Nepal's noble echocardiography-database with video clips and color still images: A single individual's 6 years' experience at the Echocardiography lab of Nepal Medical College, Teaching Hospital

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ABSTRACT

Echocardiographic reporting system is very poor in Nepal. No long term feasibility and efficacy data about the echocardiography database with video clips has been studied. Snazzi Movie Studio S4 was used to convert analog video signals into MPEG2 and color photographs were converted into JPEG format for storage and use for the database. All together 2272 patients' echocardiography were performed by one individual prospectively at the Nepal Medical College Teaching Hospital from10th January 2007 to 9th January 2012. Echocardiographic findings of these patients were evaluated. Mean age ± SD were 44.4 ± 28.7 years. Male female ratio was 0.8:1. *Brahman*/*Chhetri* were the usual ethnic group to undergo echocardiography (943, 41.5%), followed by janajati (631, 27.8%) and newar (496, 21.8%). Age group of 60-69 years was the most common echo users (519, 22.8%). Total time for echocardiography/ report writing with database compared to non database was 13.9 ± 2.4 minutes vs. 12. 3 ± 0.8 minutes, p=0.51. Out of all lesions, valvular lesions were the most common lesions detected (4885, 215%). Mild tricuspid regurgitation (1213, 53.4%) was the most common valvular lesion followed by mild mitral regurgitation (742, 32.7%). Patent foramen ovale was the most common congenital heart disease (32, 45.7%) followed by atrial septal defect (12, 17.1%). About one seventh of the total patients (318, 13.9%) had systolic dysfunction. Out of total chronic cor pulmonale (383, 16.9%), severe Pulmonary arterial dysfulction (PAH) was noted in more than one third of the patients (169, 44.1%).

Keywords: Echocardiography, database, video clips, reporting.

INTRODUCTION

Usually video images of echocardiography are stored in video tapes, preferably super video tapes however; digital echocardiography has been developed with lots of advantages over the conventional video tape recording.[1,2] Conversion to digital technology improves efficiency.[3] Even an established digital echo laboratory must be prepared to provide storage at a minimum of two separate sites along with tape back up to ensure guaranteed access to medical information, even in the event of catastrophic failure at one site. Many laboratories that rely heavily on digital imaging still record standard analog videotape as a means of long-term archiving for regulatory purposes.[2] In Nepal, however, a very ancient way of performing data management after performing echocardiography is the usual practice even in the pioneer hospitals like Tribhuvan University Teaching Hospital and the superspeciality hospital like Sahid Ganga Lal National Heart Centre. The recording of the video clips during echocardiography is considered as a wastage of time, energy and material. Hence video images are not recorded in almost all hospitals of Nepal. Reporting system after performing echocardiography is very poor as well.

A noble echocardiography database has been introduced in Nepal Medical College Teaching Hospital (NMCTH), Kathmandu with a permanent storage of the video/ audio/ color still images and addition of the comment of a cardiologist as a complete report of echocardiography.[4] It is the first of its kind that has been partly developed and used in Nepal in real clinical scenario. Short term feasibility and efficacy has been confirmed. No long term feasibility and efficacy information about this database system has been studied on an institutional basis or an individual basis. Here a single individual's 6 years prospective study is reported. This may be an individual's largest and the longest prospective study using this noble complete echocardiography database in Nepal.

MATERIALS AND METHODS

Details of the complete echocardiography database with permanent storage of video recording, still images and reporting has already been published previously.[4]

In short, analog video images and color still images of echocardiographic investigation were transferred into a desk top computer using a locally available imported video capture system, [Snazzi Movie Studio S4: Set up Options (V One Multimedia Pte Ltd, Blk 54 Kallang Bahru # 02-04,

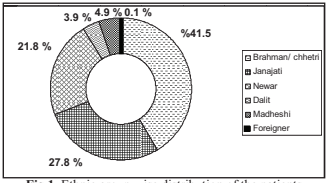

Fig.1. Ethnic group wise distribution of the patients attending echo lab of NMCTH

Singapore 339 336) (www. snazzie.com) for storing video and still images as clips and snaps. Analog video output (S video) and audio output are connected with a computer (video output NTSC) and video signals are converted into MPEG2 (full D1, resolution 720X480), audio signals as MPEG1 and still color snaps are converted into JPEG format. Window media player may also be used to review/ observe/show the video clips. Video clips and color snaps are stored into the hard disk/ external hard disk and are regularly transferred to multimedia devices like DVD/CDs.

