Prof. T. Varagunam Oration*

Blood pressure beyond numbers: An experimental analysis

Kumanan T[1]

[1]Professor and Chair, Department of Medicine, Faculty of Medicine, University of Jaffna, Sri Lanka

Article Information

Corresponding Author
T Kumanan
Email: tkumanan@univ.jfn.ac.lk

https://orcid.org/0000-0001-5735-4713

https://doi.org/10.4038/sljms1.v1i2.35

Conflicts of Interest: None

Introduction

The concept of high blood pressure and its lethal consequences to the human body has a long historical journey.

It began in the year 1628, when William Harvey an English physician in a 72-page publication titled "On the Motion of the Heart and Blood" introduced the concept of the circulation of the blood. However, it took another 100 years until the concept of "blood pressure" was recognized. This year – 1733 – therefore needs to be celebrated as the golden year in the history of hypertension. It was then that, not a physician, but an English man of cloth, Stephen Hales, invented a manometer and made the first published measurements of arterial blood pressure in a female horse.

Figure 1. Stephen Hales.

Cite this article as: Kumanan T. Blood pressure beyond numbers: An experimental analysis SLJMS 2024; 1(2): 58-70

**Presented at the Annual Academic Sessions of the Sri Lanka College of Internal Medicine on 7th November 2024.*

Stephen Hales was an extraordinary individual, who was multifaceted and was able to cross the boundaries of the humanities, physical and biological sciences. It is of relevance today as the practice of medicine begins to cross multiple boundaries across advanced technologies involving biotechnology, digital platforms and artificial intelligence. Perhaps the future of healthcare will indeed need more of the multifaceted skills of Stephen Hales!!! The other interesting observation was the description of measuring the blood pressure in his experimental animal, probably without the use of any anaesthesia, something which would be totally unacceptable in today's environment and rightly so. Animal experimentation, which is an essential part of scientific advance needs to be balanced with appropriate precautions on animal welfare. Regulations and ethics are the guardians of scientific advances but need to be managed without stifling innovation.

Measuring blood pressure

Blood pressure is not just a set of numbers. It is a physiological variable that has a considerable pathological impact on various vital organs without producing any symptoms. Hence, it is known as a silent killer. However, its impact on human health is dependent on medical practitioners determining with care the accuracy of its numbers and hence the accuracy of its measurements.

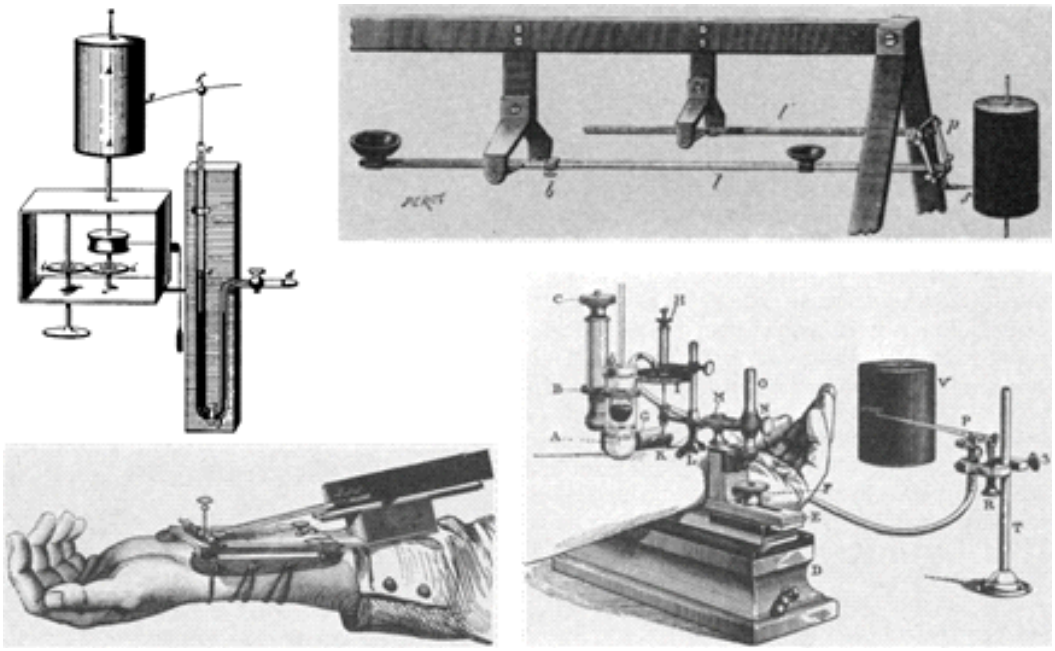

Figure 2. Development of sphygmomanometers over the time
(Courtesy: Proc.roy.Soc.Med.Volume70 November1977).

