Introduction

The term "vertigo" implies a dysequilibrium, an effect of dysfunction of central or peripheral vestibular system. True vertigo usually implies spinning or sensation of rotation. Dizziness broadly includes presyncope, feeling of light headedness, imbalance, and vertigo. It also encompasses other disorders due to cardiovascular, metabolic illness and neurological conditions. It is estimated that about 30% of all people need medical care once in their life due to this index symptom. The neurological expertise required is usually scarce in underprivileged areas. One medical discipline that can be used to make a diagnosis is ophthalmology. The patient’s eye can be examined for spontaneous nystagmus, which is spontaneous, involuntary to-and-fro movement of the eyeball which aids in the diagnosis, can be better elicited by Frenzel glasses, Munich glasses. These devices consist of the combination of magnifying glasses and a lighting system to detect eye movements better than routine examination.

OBJECTIVE: To test usefulness of modified Google cardboard as Frenzel glasses in poor resource setting.

STUDY DESIGN: A modified Google cardboard was used in 52 consecutive cases of vertigo and compared with examination with naked eye. The device consists of 2 magnifying lenses, 1 for each eye with power of +24 dioptres.

OBSERVATION: The tool was found to be better for identifying spontaneous nystagmus, in Dix–Hallpike maneuver and during head impulse test as compared with the naked eye owing to the property of magnification and inhibition of fixation. Being a cheaper alternative and handy, it could be carried by every doctor in any setting.

KEYWORDS: Google cardboard, virtual reality, vertigo, Frenzel glasses, vestibular rehabilitation
are 6 sources of the optical Frenzel glasses that are known. Baxter (cat # Au5050), ICS Medical, Nagashima, Bausch and Lomb (same as Baxter), US Neurologicals (Blessing goggles), and Do it yourself. Another alternative is Munich glasses, which are remarkably cheaper and can be carried in the doctor’s coat and serve the same purpose of detecting nystagmus after suppression of fixation.

Materials and Methods
The Google cardboard (Figure 2) was bought online (less than 10 dollars). The Google Cardboard is a device made by engineers as a prototype to understand and build on Virtual Reality Console. It is essentially a foldable cardboard box with glasses fitted for viewing. One can mount a smart phone on to it and experience a basic virtual reality experience by running VR videos or applications on it. While wearing it on self, the author realized it was inhibiting visual fixation. The power of lens was calculated, which was +24 dioptres, similar to that in Frenzel glasses. The Google cardboard was cut out in such a way that on wearing it, the eyes of the subject were clearly visible (Figure 3).

A prospective study was carried out at a tertiary care hospital after obtaining approval from ethical committee. It aimed at testing usefulness of Google cardboard for identifying spontaneous nystagmus, Dix–Hallpike maneuver, and Head Impulse test as compared with the naked eye. Fifty-two consecutive adult cases of vertigo attending outpatient department in tertiary care hospital were enrolled after informed consent. Two independent doctors examined patients of vertigo by modified Google cardboard and naked eye (the order was changed alternately).

Observations
It was felt by the examining ENT surgeons that the pickup rate of nystagmus was better on using the modified Google cardboard box as compared with naked eye due to magnification and inhibition of visual fixation. Also the modified tool was light weight and small in dimension, enough to carry around in an apron pocket. It was user-friendly for mounting it on subject’s eyes. The drawback is that unlike Frenzel glasses, it does not have an inbuilt lighting system.

Results
The study included 52 patients, 20 male and 32 female patients. The age ranged from 18 to 66 years. All were examined by modified Google cardboard and naked eye by 2 independent doctors alternately. The diagnosis reached was as follows: (1) BPPV—20 patients, (2) Acute vestibular neuronitis—18 patients, and (3) Meniere disease—2 patients. Twelve patients were found to be having imbalance/atypical vertigo secondary to Diabetes Mellitus (DM), Hypertension, Vertebro-basilar insufficiency, and peripheral neuropathy.