Patient information system was developed by a local engineer team with Microsoft programming tool. Microsoft visual Basic 6.0 was used as a front end. It helped user to input data and other required information. As for storage of user input data, Microsoft Access was used as backend data server.

Technique of performing transthoracic echocardiography in adult is as per the recommendation of American Society of Echocardiography.[5-7] Liberal use of sub costal and suprasternal echo windows are used when deemed necessary. In pediatric patients, segmental approach of performing echocardiography has been undertaken for the examination.[8] Echocardiography machine used for this study are LOGIQ 400 MD MR3 Version 4.31 (GE, USA) and Nemio XG (Toshiba, Japan).

All together 2272 patients' echocardiography were performed by one individual prospectively at the NMCTH from10th January 2007 to 9th January 2012. Echocardiographic findings of these patients were evaluated.

Left ventricular ejection fraction (LVEF), left ventricular hypertrophy (LVH), valvular lesions, pericardial effusion and segmental wall motion abnormalities. (without dobutamine stress echo) were evaluated for this study. Diagnosis of LVH was based on previous criteria.[9] Diastolic dysfunction was considered present when A wave was taller than E wave on left ventricular inflow pulsed wave Doppler)[10] LVEF based systolic dysfunction was sub grouped into mild (45-54%), moderate (30-44%) and severe (< 30%).[11]

Pulmonary arterial hypertension was diagnosed when estimated systolic pulmonary artery pressure, derived from tricuspid regurgitation (TR) based trans-tricuspid pressure gradient (4 V2 of TR volicyty, V) + right atrial pressure, RAP (empirically fixed as 10 mm Hg) was more than 36 mm Hg as recommended previously.[12] The PAH was sub grouped into mild PAH (36-45 mm Hg), moderate PAH (46-60 mm Hg) and severe PAH (>60 mm Hg).[13] Data are presented as number and percentage. Paired T test were performed where appropriate and $p < 0.05$ was considered as significant.

RESULTS

All together 2540 echocardiographic examinations of 2272 patients were performed prospectively by a single individual at the Echo-lab of NMCTH during 6 years period from10th January 2007 to 9th July 2012. Echocardiographic findings of these patients were evaluated for this study. Age ranged from 5 days to 97 years, mean ± SD were 44.4 ± 28.7 years. Male/female ratio was 0.8:1**.**

Ethnic groupwise distribution of the patients attending echo lab of NMCTH is shown in Fig. 1. *Brahman/Chhetri* were the usual patients to undergo echocardiography (943, 41.5%), followed by janajati ethnic group (631, 27.8%) and newar (496, 21.8%).

Age and gender wise distribution of patients attending echo lab of NMCTH is shown in Fig.2. More females underwent echocardiography (Male: Female ratio 0.8:1). Greater number of patients underwent echocardiographic examination at the echo-lab of NMC-TH as their age were increased. This trend is noticeable after 40 years. Age group of 60-69 years were the most common echo users (519, 22.8%) followed by the age group of 70-79 yr (439, 19.3 %). Elderly age group (>60 yr) comprised of about half of the total patients (1111, 48.9%). Age group of less than 20 years (usually pediatric patients) under went echo in minimal numbers (104, 4.5%).

Time durations required for performing echocardiography/ report writing for database set-up and non-database traditional echocardiography set up are shown in Fig. 3. Time duration required for performing echocardiography and report writing in database compared to non-database echocardiography was evaluated in small groups of

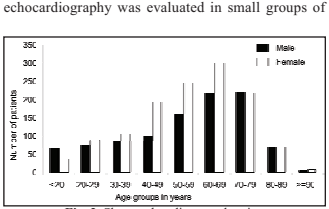

Fig. 2. Shows a bar diagram showing age/gender wise distribution of patients.