It is surprising to note that the history of blood pressure measurement has begun with an invasive intra-arterial monitoring in an animal by Hales. Since then a number of clinicians and scientists toiled themselves to improvise the method of noninvasive blood pressure monitoring and ultimately designed the most popular mercury sphygmomanometer that we all utilized and considered to be the gold standard in measuring blood pressure until the beginning of the 21st century. Due to various reasons, it is no longer considered the gold standard and vastly replaced by oscillometric devices, which are more precise, independent of observer variation and easy to employ for self-monitoring. It is also environmentally friendly as it is devoid of mercury.

Figure 3. Aneroid sphygmomanometers and oscillometric devices.

Aneroid sphygmomanometers function on the same auscultatory principle as mercury manometers and are in common use in Sri Lanka. Even though considered cost-effective and safer than mercury manometers, they need calibration checks and are less accurate. A major cause of departure from calibration is the mechanical jarring that is frequently observed in our hospital settings.

The function of the oscillometric devices is based on a completely different principle. The oscillogram is measured, and blood pressure is then estimated via an empirical algorithm using various mathematical models. It does not measure the blood pressure directly as in a mercury sphygmomanometer.

Blood pressure and elders

Since blood pressure and its impact increases with age, it is important to consider the consequences of aging. Studies have shown that brachial artery diameter increase with age is more pronounced in women than in men and in contrast to the well-known decrease in arterial compliance of elastic arteries with age, brachial artery compliance is not decreased with age but even increased in women.[1] To understand whether these changes would have a significant impact on blood pressure measured using different instruments in elders, an observational study was conducted in the medical wards of Teaching Hospital Jaffna.[2]

Table 1. Mean blood pressure readings of the right and left arm by both methods (paired samples descriptive statistics)

Pair	*Variable*	*Mean*	*SD*	*SEM*	*P-Value*
Pair 1	MSR-OSR	–4.18	12.44	0.87	0.00
Pair 2	MDR-ODR	1.67	8.86	0.62	0.01
Pair 3	MSL-OSL	–3.66	12.84	0.90	0.00
Pair 4	MDL-ODL	1.64	8.88	0.62	0.01

The study compared the systolic and diastolic blood pressure in both arms in elderly patients by mercury sphygmomanometer and oscillometric recorders adopting the standard practice of measuring blood pressure in 204 elderly patients aged more than 60 years. The study group consisted of 54.3% males and 45.7% of females. The mean age of the study group was 69. 46 years. The mean systolic blood pressure (SBP) by oscillometric recorder on both right and left arm was 4.18mmHg and 3.66 mmHg higher than mercury sphygmomanometer readings. The mean diastolic blood pressure (DBP) by oscillometric recorder on both right arm and left arm was 1.67 and 1.64 mmHg lower than mercury sphygmomanometer readings. There was no significant difference in inter-arm blood pressure measurements. Although there is no much difference observed in the gross values in reading the blood pressure by both oscillometric recorders and mercury sphygmomanometers, there is a statistically significant discrepancy in blood pressure readings in the elderly population which needs to be studied further in detail.

Table 2. Comparison of systolic and diastolic blood pressure by both devices (paired samples test)

PR	*N*	*OSR*	*ODR*	*OSL*	*ODL*
PR less than 72	44	131.89	69.61	129.05	69.30
PR more than 72	160	132.59	73.65	132.16	73.31

This finding is on par with the concept of pseudo hypertension in the elderly as described by William Osler. Non-compressibility artery syndrome or Osler' sign of pseudo hypertension is a falsely elevated blood pressure reading obtained through sphygmomanometry due to calcification of blood vessels, that cannot be compressed. It could be reaffirmed by Osler maneuver a simple bedside clinical examination.

To perform the test, the blood pressure cuff should be inflated above systolic pressure to obliterate the radial pulse and then attempts to palpate the radial artery; a positive test is if it remains palpable as a firm "tube". However, pseudo-hypertension is no longer considered as a benign phenomenon and it carries significant risk of cardiovascular mortality. It represents the entity of isolated systolic hypertension of the elderly.

Figure 4. Locomotor brachialis.

Brachial artery thickness could also be inferred by simple observation of the medial aspect of the arm in the elderly. "Locomotor Brachialis" is yet another neglected physical sign often observed in the elderly that refers to a dilated, thickened, tortuous and pulsatile brachial artery, usually associated with atherosclerosis and long-standing hypertension. The presence of this invaluable physical sign could warn the healthcare professional of the possibility of pseudo-hypertension as well. We highlighted the importance of picking up this invaluable bedside physical sign by a letter to the editor of the *Ceylon Journal of Medical Science* under the title of "Locomotor Brachialis: A clinical peep into atherosclerosis and hypertension mediated organ damage in the elderly".[3] The junior doctors and the allied health staff involved in blood pressure measurements should be made aware of this physical sign that could be simply observed while wrapping the blood pressure cuff.