It was found that pickup rate of nystagmus was more using the tool used as illustrated in Table 1. Spontaneous nystagmus by head shake test was better elicited in 18 patients of vestibular neuronitis by using cardboard as compared with only 9 patients by naked eye (a gain of 50%). Also 30% of patients of BPPV (6/20) were missed on naked eye examination as compared with Google cardboard (14/20). It was also found that fine nystagmus in patients at recovery stage of vestibular neuronitis was elicited better using the device. The authors felt it to be clinically significant.
Discussion
The Frenzel glasses being expensive, modified Google cardboard VR box can be used as a cheaper alternative to detect nystagmus better. It is useful during head impulse test of Halmagyi, the head shake test, and Dix–Hallpike test at the bedside. This can be used by every doctor in rural settings in developing countries and in less equipped hospitals considering the cost of conventional Frenzel glasses.

The limitations of the study are as follows: (1) the drawback of this device is lack of illumination. Therefore, it has to be used in a well-lit room and cannot be used in a dark room. (2) The number of subjects being very small in subgroups of vertigo, the statistical analysis is not performed. (3) The reliability of the examiners seeing with naked eye cannot be calculated as it is subjective.

Another cheaper modification of VR box made up of plastic with external illumination is studied and researched on to eliminate the shortcomings of modified Google cardboard box.

Conclusions
The modified Google cardboard can be used to detect spontaneous nystagmus in an emergency/bedside setting with better accuracy than naked eye in absence of Frenzel or Munich glasses owing to its property of magnification and inhibition of visual fixation. This will result in better diagnosis of the type of peripheral vertigo and subsequent treatment. A larger study needs to be carried out at multiple centers to validate these results.

Table 1. Pickup rate of nystagmus.

| NYSTAGMUS PICKUP BY | GOOGLE CARDBOARD | NAKED EYE |
|---------------------|------------------|-----------|
| BPPV                | 20/20            | 14/20     |
| Vestibular neuronitis | 18/18           | 9/18      |

Abbreviation: BPPV, benign paroxysmal positional vertigo.

Authors’ Note
The manuscript has been read and approved by all the authors, the requirements for authorship as stated earlier in this document have been met, and each author believes that the manuscript represents honest work.

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Author Contributions
AMY: original idea. Study protocol, study execution. HQ and KJS: technical inputs and manuscript assistance.

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REFERENCES
1. Karatas M. Central vertigo and dizziness: epidemiology, differential diagnosis, and common causes. Neurologist. 2008;14:355-364.
2. Royl G, Ploner CJ, Leitner C. Dizziness in the emergency room: diagnoses and misdiagnoses. Eur Neurol. 2011;66:256-263.
3. Cutfield NJ, Seemungal BM, Millington H, Bronstein AM. Diagnosis of acute vertigo in the emergency department. Emerg Med J. 2011;28:538-539.
4. Singhal BS, Khadilkar SV. Neurology in the developing world. Handb Clin Neurol. 2014;121:1773-1782.
5. Matthias AT, Nagasingha P, Kanasinghe P, Gunatilake SD. Neurophobia among medical students and non-specialist doctors in Sri Lanka. BMC Med Educ. 2013;13:164.
6. Newman-Toker DE. Symptoms and signs of neuro-otologic disorders. Continuum (Minneap Minn). 2012;18:1016-1040.
7. Seemungal BM, Bronstein AM. A practical approach to acute vertigo. Pract Neurol. 2008;8:211-221.
8. Kattah JC, Talkad AV, Wang DZ, Hsieh YH, Newman-Toker DE. HINTS to diagnose stroke in the acute vestibular syndrome: three-step bedside oculomotor examination more sensitive than early MRI diffusion-weighted imaging. Stroke. 2009;40:3504-3510.
9. Turnmeyer AA, Berkowitz AL, Robinson KA, Hsieh YH, Newman-Toker DE. Does my dizzy patient have a stroke? A systematic review of bedside diagnosis in acute vestibular syndrome. CMAJ. 2011;183:E571-E592.
10. Newman-Toker DE, Sharma P, Chowdhury M, Clemons TM, Zee DS, Della Santina CC. Penlight-cover test: a new bedside method to unmask nystagmus. J Neurol Neurosurg Psychiatry. 2009;80:900-903.
11. Halmagyi GM. Diagnosis and management of vertigo. Clin Med (Lond) 2005 March-April;5(2):159-165.
12. Guevarra JR, Chiang CM. Low cost Frenzel goggles (LCVFG). Philippine J Otol HNS. 2004;19:1-2.
13. Strupp M, Fischer C, Hanss L, Bayer O. The takeaway Frenzel goggles: a Fresnel-based device. Neurology. 2014;83:1241-1245.