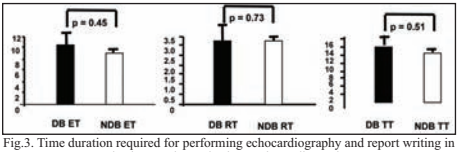

Fig.3. Time duration required for performing echocardiography and report writing in database and non-database echocardiography

(DB ET = database echo time, NDB ET = Non-database echo time, DB RT = database reporting time, NDB RT = Non-database report writing time, DB TT = database total time, NDB TT = Non-database total time)

patients (n = 8 in each group). Use of echo-database did not significantly increased the time duration of echocardiography procedure. Echo duration for database compared to non-database was 10.6 ± 1.8 minutes vs. 9.0 ± 0.6, p = 0.45, time for report writing for database compared to non-database was 3.3 ± 0.9 minutes vs. 3.3 ± 0.3, p = 0.73, total combined time for echocardiography and report writing for echo with database compared to non-database was 13.9 ± 2.4 minutes vs. 12. 3 ± 0.8 minutes, p= 0.51.

Echoardiographic findings are shown in Table-1. Total lesions (8552) were more than total patients (n=2272)

Table-1: Lesion- wise distribution of all echocardiographic diagnoses.

Diagnosis	n. (%)
VHD	4885 (215)
PAH	683 (30.1)
LVSD	322 (14.2)
LVDD	820 (36.1)
LVH	570 (25.1)
CHD	70 (3.1)
CAD	50 (2.2)
Aortic aneurysm	21 (0.9)
PA dilatation	3 (0.1)
PE	220 (9.7)
Cor pulmolmonale	383 (16.9)
DCM	145 (6.3)
Mass #	56 (2.5)
Valvular thickening *	263 (11.6)
Post op	4 (0.2)
NAD	57 (2.5)
Total	8552 (376.5)
Patients	2272 (3.8 lesions/ patient)

(Abbreviations: VHD: valvular heart disease; PAH: pulmonary arterial hypertension; LVSD: left ventricular systolic dysfunction; LVDD: left ventricular diastolic dysfunction; LVH: left ventricular hypertrophy; CHD: congenital heart disease; CAD: coronary artery disease; PA: pulmonary artery; NAD: no abnormality detected)

#Both intracardiac (e.g. myxoma, LA, LV clot, vegetation) and extracardiac masses (mediastinal lymphadenopathy, bronchogenic carcinoma) were included

*All vavlular thickening, calcification, mitral annular calcification and aortic sclerosis are included in valvular thickening.

as a single patient could have more than one lesion (3.8 cardiac lesions/ patient). Out of all lesions, valvular lesions were the most common lesion detected (4885, 215%) followed by Left ventricular diastolic dysfunction (LVDD) (820, 36.1%) and pulmonary arterial hypertension (PAH) (683, 30.1%) which included PAH due to chronic cor pulmonale, valvular heart disease, VHD and dilated cardiomyopathy, DCM.

Valvular lesions as diagnosed with echocardiography are shown in Table-2. There were 4885 valvular lesions in total patients (n=2272) or 2.2 valvular lesions per patient. Mild tricuspid regurgitation, TR (1213, 53.4%) was the most common valvular lesion followed by mild mitral regurgitation, MR (742, 32.7%), mild pulmonary regurgitation, PR (651, 28.7%) and mild aortic regurgitation, AR (512, 22.5%).

Congenital heart disease, CHD as diagnosed with echocardiography are shown in Table-3. Patent foramen ovale (PFO) was the most common lesion (32, 45.7%) followed by ASD (12, 17.1%) and VSD (7, 10%).

Various grades of systolic dysfunction (LVEF) is shown in Fig. 4. About one seventh of the total patients (318, 13.9%) had systolic dysfunction, ranging from mild (126, 5.4%) to severe dysfunction (75, 3.3%).

Pulmonary arterial hypertension, PAH based on echocardiographically estimated systolic pulmonary arterial pressure-wise distribution of chronic cor pulmonale patients (383, 16.9%) are shown in Fig. 5. Severe PAH was noted in more than one third of the patients (169, 44.1%). These PAH data represent a fraction of total PAH due to various diseases e.g. VHD, DCM and chronic cor pulmonale.