Norman Kaplan, who is considered to be the godfather of hypertension of this era. He said that "The measurement of blood pressure is likely the clinical procedure of greatest importance that is performed in the sloppiest manner". Standard protocols for measuring blood pressure recommended by the scientific committees are often not adhered to in most circumstances. Several reasons could be attributed to this important drawback in clinical practice. In a country like Sri Lanka constraints in infrastructure facilities, suboptimal human resources and inadequate knowledge and awareness regarding blood pressure measurement greatly account for this major pitfall. The measurement of this most important biological value is often overlooked in the undergraduate curriculum and even during postgraduate training. Medical educationists and clinical teachers in day-to-day practice should take this appeal seriously and take necessary steps to uplift the standards and quality of blood pressure measurements.

Despite the presence of inadequacies that are inherent to the current performance of office readings, they will continue to be widely used. It is therefore important to identify and minimize the errors that may be encountered. The common errors while taking office blood pressure could be related to patient conditions, equipment, and the technique.

Generally, it is recommended to avoid taking caffeine and not to smoke at least for half an hour before measurement. The posture of the patient is considered an important factor in measuring blood pressure. The patient should sit comfortably with the arm bared and supported at the level of the heart and the back resting against a chair. The legs should be uncrossed and the feet should touch the ground. A standing BP is a must in elderly, long-standing diabetics and those who are on multiple antihypertensive medications.

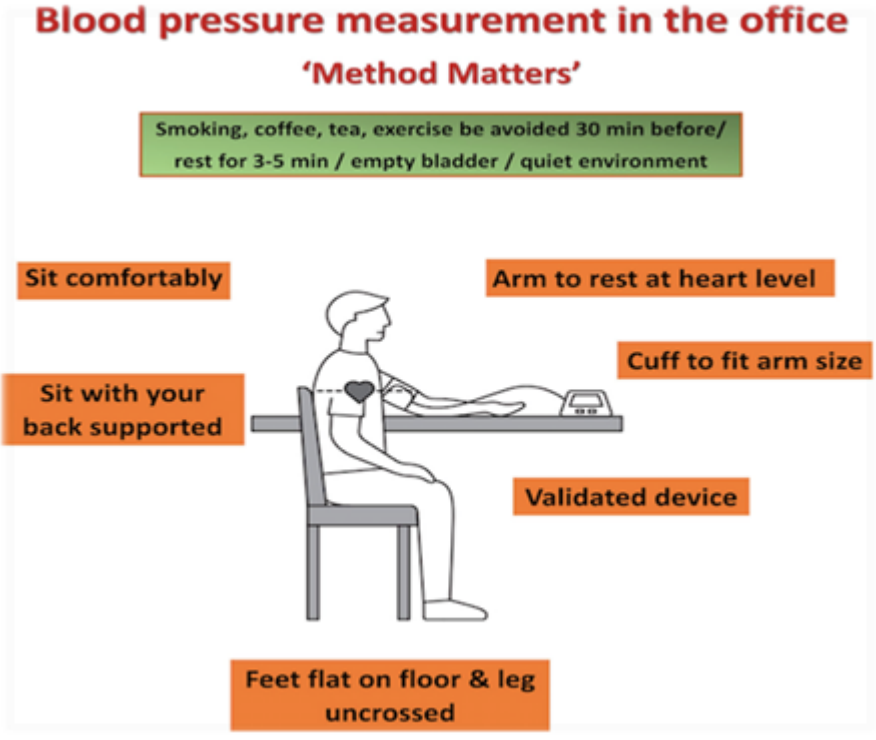

Figure 5. Factors to be considered while measuring blood pressure.

When the equipment is considered the common pitfalls identified are an inappropriate cuff size and uncalibrated equipment. As far as the technique is concerned, the number of readings has taken matters a lot. At least two readings are to be taken on a routine visit, and for the purpose of diagnosis, it should be done on two occasions at least one week apart.

Both arms' blood pressure should be taken during the initial encounter to identify any inter-arm blood pressure differences. If the reading is higher in one arm, that arm should be used for future measurements. The common causes for significant discrepancy include severe peripheral vascular disease, subclavian steal syndrome, and stroke. The discrepancy itself is considered an independent risk marker of cardio-vascular morbidity.

Record of Korotkoff sounds at phase 1 and 5 are considered for systolic and diastolic blood pressures respectively. The main disadvantage of manual blood pressure measurement utilizing Korotkoff sounds is human error, which may include an improperly placed sphygmomanometer stethoscope, or missed Korotkoff sounds due to background noise or inattention by the observer. Depending on the stiffness and thickness of the arterial wall, auscultatory readings may be subjected to error. Studies have shown that errors as significant as 30 to 50 mmHg are not uncommon in the elderly or those with advanced arteriosclerosis. Increased arterial stiffness has been shown to overestimate the systolic blood pressure compared to those patients with more compliant arteries.

