Home-based Video Module for Balance Exercise (Bal Ex): A Cost Effective tool for Peripheral Vestibular Disorders patient

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Abstract— Bal Ex module video is a fully structured homed-based video and audio guided tool developed to assist Peripheral Vestibular (PVD) patients in their treatment process. We aimed to assess the cost effectiveness of this tool as a guide to health policy makers. Complete CEA was conducted on data set prospectively collected from the ORL Clinic, Hospital Universiti Sains Malaysia in 2016 to 2018. More than 53% of the patient's age above 61 years old diagnosed for having PVD. The patients' health outcome was measured by the modified version of MVVS and the cost involved in treating the related patient was calculated based on activity base costing. The health status of the patient increased by 17% and the cost saving appeared positive after 3 months applying Bal Ex at home. It is clearly demonstrated from the CEA plane. Bal Ex module innovation is a cost effective PVD treatment and align with the Sustainable Development Goal to achieve healthy wellbeing by 2030.

Keywords: PVD, BalEx Module, Cost Effectiveness Analysis

1. INTRODUCTION

Balance Exercise (Bal Ex) module is developed in 2010 by the Otorhinolaryngology team base in Hospital Universiti Sains Malaysia (HUSM), mainly to provide treatment option for balance disorder patients or clinically known as peripheral vestibular disorders (PVD) or vertigo. Balance disorder are amongst the most common reported in older people (Bouccara, D., Rubin, F., Bonfils, P., Lisan, Q. (2018), Shinichi Iwasaki, Tatsuya Yamasoba. 2015). This is a growing public health concern since they put older people at a significantly higher risk of falling. In the Sustainable Development Goals (SDG), which were developed to secure "The Future We Want" for present and future generations was highlighted about maintaining the functional ability that allows you to do the things you value (WHO, 2016). This means preserving both the physical and mental capacity as you age. Therefore, implementing an action plan on ageing and health will contribute to the realization of this ambitious goal.

These symptoms of PVD patient would usually feel their surroundings are moving when they are at rest (no actual movement). Whenever they have severe vertigo, they might feel very nauseated or vomit. Patients also may have trouble walking or standing, and they may lose their balance and fall. Based on the symptoms that being described, vertigo can affects the health status of patients in several manners; it may limit certain head and body movements, and jeopardize professional, domestic, social and/or leisure activities. Autonomy may be lost, resulting in dependence, fear, depression, anxiety, and withdrawal. It seems that peripheral vestibular disorders patient exhibit declining quality of life due to their disability of performing normal activities in life (Yuri Agrawal (2018), Benecke, H et al. (2013), The above mentioned underlying cause should be investigated and treated to lessen the abnormal sensation and to alleviate vegetative symptoms such as nausea and vomiting. The quantitative measurements of the vestibulo-ocular reflex with rotational testing and of the vestibulo-collic reflex with testing of vestibular evoked myogenic potentials. To reduce the symptom immediately, patients need to take medication repeatedly if the symptom re-occurring. This is happening because medication does not cure the symptom. Well acknowledge, PVD can be treated by vestibular rehabilitation (Vincent A van Vugt, Henriëtte E van der Horst, 2017). Patients need to do this at rehabilitation unit at the nearest hospital. Obviously, there are huge health economic burden (Ali S. et al. 2013). The patient has to bear in term of their expenditure to come to the hospital for rehabilitation session. Therefore, as an alternative, Bal Ex module was developed as a home based video module therapy, where

patients just need to do the rehabilitation exercise at home assisted with a complete instruction in the module.

In Hospital USM, a standard of operation (SOP) has required patient come with a complaint of having the symptom mentioned above, need to be assessed and to confirm that is due to the balance disorder. If it is positive, the level of their vertiginous by the Modified Vertigo Malay Version of Symptom Scale (MVMVSS) questionnaire and came back for balance rehabilitations at rehab center according to schedule that being given by rehab center. MVMVSS is a translated from of the Vertigo symptom scale (VSS) by Davies et a.l in 1998. At this center, patient will go through rehabilitation process based on Cawthorne-Cooksey Exercises. After 3 months, the patients needed to come back to the clinic for follow-up. Again, the patient will re-assessed their health condition by using the same measuring tools as before.