DISCUSSION

Digital echocardiography has emerged as a better technique of performing echocardiography and quickly replaced the conventional video tape recording/evaluation. It has lots of advantages over the conventional video tape recording.[1-3]

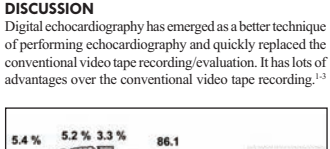

Fig. 4. Left ventricular ejection fraction (LVEF) - wise distribution of patients

Table-2: Valvular heart disease, VHD as diagnosed in echocardiography

Lesions	n. (%)
AR Trivial	139 (6.1)
AR Mild	512 (22.5)
AR Moderate	23 (1)
AR Severe	5(0.2)
AS Mild	29 (1.3)
AS Moderate	9 (0.4)
AS Severe	11(0.5)
MR Trivial	546 (24)
MR Mild	742 (32.7)
MR Moderate	90 (3.9)
MR severe	1 (0.04)
Mild MS	12 (0.5)
MS Moderate	14 (0.6)
MS Severe	15 (0.7)
TV Hypoplastic	1 (.04)
TR Trivial	435 (19.1)
TR Mild	1213 (53.4)
TR Moderate	115 (5.1)
TR Severe	5 (0.2)
PR Trivial	307 (13.5)
PR Mild	651 (28.7)
PR moderate	2 (0.1)
PS Mild	6 (0.3)
PS moderate	2 (0.1)
Total	4885 (2.2 lesions/ patient)
Patients	2272

(Abbreviations; AR: aortic regurgitation; AS: aortic stenosis; MR: mitral regurgitation; MS: mitral stenosis; TR: tricuspid regurgitation; PR: pulmonary regurgitation; PS: pulmonary stenosis)

Development of Digital Imaging and Communications in Medicine, DICOM standard compatible echocardiography machines for storing video images digitally and practice of paper less and tape less echocardiography has not reached the clinical practice scenario in Nepal because these machines are very costly. Technique of transferring analog video signals and color still photographs from echo machine to a high power desk top computer and permanent storage of these video clips/ snap shots in digital formats and incorporate them in a locally constructed database for using a complete echo-database system has been introduced in NMCTH as the first of its kind for the use in the real practical scenario in Nepal.[4]

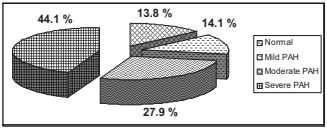

Fig. 5. Estimated systolic pulmonary artery pressure- wise distribution of total chronic cor pulmonale patients

Video tape interpretation is inferior in terms of cost and time effectiveness in comparison to digital video clips stored.[14,15] To overcome the problem of storage, concept of data compression have been attempted without impairing the image quality.[16] Acceptable image quality preservation by data compression in MPEG4 format has been achieved by Umeda *et al*[17] and in MPEG 1 format by others.[18] Similarly compression of still color photographs data without deteriorating the image quality has also been achieved.[19] Video files were saved in MPEG2 for this study as per the availability in the local market. According to the manual of the software, MPEG2 format has better resolution (720X480) than MPEG1 and is DVD compatible.[20] The clarity of video and color still images are quite good and are almost equivalent to the analog images in the monitor of the echo machines.

People have practiced the transfer of the video signals from remote hospitals to referral centers and utilized the concept of telemedicine in foreign countries.[21-23] With this present technique of video clips and snap shots storage and data management, such practice of telemedicine is now feasible for echocardiography in Nepal.

The report system with vivid video clips, color snaps are quite useful to explain patients about their disease as well. Academic and research potential of such database is enormous. Development of the Echo library in NMC-TH has been achieved in reality now. The echo-database is a very useful research tool and has aided in several published scientific publications[4,24] and ongoing researches.

Table-3: Congenital heart disease, CHD as diagnosed in echocardiography.

CHD	n. (%)
PFO	32 (45.7)
ASD	12 (17.1)
VSD	7 (10)
Bicuspid AV	6 (8.6)
Dextrocardia	5 (7.1)
Tetralogy of Fallot	2 (2.9)
PDA	2 (2.9)
Epstein anomaly	2 (2.9)
Coarctation of aorta	1 (1.4)
PLSVC	1 (1.4)
Total	70 (100)

(Abbreviations: CHD: congenital heart disease; PFO: patent foramen ovale; ASD: Atrial septal defect; VSD: ventricular septal defect; AV: aortic valve; PDA: patent ductus arteriosus; PLSVC: persistent left superior venacava)

Observation of higher number of female patients undergoing echo study is a bit strange in male dominated Nepalese society as male gets better attention and treatment opportunity. Demographics of Nepal showed more females in general population[25] with male female ratio in the year 2012 of 0.88:1 in the age group 25-54 years, 0.95:1 in the age group of 55-64 years and 0.87:1 in the 65 years or above age group.[25]