Knowing the importance of accurate blood pressure measurement in clinical practice, a study was designed to evaluate the knowledge regarding blood pressure measurement among junior doctors, and intern medical officers under the title "Knowledge regarding the accurate measurement of blood pressure among intern medical officers practicing at three teaching hospitals in Sri Lanka".[4]

A total of seventy-nine (79) intern medical officers from the National Hospital of Sri Lanka, Teaching Hospital, Kandy and Teaching Hospital, Jaffna were recruited for the study. The study revealed that knowledge regarding accurate measurement of blood pressure among newly qualified doctors was suboptimal. In particular, the participants' knowledge is extremely poor in selecting the correct arm for future measurements, and the effect of incorrect positioning of the patient. The majority of them were not aware of the waiting time and the required number of readings as well.

The study again reiterates the fact that junior doctors should be motivated to improve their knowledge and skills of blood pressure measurement through regular in-service training.

Blood pressure targets

According to the World Health Organization's statistics, an estimated 1.28 billion adults aged 30-79 years worldwide have hypertension and most importantly two-thirds of them live in low- and middle-income countries. An estimated 46% of adults with hypertension are unaware that they have the condition and less than half of adults (42%) with hypertension are diagnosed and treated.

As with most biological parameters, blood pressure is a continuum. A rise in blood pressure with age is a physiological phenomenon and drawing a cutoff limit between physiological and pathological values of blood pressure has always been a subject of debate!

Ever since the landmark SPRINT trial which compared Intensive versus standard blood pressure control was published in 2015, most of the international guidelines abide by the results and brought down the treatment targets. Sri Lanka is not an exception. According to a Sri Lankan study published in the *Global Heart Journal*, the overall weighted prevalence of hypertension among all Sri Lankan adults was 28.2% using the JNC7 definition, which almost doubled to 51.3% using the ACC/AHA 2017 definition.[5] We have expressed the consequences of this in a letter to *British Medical Journal* in 2019. In the letter, we highlighted the fact that healthcare systems in resource-poor countries will be negatively affected by lowering these thresholds. The focus of healthcare investments in many low- and middle-income countries has been on secondary and tertiary care institutions, while primary care systems remain poorly developed, leading to delays in diagnosis and suboptimal management of hypertension. Non-adherence to antihypertensive drugs is also a serious public health issue. Further lowering of the thresholds for diagnosis and treatment will expand the pool of "patients with hypertension," which has major resource implications. None of the guidelines consider two important issues for populations in resource-poor settings – the risk of harm and the net benefits over harm.[6]

Office versus out of the office measurements

The cut-off values for hypertension greatly depend on the place in which the blood pressure is measured. In other words, whether the blood pressure is measured in the office (OBP) (health institution) or out of the office (AOBP) (home). This also depends on the apparatus, whether an automated /mercury sphygmomanometer is used or an ambulatory blood pressure monitoring (ABPM) is employed. By coupling both the office and out-of-the-office methods there are four possible groups of patients could be identified.

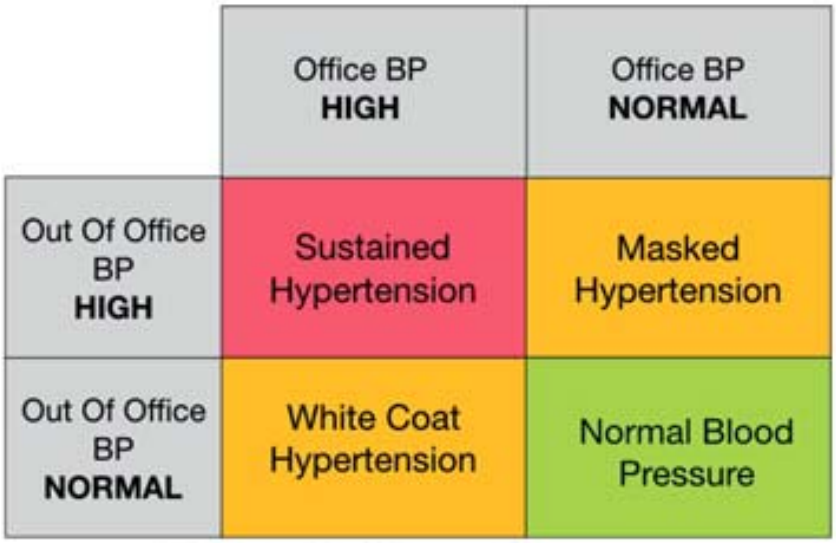

Figure 6. Classification of blood pressure (BP) subtypes by combination of clinic – office BP and out-of-office BP.

a) Sustained hypertension – found to be hypertensive by both methods

b) White coat hypertension – only the office readings are elevated

c) Masked hypertension – only the out-of-office readings are elevated

d) Normal blood pressure – high blood pressure excluded by both methods.

India heart study, a large multicenter study published in 2020 was aimed at investigating the agreement between office blood pressure measurement (OBPM) and self (S)BPM in a hypertension-naive population. It has been found that 42% are at risk of misdiagnosis of hypertension due to office blood pressure readings. On the other hand, masked hypertension may go undiagnosed running the risk of complications of heart, brain and kidneys leading to premature mortality.[7] The results of the study reemphasized the need for out-of-office blood pressure monitoring to diagnose hypertension. Even though ABPM is considered the gold standard of blood pressure measurement, it has its limitations.