The Bal Ex video module had been selected in this study compared other type of video that available online because this is the only video module that being developed to help patients with balance disorders at home. It is a home based video, which is fully structured module comprises of step by step instructions with visual cues of balance exercise to assist patients to achieve the desired recovery. The difference between rehabilitation at rehab center and using Bal Ex module at home is, the exercise in Bal Ex module is based on the Cawthorne-Cooksey Exercises that being improved and strengthen with the 'solat' movement. Moreover, aligned with the demand and multimedia era, Bal Ex is invented in a video form to assist these patients to achieve the desired recovery. It is claimed as a special tool to be used away from clinic that contributes lots of ease for vertiginous patient to utilize. Accomplished with step by step instructions with audio and video-guided cues exhibit such a convenient and practical tool for patient plus value added particularly for disabled patient. Bal Ex is the only home-based video guided balance exercises available in 15 different languages include Malay, English, Chinese, Tamil and Arab. This exercise is consisting of 20 movements which are divided into 3 levels and it is targeting on the specific functions of balance organs. The others video module available online are mostly in English version and not being validated among Malaysia patient. A fundamental challenge remains for Bal Ex is to determine how effective it is in term of benefit and costs elicitation to the related patient that could improve their quality of life (E Grill1,2*, M Müller, T Brandt, K Jahn 2013).

Therefore, this research was specifically focused on evaluating the effectiveness of Bal Ex module in treating patients with PVD in Hospital Universiti Sains Malaysia as part of management for vestibular disorder. The economic evaluation approach was adopted as an integral part of healthcare interventions (Bal Ex complement medical treatment). The aim was to describe, measure and value all relevant alternative courses of action, the resource inputs and consequences. In this study, we conducted cost-effectiveness analysis (CEA) to evaluate the costs and health effects of Bal Ex module. The growing use of CEA to evaluate the costs and health effects of specific interventions is dominated by studies of prospective new interventions compared to current practice and presented in an incremental cost-effectiveness ratio (ICER). The ICER is an analysis that used in CEA to summarize the cost effectiveness of a health care intervention. It is defined by the difference in cost between two possible interventions, divided by the difference in their effect. CEA are often visualized on a plane consisting of four-quadrants, the cost represented on the Y–axis and the effectiveness on the X– axis.

2. MATERIALS AND METHOD

Research activities of an observational prospective cohort study was conducted for 2 years from March 2016 to September 2018 that required two groups of patients identified from daily treatments at ORL's specialist clinic, Hospital USM. The two groups consist of patients using the Bal Ex Module and the second group consists of patients who did not use the Bal Ex Module. The Bal Ex complementation group was recruited from the newly-visit outpatients seeking health treatment at Otorhinolaryngology (ORL) Clinic, Hospital USM and complain of having severe headache. This group of patient was underwent screening for PVD by the clinician in-charge. Patients who positively diagnosed for having PVD was asking for his/her consent to be included in the study. The patient was then, need to complete the MVMVSS form and supplied them with the Bal Ex module. Patient was demonstrated on how to use the Bal-Ex Module and be advised to do the exercise at home. The patients was given an appointment date to come back to the clinic after 3

months. Again, the patient will be assessed their health condition by using the same measuring tools as before (stated below). The cost expenditure committed by patient for the PVD treatment was directly asked to the patient. For the non-Bal Ex patient group, the existing patient who came for follow-up was identified. The information captured from this group were patient's health status progressed based on the MVVSS reading from the clinical profile. The patient was also asked about the financial commitment that the have to bear for seeking treatment for their health problem.

In determining the sample size, the method of comparing means of the two groups was adopted by using the PS Power and Sample Size Calculations software. The average and standard deviation used by the researchers in the sample size calculation is derived from previous studies by Zuraida Zainun et al, in 2012. The sample size calculated for this study generated for each group is 35 patients. The overall sample size for two groups is 70 patients. Given the potential of patients to be removed from the study, 10% additional sample size is included in the sample size calculation for the entire study. Thus, a total of 78 patients are required for this research study.