The higher number of females patients undergoing echocardiography may be due to higher incidence of valvular heart disease like mitral stenosis in females. Similar finding has been previously reported by Sayami *et al*.[26] Female preponderance in mitral stenosis has been documented almost as two third of cases in other studies as well.[27,28]

Exposure of both passive and active smoking and domestic pollution may have resulted in higher number of chronic obstructive pulmonary disease (COPD) and corpulmonale in elderly females. There were 383 (16.9%) chronic cor pulmonale with male female ratio of 0.6:1 (Table-1). This finding is similar to our previous study.[24] Higher prevalence of cor pulmonale in female has been reported previously as well.[29] It may be one of the contributing causes of higher number of female patients undergoing echocardiographic studies.

Higher number of Brahman/chhetri could be due to the increased awareness. Greater number of *janajati* ethnic group (previously called as Mongolians such as *Tamang*, *Sherpa*, *Gurung* etc) may be due to the accessibility of these ethnic groups who have been migrating and densely populating in the surrounding villages nearby NMCTH.

Greater number of patients underwent echocardiographic examination at the echo-lab of NMC-TH as their age were increased. This finding is similar to previous study[4] however, sub grouping of age groups were a bit different in that paper. This trend was especially apparent after the age of 40 years, when several chronic diseases like hypertension, diabetes, ischemic heart disease starts manifesting. Elderly people (>60 years) comprised about half of total patients (1122, 48.6%). Increased prevalence of several co morbid diseases such as hypertension, heart failure, diabetes, chronic kidney disease etc in elderly age group may have resulted to this finding.

Our efforts have been to prepare a good standard echocardiography procedure and reporting as per the recommendations of American Society of Echocardiography.[30] Naturally, it will demand good time duration for it. Time for echo duration, report writing and total combined time duration for echo-database as evaluted in small groups of patients (n=8) is not excessively increased in comparison to non-database echocardiography (Fig. 3). This should encourage other hospitals and clinic to start this database to upgrade their echocardiography and traditional hand written data management. Use of recent DICOM compatible expensive echocardiography machines with similar database may also be an option.

Total number of patients undergoing echocardiographic evaluation at echo-lab of NMCTH is quite good and is almost equal to previous data of Tribhuvan University Teaching Hospital at the time of peak of its performance with few cardiologists similar to this hospital.[29]

Normal echo findings (2.5%) in this study is less than in some previous findings.[29] Their report of 20% normal echo study is higher than our finding (2.5%). One contributing factor for a bit higher incidence of normal study in that study may be due to the use of old echo machine without color Doppler at that time. Better machines may detect minimal lesions and may have resulted to this finding. Better effort by better trained personnel may also have contributed to this result.

This study also has included many physiological regurgitant lesions even if they were trivial or minimal in grade. Attempts have not been made to differentiate physiological with pathological regurgitant lesions. This may have been one important cause for having very low normal echo finding rate in this study. The prevalence of physiological valvular regurgitation in normal people have been reported to have varied by valve: MR was present in 2.4-45% of normal individuals[31,32] AR in 0-33%[31,33], TR in 6.3 – 95%[31,34] and PR in 21.9-92% of normal individuals.[31,33]

Rheumatic fever and rheumatic heart disease are important health problems with more morbidity and mortality in developing countries (Mortality per 100000 was 1.8 in WHO regions of Americas in comparison to 7.6 in WHO South- East Asia Regions).[35]

There has been dramatic decline of incidence of rheumatic fever from 100 to 200 cases per 100000 populations to 0.5 per 100000 populations in the past century in developed country like USA and the sharp decline has been observed especially after the introduction of antibiotics.[36]

The incidence of RHD among Nepalese school children has been reported as 1.0/1000 to 2.3/1000 [37-39] RHD has been the leading cause of hospital admission (27.3% among admitted cardiovascular diseases in Shahid Ganga Lal National Heart Centre. It is the second commonest cause of open heart surgery in Nepal.[40]