The BP-CHECK study 8 found that there is no place like home to diagnose hypertension. It further says "From a patient-centered perspective, home BP monitoring is the most acceptable method for diagnosing hypertension, although participants were willing to complete ABPM and appreciated its accuracy."

In the Sri Lankan context, considering multiple factors such as work overload at clinics, and limited access to new technology that contribute to suboptimal management of hypertension at the state hospital setup, home blood pressure monitoring appears to be an effective way forward as it provides an opportunity for longitudinal monitoring in people with white coat hypertension and masked hypertension and as patient could play a proactive role with self-maintenance of health records that would help to optimize management of hypertension.[9]

For instance, Sri Lanka delivers healthcare services through 800 primary healthcare centers throughout the country. If each center is provided with 5 portable oscillometric devices that could be borrowed by patients to diagnose and monitor their BP by home blood pressure monitoring on a weekly basis, a total number of 2000 such devices are needed. On a rough estimate, the cost to provide this service would be definitely less than 20 million Sri Lankan Rupees but the return on this relatively modest investment would be enormous and could save many lives and millions of rupees in state health expenditure.

Continuous Glucose Monitoring, although a relatively costly exercise, is commonplace in the developed world and has revolutionized the care of diabetes. The cost implications limit its wider use in low and middle-income countries. However, Home Blood Pressure Monitoring (HBPM), in comparison to continuous glucose monitoring, is relatively a cost-effective intervention that could be feasible and impactful in a country like Sri Lanka with a very high health statistics index and literacy rate.

Value of ambulatory blood pressure

Ambulatory blood pressure monitoring has revolutionized the understanding of hypertension. It has given a clear insight into various physiological phenomena related to blood pressure during the day. In particular, the diurnal changes of blood pressure are clearly visualized in health and disease conditions. In addition to the systolic and diastolic blood pressure and its variability, the heart rate and its variability, pulse pressure, nocturnal dipping status, early morning and evening surges, white coat window, and siesta period are some of the important parameters that could be observed. And each of them has significant clinical implications on health and cardiovascular outcomes.

Dipping vs non-dipping

A number of studies have revealed non-dipping status of nocturnal blood pressure is associated with increased hypertension-mediated organ damage and cardiovascular risk in particular the risk of thrombotic stroke. In the meantime, the accentuation of morning surge is largely responsible for wake-up hemorrhagic stroke.

Several risk factors are identified for non-dipping status including sleep disturbance, obstructive sleep apnoea, obesity, high salt intake in salt-sensitive subjects, orthostatic hypotension, autonomic dysfunction, chronic kidney disease, diabetic neuropathy and old age.

Autonomic dysfunction is an important cause of nocturnal non-dipper status or even reverse dipping and is commonly observed in patients with Parkinson's disease and other akinetic rigid syndromes in particular Multiple System Atrophy. We tried to test this hypothesis in diabetic patients with erectile dysfunction which is a common manifestation of autonomic dysfunction. We selected a cohort of patients followed up at the diabetic center of Teaching Hospital Jaffna with erectile dysfunction and performed 24-hour ABPM on those patients and published the findings under the title "Nocturnal systolic blood pressure pattern of type 2 diabetic hypertensive men with erectile dysfunction: a cross-sectional study from Northern Sri Lanka".

Among 29 participants who underwent ABPM, 21 showed a non-dipping pattern of nocturnal systolic blood pressure. There was no statistical difference observed in mean SBP and DBP between patients with dipping nocturnal SBP and non-dipping patterns. Variability of SBP was high among the participants and DBP also showed relatively high variability. A significant difference in heart rate (HR) between patients with non-dipping and dipping patterns was noted.[10]

Table 3. The statistical comparisons of ABPM measurements, and heart rate variability in patients with dipper and non-dipper hypertension

Statistics	*Patients with dipping pattern of SBP during sleep N:8*	*Patients with non-dipping pattern of SBP during sleep N:21*	*P value*
Mean age	51.13±/5.82	51.29±/6.26	0.950
Mean systolic blood pressure	123.38±/15.66	126.38±/13.78	0.617
Mean diastolic blood pressure	80.38±/13.47	82.05±/12.87	0.760
Average HR	67.25±/9.85	76.16±/9.39	0.034
Average MAP	100.13±/14.17	102.24±/12.94	0.705
Mean SD of SBP	12.34±/4.21	11.82±/2.05	0.660
Mean SD of DBP	10.82±/3.12	8.69±/2.65	0.076
Mean dipping % of SBP during awake	8.62±/4.76	1.06±/5.66	0.002
Mean dipping % of SBP during sleep	12.76±/3.01	2.80±/5.50	<0.001

This study clearly demonstrates the need for an ABPM on long-standing diabetic patients with special reference to autonomic dysfunction like erectile dysfunction and postural dizziness or hypotension.