The cleaned data was further analyzed by using the Statistical Package for the Social Sciences (SPSS) versi 22. Data normality is determined using the p value of the Kolmogorov-Smirnov and Shapiro-Wilk tests. If the p value is less than 0.05, the data is in the form of abnormal distribution while if the p value is more than 0.05, the data in the normal distribution form. The variables examined would be statistically significant if the p-value was less than 0.05 ($p < 0.05$). Descriptive statistics was presented to summarize the socio-demographic characteristics of subjects. Categorical data will be presented as frequency (percentage). Univariate and multivariate analysis will be done. Paired test will be used to compare severity level of vertigo symptoms from the result of pre and post interventions of Bal Ex module by using the score from MVMVSS questionnaires. For severity level of vertigo symptoms analysis, researcher will compare the result of MVMVSS questionnaires for pre and post treatment from both non-Bal Ex user and Bal Ex user. The score of the MVMVSS will determine the patient's severity level of vertigo symptoms. If the score were 0 – 14, its indicated patients were in mild vertigo and if the score were 15 – 28, patients were in moderate vertigo. Patients were in severe vertigo if the score were 29-56. For the Bal Ex user health improvement, their MVMVS score was determined by calculating the difference between pre and post Bal Ex user MVMVS score after 3 months of Bal Ex usage at home. Whereby, for the non-Bal Ex patients, the first three-months of MVMVS score (after initial diagnosed for PVD) was captured from their case note.

The CEA is presented in the form of Incremental cost effectiveness ratio (ICER). It is determined by calculating the cost difference between the two interventions, divided by the difference in computation of health benefits between the two study groups. Similarly with health benefits calculated from pre-and post-intervention differentials and compared between the two interventions involved.

$$\text{ICER} = \frac{\Delta \text{ Total Cost expenditure for Bal Ex and Non-Bal Ex user.}}{\Delta \text{ Total Health Outcome for Bal Ex and Non-Bal Ex user.}}$$

$$\text{ICER} = \frac{\Delta (C_B - C_C)}{\Delta (H_B - H_C)}$$

C_B = Cost expenditure for Bal Ex user.
C_C = Cost expenditure for Non-Bal Ex user.
H_B = Health Outcome for Bal Ex user.
H_C = Health Outcome for Non-Bal Ex user.

3. RESULTS AND DISCUSSION

A total of 39 and 23 patients respectively who were newly screened and confirmed by the specialist for having PVD and those patients who came for follow-up (non-Bal Ex user), at Vertigo Clinic, Hospital USM in 2016 and 2017. The newly screened group of patients had been supplied with the Bal-Ex Module for them to do the exercises proposed in the CD at home at their own convenience. While the follow-up patient was remained with the routine supplied of medication and rehabilitation session. 66.7% of the respondents was female patients and the average age was 61 years old. The patient demographic data is tabulated in Table 1.

Table 1: Respondent's sociodemographic

	Non-Bal-Ex User					Bal-Ex User			
	N	%				N	%		
Male	6	26.1				13	33.3		
Female	17	73.9				26	66.7		
	N	Min	Max	Mean	SD	N	Min	Max	Mean	SD
Age	23	24	71	50.65	13.90	39	30	80	61	13.32

Besides having PVD, the patients were also suffering from other underlying health problems. Hypertension is the highest prevalence suffering by the respondents in this study. Only 30.4% and 20.5% of the non-Bal Ex user groups and Bal-Ex user groups, respectively suffering from PVD without other undelying illness (Table 2).

Table 2: Respondent's health status

Type of health problem	Non-Bal-Ex User		Bal-Ex User	
	N	%	N	%
Hypertension	6	26.1	6	15.4
Athma	1	4.3		
Hypertension and diabetes			4	10.3
Hypertension, diabetes and high cholesterol			1	2.6
Gastric	3	13.0		
Gynea problem			1	2.6
Diabetes	1	4.3	9	23.1
Diabetes and CHD	1	4.3		
Diabetes and high cholesterol			1	2.6
High cholestrol	1	4.3	4	10.2
Migrain	1	4.3	1	2.6
Nerve problem	1	4.3		
High cholesterol and earing problem			1	2.6
Pelvic inflammatory disease	1	4.3	1	2.6
Prostate and back bone problem			1	2.6
None	7	30.4	8	20.5
Total	23	100.0	39	100.0

Most of the non-Bal-Ex and Bal-Ex user's patients in this study are among pensioners or housewife (respectively 43.5% and 74.4%). Only 17.9% still working in government sector (respectively 30.4% and 17.9%) (Table 3).

Table 3: Respondent's occupation

Occupation	Non-Bal-Ex User		Bal-Ex User	
	N	%	N	%
Government	7	30.4	7	17.9
Private	2	8.7	1	2.6
Self employed	4	17.4	2	5.1
Retired/Housewife	10	43.5	29	74.4
Total	23	100.0	39	100.0

The Bal Ex user and Non-Bal Ex users respectively need to spent RM10.76 and RM10.44 out-of-pocket (OOP) money to pay for the treatment at Hospital USM (Table 4). However, the OOP both groups had to bear is not significantly different for PVD treatment at this hospital ($p \geq 0.005$).

