Inj.pow. Alteplase, Inj. Dobutamine and Inj. Dopamine's consumption were the largest part of the total expenditures over 3 years.



****Inj.pow. – Injection powder***
Inj. – Injection
Tab. – Tablets

Figure 1. Class A medicines used at the CVC over the 3 years.
As illustrated in the **Figure 1**, the rest of the Class A medicines, except Inj.pow. Alteplase, Inj. Dobutamine and Inj. Dopamine were not used in all three years of 2016, 2017 and 2018.

VEN analysis
The VEN analysis showed that a greater number of the CVMs belonged to the Class V medicines, which constituted 64.52%, 71.88% and 70% of total CVMs in 2016, 2017 and 2018 respectively. They consumed most of the budget for CVMs at 51.03% (68323684 MNT),69.86% (74205068 MNT) and 57.6% (85318172) of the total budget for 2016, 2017 and 2018 respectively. The results of the VEN analysis over the 3 years are shown in the **Table 1**.

The Class E medicines represented the moderate part (29.03%, 21.88% and 24%) of the total CVMs for the years 2016, 2017 and 2018 respectively. While, only an average of 6.23% of total CVMs were classified as the Class N medicines and they consumed the smallest proportion of the total budget: 0.4% - 544000 MNT, 8.23% - 8744125 MNT and 8.4% - 12481945 MNT for 2016, 2017 and 2018 respectively.

ABC-VEN matrix analysis
The ABC-VEN matrix analysis showed that the Category I (AV, AE, AN, BV and CV),which requires strict management control contains the vast majority (70.97%, 81.25% and 78.8%) of the total CVMs analyzed and constituted the biggest amount of the total expenditures at87.3% (116890484 MNT), 89.53% (95107593 MNT) and 87.56% (129608248 MNT) in 2016, 2017 and 2018 respectively. The results of ABC-VEN matrix analysis over the 3 years are shown in the **Tables 1-2**.

According to the **Tables 1**, about one fourth (an average of 20.9%) of the total CVMs analyzed are belonged to the Category II (BE, CE and BN) and constituted the modest part of the total expenditures at the average of 11.14% over the 3 years.
The Category III (CN) included only 3.23% and 3% of the total CVMs and consumed the little amount (1040000 MNT and 2076445 MNT) of the total budget in 2016 and 2018. There was no medicine classified as the Category III in 2017.

The results of the ABC-VEN matrix analysis, which shows the International Nonproprietary Names of the CVMs by the categories are shown in **Table 2**. As can be seen in this table, the majority of the CVMs used at the CVC over the 3 years were classified as CV subcategory medicines. Which means the most of the CVMs were vital, yet constituted the little amount of the expenditures.

Table 2. The International Nonproprietary Names of the CVMs belonged to the Category I, II and III respectively in 2016-2018

	2016	2017	2018
		Category I	
AV	Inj. Dobutamine, Inj. Dopamine, Tab. Amlodipine	Inj. Dobutamine, Inj. Dopamine, Tab. Lisinopril, Tab. Rosuvastatin	Inj. Dobutamine, Inj. Dopamine
AE	Inj.pow. Alteplase, Inj. Inosine	Inj.pow. Alteplase, Inj. Inosine	Inj.pow. Alteplase, Inj.pow. Sodium nitroprusside
AN	-	Inj. Urapidil	Inj. Nicardipine
BV	Tab. Lisinopril, Inj. Urokinase, Tab. Atorvastatin, Inj. Amiodarone	Inj. Urokinase, Tab. Amlodipine, Inj. Amiodarone, Tab. Losartan	Tab. Lisinopril, Tab. Atorvastatin, Inj. Lidocaine, Inj. Amiodarone, Tab. Losartan
CV	Tab. Losartan, Tab. Carvedilol,	Inj. Lidocaine, Tab. Isosorbide dinitrate,	Tab. Glyceril trinitrate, Tab. Isosorbide dinitrate,

	Tab. Enalapril, Tab. Ramipril, Tab. Perindopril, Tab. Acetylsalicylic acid, Tab. Atenolol, Tab. Bisoprolol, Tab. Valsartan, Tab. Isosorbide dinitrate, Tab. Amiodarone, Tab. Verapamil, Tab. Glyceril trinitrate	Tab. Ramipril, Tab. Perindopril, Tab. Carvedilol, Tab. Enalapril, Tab. Acetylsalicylic acid, Tab. Bisoprolol, Tab. Valsartan, Tab. Amiodarone, Tab. Verapamil and Inj. Verapamil, Tab. Atenolol, Tab. Methyldopa, Tab. Glyceril trinitrate	Tab. Verapamil and Inj. Verapamil, Tab. Bisoprolol,Tab. Amiodarone, Tab. Methyldopa, Tab. Atenolol, Tab. Carvedilol, Tab. Amlodipine, Tab. Enalapril, Tab. Ramipril, Tab. Perindopril,Tab. Valsartan,Tab. Amlodipine+Valsartan,Tab. Acetylsalicylic acid
		Category II	
BE	Inj.pow. Sodium nitroprusside, Inj. Epinephrine	Inj. Epinephrine, Inj.pow. Sodium nitroprusside	Inj. Inosine, Inj. Epinephrine
CE	Inj. Digoxin, Inj. Labetolol, Tab. Nifedipine, Tab. Hydrochlorothiazide, Tab. Propronalol	Inj. Digoxin, Tab. Nifedipine, Tab. Propronalol	Inj. Labetolol, Inj. Digoxin, Tab. Nifedipine, Tab. Hydrochlorothiazide
BN	Inj. Nicardipine	Inj. Nicardipine	-
		Category III	
CN	Inj. Urapidil	-	Inj. Urapidil
Total	**31**	**32**	**33**

Inj.pow. – Injection powder
Inj. – Injection
Tab. – Tablets

Among the Category I medicines, the ANsubcategory, which represents non-essential and costly medicine, includedInj. Urapidil in 2017 and Inj. Nicardipine in 2018. There was no medicine belonged to the AN subcategory in 2016.