On the other hand, extreme dipping or a greater fall of the nocturnal blood pressure is also considered pathological. It is suggested that nocturnal falls in blood pressure could induce myocardial ischaemia in hypertensives with left ventricular hypertrophy and impaired coronary vasodilator reserve contributing to the J-curve of increased coronary events when diastolic blood pressure is lowered below 65 mmHg. Similarly, it is documented that nocturnal extreme systolic blood pressure drop resulted in silent cerebrovascular disease. Extreme dipping also resulted in anterior ischaemic optic neuropathy and glaucoma.

Blood pressure variability

Blood pressure variability is yet another important factor that contributes to morbidity and mortality due to hypertension. It could be further classified as short-term which is picked up by an ABPM, mid-term identified by day-to-day home blood pressure monitoring and long-term or visit-to-visit office blood pressure fluctuations.

Variability may arise from measurements or could be due to a result of complex interactions between intrinsic cardiovascular regulatory mechanisms and extrinsic environmental and behavioural factors.

Studies have proven that it can be predictive of both stroke and cardiovascular events; predict the occurrence of fatal and nonfatal cardiovascular events as well as total mortality and predict hypertensive target organ damage.

Using data from the J-HOP study, short-term blood pressure variability was found to be significantly associated with cardiovascular risk independently of home SBP, with risk increasing as variability increases.[11] However, blood pressure variability remains a research topic without application in daily practice.

In this context, we conducted a study among 406 patients attending the cardiology outpatient department of Teaching Hospital, Jaffna, Sri Lanka, in 2018 to assess the long-term variability of blood pressure by reviewing the last six

consecutive BP readings from the records retrospectively. Data regarding sociodemographic variables and behavioural factors such as medication adherence, physical activity, smoking, alcohol consumption, and relevant comorbidities were taken through an interviewer-administered questionnaire.

SBP showed high visit-to-visit variability (VVV) among the participants and comorbidities such as diabetes mellitus, chronic kidney disease, and risk factors for obstructive sleep apnoea and physical activity also showed significant variation (Table 4).

Table 4. Characteristics of participants based on the level of visit-to-visit variability (VVV) of systolic blood pressure (SBP)

characteristics	VVV		*P* value
	Low variability (188)	High variability (218)	
Sex			
Male	125	129	0.129
Female	63	89	
Income			
Poorest	118	140	0.674
Middle Income	64	74	
Rich	6	4	
Age			
40–49	5	8	0.656
50–64	153	181	
65 and above	30	29	
Education			
No education	2	4	0.733
Primary	26	37	
Secondary	151	168	
Tertiary	9	9	
Alcohol			
Current drinkers	6	5	0.635
Smoking			
Current smokers	6	2	0.256

Characteristics	VVV		*P* value
	Low variability (188)	High variability (218)	
Physical activity			
Insufficiently active	42	66	0.044**
Moderately active	34	49	
HEPA active	112	103	
Medication adherence			
Low adherence	40	52	0.536
Medium adherence	148	166	
Years from diagnosis			
Less than 5 years	81	97	0.775
≥5 years	107	121	
BMI			
Underweight	7	2	0.270
Normal weight	92	114	
Overweight	63	70	
Obesity	26	32	
Comorbidities			
DM	76	117	0.008**
CKD	2	15	0.004**
Medication			
Beta blockers	88	111	0.409

In conclusion, we recommended simple practical measures to achieve sustainable blood pressure control among hypertensive patients with diabetes and chronic kidney disease to minimize the VVV and improve their cardiovascular outcome.[12]

Table 5. Odds ratios of comorbidities for high visit-to-visit variability patients

Comorbidities	*AOR*	*CI*	*P value*
DM	1.561	1.036-2.353	0.033
CKD	5.999	1.336-26.929	0.019

Blood pressure variability could be nullified by the choice of antihypertensive medications. Some antihypertensive drugs and drug combinations could be more beneficial than others in patients with increased blood pressure variability. For example, long-acting calcium channel blockers, Angiotensin Receptor Blockers or Angiotensin Converting Enzyme Inhibitors and thiazide or thiazide-like diuretics could minimize the variability.

The cardiovascular outcome of antihypertensive therapy not only depends on the choice of antihypertensive medication but also on the timing of the dosing. Chronotherapy is an important concept in the management of hypertension. Chronotherapy is defined as the evening or bedtime administration of medication based on biological rhythms detected by ABPM and is merging as a potential strategy to improve blood pressure control and treatment outcomes. By studying the circadian rhythm of the patient, we could match the dosing regimens and minimize hypertension-mediated organ damage and also prevent medication-induced hypotensive spells.