Table 4: Respondent's health expenditure

	Bootstrapping on cost treatment for headache						Paired Samples Test *Paired Differences*
	N	Min	Max	Mean	SD	SE	Sig. (*p*)
Non-Bal-Ex intervention	23	0.00	70.00	10.76	4.00	3.75	
Bootstrap[a]	*Lower*			4.10	10.17		
95% Confidence Interval	*Upper*			18.70	25.58		
Bal-Ex intervention	39	0.00	50.00	10.44	17.23	2.76	0.398
Bootstrap[a]	*Lower*			5.18	11.66		
95% Confidence Interval	*Upper*			16.00	20.74		

The measurement of patient's health status was based on MVVSS, measured pre and post intervention with Bal-Ex Module and also the MVVSS for non-Bal-Ex user group (data-mined from the Patient Medical Record Unit for the intervention). These measurement was done by the Specialist at Vertigo Clinic, Hospita Data normality determined from the Kolmogorov-Smirnov and Shapiro-Wilk tests, showed that the p value for is greater than 0.05, so the data is in normal distributed (Table 5).

Table 5: Respondent's health improvement

	Bootstrapping on health improvement					
	N	Min	Max	Mean	SD	SE
Non-Bal-Ex intervention	23	-20	40	17.91	14.61	2.52
Bootstrap[a]	*Lower*			11.48	9.09	
95% Confidence Interval	*Upper*			23.39	18.71	
Bal-Ex intervention	39	-12	79	42.54	18.20	2.86
Bootstrap[a]	*Lower*			36.69	12.98	
95% Confidence Interval	*Upper*			48.08	22.60	

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Based on the Independent T-Test outcome, there was a significant difference between healing scores for patients using Bal Ex and not using Bal Ex tested on significance level p = 0.000. This significant level was smaller than 0.05 (p <0.05) as presented in Table 6.

Table 6: The relationship between Bal-Ex intervention & health outcome.

	Mean (SD)			
Variables	**Bal-Ex**	**Non Bal-Ex**	**T statistics(df)**	***p***
Score	42.54 (18.195)	13.00 (15.738)	7.668	0.000

The entire ICER calculation for both Bal Ex and Non-Bal Ex groups was not significantly different ie p≥0.005 (Table 7). It means that the healing process, along with the costs that the patient had to spent are almost the same between the two groups in this study. However, significant changes occur in PVD patients using the Bal Ex Module in their treatment, where the level of disease symptoms is significantly reduced two-fold compared to the symptom experienced by patients who did not use the Bal Ex Module that measured from the MVVS score. Details can be found in Table 7.

Table 7: ICER for Bal-Ex user and Non-Bal-Ex user.

	Bootstrapping on Individual ICER						
	N	Min	Max	Mean	SD	SE	*p*
Non-Bal-Ex intervention	23	-1.50	6.25	0.500	1.509	0.3194	
Bootstrap[a]	*Lower*			-0.0117			
95% Confidence Interval	*Upper*			1.2417			0.518
Bal-Ex intervention	39	0.00	2.31	0.2313	0.551	0.1139	
Bootstrap[a]	*Lower*			0.0371			
95% Confidence Interval	*Upper*			0.4699			