This study showed less severe forms of various regurgitant lesions in comparison to previous papers.[4] Many echocardiologists have the tendency to use length of valvular regurgitant jet (e.g. in AR) for grading it rather than the recommended criteria of using the width of AR

jet.[11,41] Similarly length of MR jet may have been used by many echocardiologists in stead of using the concept of regurgitation area in comparison to left atrial area mimicking regurgitant fraction as per recommendation.[11,41] In special condition such as eccentric regurgitant jet of MR hitting left atrial wall will not show the exact regurgitation jet area in comparison to another MR jet which is not hitting left atrial wall. In this condition, grade of MR may be upgraded by 1 grade (as practiced in Tokyo Women's Medical University, The Heart Institute of Japan). Many echocardiologists may be just concentrating on regurgitant jet only and not on the implication of this jet in the form of left atrial size or left ventricular size. It may be unusual or unlike to have severe AR but size of left ventricle being normal or severe MR but size of left atrium being normal. We should evaluate carefully considering all these issues. Similarly when the echocardiographic windows were suboptimal, commenting on grades of regurgitant lesion or stenotic lesions may not appropriate. Regarding the regurgitation grades, single individual's data may be more accurate as it is free of inter-personel variation which may be significant when there are many people in a hospital but have training from different national and international centres. Use of three dimensional modern expensive echocardiographic machines will minimize these problems of interpersonal variations. Working together to develop unanimous approach will be beneficial for standardization.

Valvular lesions (Table-2) in this study showed MR and AR as common lesions. These lesions, MR and AR were reported as common valvular lesions in other paper as well.[42,43] Among congenital heart diseases (Table-3), PFO and ASDs were common lesions detected. Similar data with ASD being the most common congenital heart disease has been reported.[43] In another study VSD was reported as the most common congenital heart disease. [44]

Echocardiography is very useful tool to detect systolic dysfunction. One seventh (13.9%) of the total patients had systolic dysfunction (Fig. 4). Even among COPD patients, significant proportion of patients were reported previously to have systolic dysfunction.[24]

Doppler echocardiography has been useful noninvasive tool to estimate systolic pulmonary artery pressure.[12,13] Echocardiography based estimated systolic pulmonary artery pressure PAP have some over estimation of PAH approximately 10mm Hg.[14] Our estimated systolic PAP may also have some overestimation in comparison to right heart catheterization based values. For simplicity, we have used RAP fixed at 10 mm Hg as per our day to day practice. For better accuracy, RAP based on echocardiographic features of inferior venacava, IVC (complete collapse means RAP 5 mm Hg, partial collapse means RAP 10 mm Hg and no collapse means 15 mm Hg).[44,45] Though, evaluation of IVC is not done routinely, sub costal views of a group of patients (poor transthoracis echo windows evaluated with subcostel view) showed partial collapse of IVC in majority of patients, suggesting our fixed RAP 10 mm Hg is not too overestimation (personal observation) however, routine evaluation of IVC in all patients with high PAP is definitely better approach. Further prospective study is necessary to evaluate the degree of collapse of IVC in sub costal approach in all patients with PAH would be necessary to confirm whether our approach of using RAP 10 mm Hg is appropriate or not.

Estimated systolic PAP has been found to range from 16.5 to 158.5 mm Hg in this study. Severe PAH was found in about half of patients with chronic cor pulmonale (Fig. 5). Similar finding has been noticed in previous paper.[24] That study had used empirical classification 40-60, 60-80 and > 80 mm Hg as mild, moderate and severe PAH. Well accepted classification of echocardiography based estimated systolic PAP was not available at that time and till this date classification of PAH based on echocardiography has been variable. Classification of PAH used for perioperative purpose has been used in this study.[13] Some have classified estimated systolic PAP < 45 mm Hg as mild (as per the classification used in this study).[13] However, WHO symposium on PPH in 1998 had classified 40-50 mm Hg as mild PAH.[46]

This database with digital video clips, color still photographs and comment report are not very expensive but demands minimal extra time and energy. It has been feasible on a short term basis.[4] Long term feasibility of this complete echo- database has been confirmed on individual basis in this study. It may be used as a good and complete echocardiography in an individual clinical set up on long term basis.

ACKNOWLEDGEMENTS

I would also like to thank Dr. Phanindra Kafle, PhD (Sociology), lecturer of the Community Medicine department of Nepal Medical College (NMC) and Mr. Prem Raj Panta, (Statistics) Lecturer Community Medicine department of Nepal Medical College (NMC). I am greatly indebted to Mrs. Mani Jirel for her kind cooperation and help.

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