Role of the clinician in combating high blood pressure

Once high blood pressure is confirmed, it is the treating clinician's responsibility to impart knowledge regarding this "silent killer" to the patient. Educating and enlightening the patient on hypertension and its treatment by the primary care physician during the initial encounter appears to be very promising. This initial talk therapy is often overlooked by most physicians working in poor resource settings. Primary care physicians should be trained to deliver "Two Minutes Talk Therapy" and we have attempted to formulate a model for this exercise in a letter to the editor of the *Jaffna Medical Journal*.[13]

The prescribing patterns of antihypertensive medications are highly dynamic due to the invention of new medications and regular updates in the existing guidelines. A cross-sectional study was carried out in the medical outpatient clinics of the Teaching Hospital, Jaffna to study the prescription patterns among health care providers. The study revealed most of the patients were on monotherapy (46.7%) followed by two medication regimens (33.8%). Among the monotherapy group, "angiotensin converting enzyme inhibitors" (ACEI) (30.1%) were the most widely prescribed medication. Commonly used medications for the treatment of hypertension either as monotherapy or combination therapy were ACEI (72.6%), CCB-DP (35.9%), thiazide diuretics (32%), ARB (19.8%), and alpha-blockers (11.7%). Factors such as age, family income, place of residence and diabetes mellitus were significantly associated with the choice of antihypertensive medications. Further, the types of medication regimes showed a significant influence on the SBP control.[14]

"Clinical inertia" is commonly observed among treating clinicians. The phenomenon of clinical inertia is defined as the failure to start a therapy or its intensification/non-intensification when appropriate, in the management of hypertension. An adequate understanding of the dosages of commonly used medications and regimes would alleviate this issue.

Non-adherence to antihypertensive medications

Medication adherence is the most important patient-related factor that determines the outcome of high blood pressure. To assess the patient's knowledge and awareness about hypertension and adherence to antihypertensive medication among hypertensive patients, a study was carried out with a validated Morisky questionnaire at Teaching Hospital, Jaffna. TA total of three-hundred-three (303) hypertensive patients were recruited by systematic randomized controlled sampling method and interviewed with validated Morisky questionnaires to assess their knowledge about hypertension; 69.9% had adequate knowledge about hypertension; 40.5% were unaware of their disease status; 75.8% could not recall their blood pressure values at the time of diagnosis; 72.3% were unaware of their values of blood pressure during the last outpatient clinic visit and 48.2% had an awareness of target organ damage due to hypertension (kidney, 23.7%; heart, 42.2%; brain, 46.7%; eye, 13.8%). Most of the patients had poor drug compliance. The most common reasons for nonadherence were forgetfulness (23.1%) and interruptions of daily routine (17.5%). The study concluded that the knowledge about hypertension among the majority of patients was reasonable. However, they were unaware of their disease status. The drug compliance among them was poor. Forgetfulness and interruptions of daily routine were common reasons attributed to nonadherence.[15]

Table 6. Reasons for non-adherence to drugs

Reasons	*Numbers*	*(%)*
Poor knowledge of disease and ignorance of long-term treatment	27	8.9
Religious beliefs and cultural practices	31	10.2
Adverse drug reactions	26	8.6
Patient not believing that health depends on medicine	23	7.6
Worrying about taking medicine	33	10.9
Forgetfulness	70	23.1
Drug out of supply	24	7.9
Poor communication /insufficient patient information	35	11.6
Expenses (doctors' fees, transport, medicine, and hospitalization)	45	14.9
Interruptions of daily routine	53	17.5
Lack of reminders	35	11.6
Being busy or late for work	36	11.5
Being away on weekend/vacation	23	7.6
Too many medications to take	33	10.5

A similar cross-sectional study was designed to assess the "Factors Associated with Antihypertensive Medication Adherence Among Diabetic Patients with Coexisting Hypertension at Medical Clinics of the Teaching Hospital, Jaffna" using the modified MASES (medication adherence self-efficacy scale). A negative correlation was noted between MASES scores and systolic (r= -0.033) and diastolic (r=- 0.083) blood pressure. A median score of 49 was used to classify the patients into optimal or suboptimal adherence to antihypertensive medications. A significant percentage (43.4%CI: 38.4-48.5) of research participants sub-optimally adhered to antihypertensive medications. Among the associated factors explored, gender (p=0.007), low-income (p=0.002) and employed people (p=0.046) showed significant association with poor adherence.

We highlighted this important issue that adversely affects the outcome of patients by the point of view to the *Journal of Ceylon College of Physicians*.[16]

Developing policy, advocacy and guidelines in hypertension

There are multiple international policies, guidelines and scientific communications for the management of most of the non-communicable diseases, including hypertension generated by reputed international societies and colleges and these are generally adopted and used as national guidelines by many low-middle income countries, without due recognition of local resource and practice considerations. However, it is also imperative, in an era of evidence-based medicine, to generate high-quality local evidence from randomized control studies and multi-center trials since such large trials are difficult to be planed and implemented in resource-poor settings. An alternative approach is to encourage regional centers to embark on smaller studies, as I have tried to describe in this oration, but aligned proactively nationally to encourage the use of common study designs and procedures. Such a "real world" set of studies could have greater value in generating national guidelines or modifications to the international guidelines. Professional colleges such as the Sri Lanka College of Internal Medicine could play a role as a national coordinator bodies to the regional centers. In other words, encouraging a network of regional centers could provide fruitful results by conducting more socially relevant studies pertaining to the nation. Hypertension has become a "Nobody's child" in the context of advancing specialization and it is, therefore, the duty of each and every healthcare practitioner, both in primary and secondary care.