The CEA outcome distribution is clearly displayed on the CEA Plane (Figure 1 and 2). Patients with the Bal Ex Module and without the Bal Ex Module were majority distributed in the North-Eastern plane, where they were committed with nearly equal medical cost (± RM10). However, the health outcome between both groups are significantly different, where patients without using Bal Ex indicated a low level of health improvement (MVMVSS 40) as compared to patients using Bal Ex (MVMVSS 80).
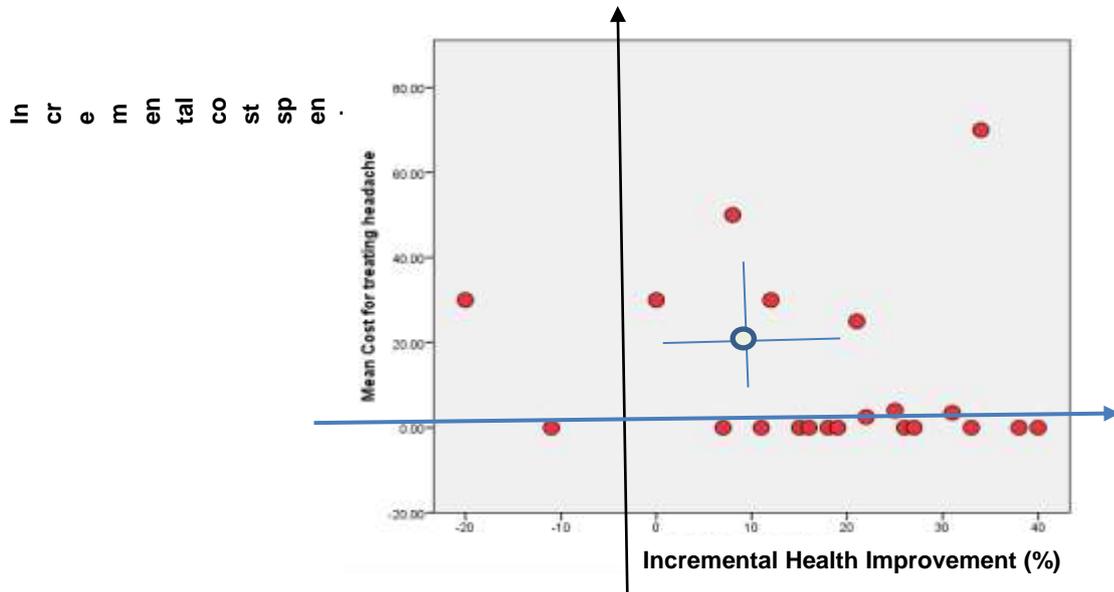

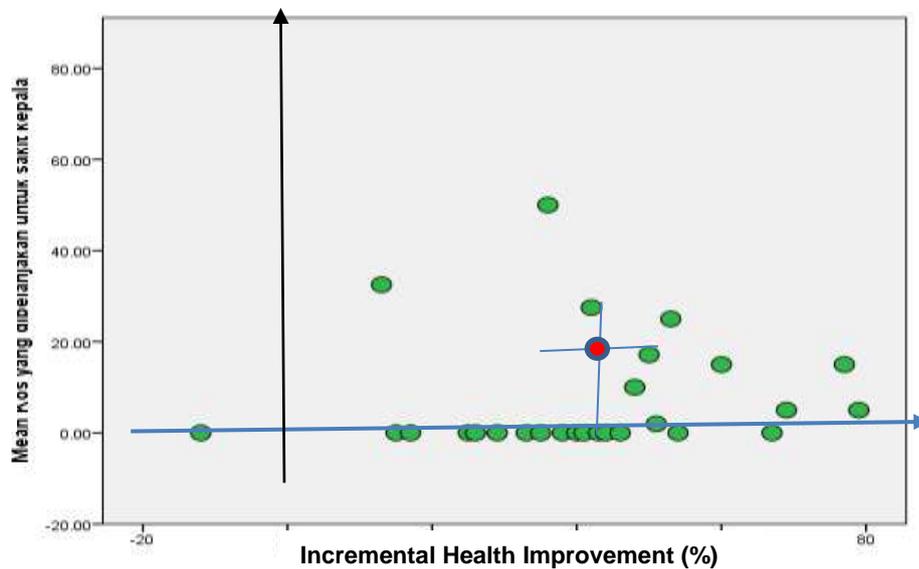Figure 1: CEA Plane for Non-Bal Ex user patient

Figure 2: CEA Plane for Bal Ex user patient

Balance disorder is one of the common problems among elderly and, clinically, the subjective measure for this problem is important. It can cause depression and anxiety to the patients leading to poor health status and they can also loss their job if the symptom is not treated. . Although the management of balance disorder is challenging Symptomatic treatment and various procedures have been described for the rehabilitation of patients with vestibular deficits. The procedure commonly involve repeated head

movements to habituate dizziness, positioning maneuvers to prevent the onset of vertigo, exercises to improve eye-head coordination and the fixation of gaze, and balance retraining therapy. Indeed, physical exercises are proven to improve patients with balance disorders.

4. CONCLUSION

Balance disorder is one of the common problems among elderly and Bal Ex module video is systematically proven cost-effective in treating PVD patients with the same cost expenditure between the patient who did not use Bal Ex module video, but with double effect of recovery for the patient to gain a better quality of life

5. ACKNOWLEDGEMENT

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