4. Discussion

To our knowledge, this is the first study on the management of the CVMs, which are in the EML of Mongolia and used at the CVC. Previously,the Mongolian researchers carried out the ABC-VEN matrix analysis on the Gastrointestinal medicines.

According to the results of this study, although Class A medicines consumed the highest percentage (an average of 70%) of total CVMs expenditures, they occupied the smallest part of the total medicines analyzed at the average of 17.7% over 3 years. This result was identical to the results of the previous studies, since the nature of ABC classification is based on Pareto's principle of "Vital few and trivial many". [5,7,8,11,17,20,23]

In this study we found that, Inj.pow. Alteplase, Inj. Dobutamine and Inj. Dopamine, which are thrombolytic and adrenergic agents were consuming huge amount of the budget (an average of 54% collectively) out of all CVMs' expenditures over the years of 2016-2018 (**Figure 1**). As mentioned in the Introduction part, this is the only one CVC available nationwide. The thrombolytic therapy is carried out quite frequently in this center, given that CVDs, including myocardial and cerebral infarction are the leading cause of mortality and the second reason of hospitalization in Mongolia.[2] This fact suggests that the consumption of thrombolytic agents such as Inj.pow. Alteplase are expected to be high in the CVC, since this therapy is performed only in this center. For this reason, the inventory manager of the CVC needs to pay close attention on the shelf life and stock status of Class A medicines, including these 3 medicines (Inj.pow. Alteplase, Inj. Dobutamine and Inj. Dopamine). Furthermore, the CVC could make savings on its budget by seeking cheaper supplier for the Class A medicines. [4,5]

Certainly the Class A medicines should attract focused attention than the Class B and C items, most of the

medicines of the latter classes were also belonged to the Class V and E. From this study, the vast majority (an average of 68.8%) of the CVMs were classified as vital (Class V) over the 3 years. This finding is matched with the result, in which the average percentage of the vital medicines was 66.08% and was done at the Specialized Hospital in Ethiopia for the years 2009-2013.[17] Conversely, this result differs from the results in the other studies, where the proportion of the Class V medicines was lower than the Class E medicines'.[5,7] The comparison with some previous studies, which were done over 3-5 years is shown in the **Table 3**. It should be noted that the present study has focused only on the CVMs.

Table3. Comparison with previous studies, regarding the average percentages of the different categories.

Category	Present study (2016-2018)	Biruk et al[7] (2015-2017)	Kivoto et al[5] (2013-2015)	Migbaru et al[17] (2009-2013)
A	17.7	15.14	13.7	14.63
B	21.8	22.47	16.5	19.1
C	60.5	62.39	69.8	66.27
V	68.8	31.19	22.8	66.08*
E	24.97	67.43	53.3	19.52*
N	6.23	1.38	23.9	0.18*
I	77	39.91	31	69.14*
II	20.9	59.17	47.7	17.7*
III	2.1	0.92	21.3	0.55*

Some medicines are not categorized in this classification due to the absense in the formulary. Thus total sum is not equal to 100%.

Class V and E medicines should not be out of stock due to its clinical importance for the patient care. [10,11] While these medicines require strict management control, Class N medicines need minimum managerial control regarding their availability.(8,17,20,23) Hence the purchase of Class V and E medicines should be prior to the Class N medicines. There were only 2 medicines: Inj. Urapidil and Inj. Nicardipine that classified as non-essential (Class N) over 3 years in this hospital.

Our study findings showed that most of the CVMs used at the CVC in 2016-2018 were belonged to the Category I(**Table 1**). These medicines are needed to be under strict management control as they are vital and costly. [11,16] Therefore, safety stock should always be maintained to prevent unavailability of the Category I medicines and the status of shelf life should always be monitored.[9,11,15,23]AN subcategory medicines should be investigated precisely. The stock of thesemedicines can be reduced, since they were classified as non-essential yet they are costly. While there was no medicine categorized as AN in 2016, Inj.Urapidil and Inj. Nicardipine were belonged to the AN subcategory in 2017 and 2018 respectively. Appreciably, Inj. Urapidil was re-classified as CN subcategory in 2018, and the purchase of this medicine has reduced in 2018. Since this is a non-essential medicine, it should not be purchased in a large amount.
The Category II (Inj.pow. Sodium nitroprusside,Inj. Epinephrine, Inj. Digoxin, Inj. Labetolol, Tab. Nifedipine, Tab. Hydrochlorothiazide, Tab. Propronalol, Inj. Nicardipine, Inj. Inosine) and III (Inj. Urapidil) medicines require medium and minimum level managerial control respectively. [11,20,14,16] Those medicines can be purchased once or twice a year in order to minimize ordering costs. [9,15,19,23]
Limitations of the study

This study has addressed the management of CVMs only at the CVC. Therefore, the findings cannot be generalizable in the context of the other hospitalsin Mongolia, because of the level of care, the type of the medicines used et cetera. But the concept of ABC and VEN analyses is common for achieving the optimal management of medicines at any health setting.

5. Acknowledgements

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6. Abbreviations

ABC: Always, Better and Control
CVC: Cardiovascular Center
CVDs: Cardiovascular diseases
CVMs: Cardiovascular medicines
EML: Essential Medicine List
MNT: Mongolian tugrik – the official currency of Mongolia
VEN: Vital, Essential and Non-essential
WHO: World Health Organization

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