In conclusion, the oration highlighted the clinical dilemmas and pitfalls that could hinder the care of hypertensive patients with a special emphasis on measuring blood pressure, setting a target, difficulties in monitoring patients with out-of-the-office blood pressure monitoring, methods, educating patients, selecting appropriate medications and the concerns related to non-adherence of antihypertensive medications. Healthcare policymakers should take this important public health issue seriously and adopt policies that suit this nation to provide comprehensive care for this silent killer.

References

1. Van Der Heijden-Spek JJ, Staessen JA, Fagard RH, Hoeks AP, Boudier HAS, Van Bortel LM. Effect of Age on Brachial Artery Wall Properties Differs from the Aorta and Is Gender Dependent: A Population Study. *Hypertension.* 2000; **35**(2): 637-42.
2. Sujanitha V, Kumanan T, Guruparan M, Inthuja T. Mercury versus Oscillometric Device in Measuring Blood Pressure in Elderly: Which Is Authentic? *OALib.* 2018; **05**(02): 1-7.
3. Kumanan T, Sreeharan N. Locomotor brachialis: a clinical peep into atherosclerosis and hypertension mediated organ damage in the elderly. *Ceylon J Med Sci.* 2020; **56**(1): 43.
4. Sakthiraj N, Fernando M, Kumanan T, Paranamana R, Udara YMS, Fernando PSU, et al. Knowledge regarding the accurate measurement of blood pressure among intern medical officers practising at three teaching hospitals in Sri Lanka: A cross-sectional analysis. *J Ceylon Coll Physicians.* 202; **54**(1): 34-8.
5. Rannan-Eliya RP, Wijemunige N, Perera P, Kapuge Y, Gunawardana N, Sigera C, et al. Prevalence and Associations of Hypertension in Sri Lankan Adults: Estimates from the SLHAS 2018-19 Survey Using JNC7 and ACC/AHA 2017 Guidelines. *Glob Heart*. 2022; **17**(1): 50.
6. Sreeharan N, Kumanan T, Sujanitha K, Guruparan M. New hypertension guidance has major implications for countries with low resources. *BMJ.* 2019; **365**: l2296. doi: 10.1136/bmj.l2296. PMID: 31142448.
7. Kaul U, Wander GS, Sinha N, Mohan JC, Kumar S, Dani S, Ponde CK, Pinto B, Dalal J, Hiremath J, Kapoor S, Baruah DK, Nair T, Alexander T, Mohan V, Joshi S, Sivakadaksham N, Omboni S, Arambam P, Suvarna V, Verberk WJ. Self-blood pressure measurement as compared to office blood pressure measurement in a large Indian population; the India Heart Study. *J Hypertens*. 2020; **38**(7): 1262-70. doi: 10.1097/HJH.0000000000002410. PMID: 32195821.
8. Green BB, Anderson ML, Campbell J, Cook AJ, Ehrlich K, Evers S, Hall YN, Hsu C, Joseph D, Klasnja P, Margolis KL, McClure JB, Munson SA, Thompson MJ. Blood pressure checks and diagnosing hypertension (BP-CHECK): Design and methods of a randomized controlled diagnostic study comparing clinic, home, kiosk, and 24-hour ambulatory BP monitoring. *Contemp Clin Trials.* 2019; **79**: 1-13. doi: 10.1016/j.cct.2019.01.003. Epub 2019 Jan 8. PMID: 30634036; PMCID: PMC7067555.
9. Kumanan T, Guruparan M, Charles JC. Home Blood Pressure Monitoring (HBPM): The way forward for Sri Lanka; a review article. *Asian J Intern Med.* 2022; **1**(2): 45-51.
10. Kumanan T, Sujanitha V, Rajeshkannan N, Nisahan B. Nocturnal systolic blood pressure pattern of type 2 diabetic hypertensive men with erectile dysfunction: a cross sectional study from Northern Sri Lanka. *BMC Res Notes.* 2019; **12**(1): 696.
11. Narita K, Hoshide S, Kario K. Difference between morning and evening home blood pressure and cardiovascular events: the J-HOP Study (Japan Morning Surge-Home Blood Pressure). *Hypertens Res*. 2021; **44**(12): 1597-1605. doi: 10.1038/s41440-021-00686-2. Epub 2021 Jul 28. PMID: 34321616.
12. Kumanan T, Sujanitha V, Guruparan M, Rajeshkannan N. Factors Associated with Visit-to-Visit Variability of Blood Pressure Measured as Part of Routine Clinical Care among Patients Attending Cardiology Outpatient Department of a Tertiary Care Centre in Northern Sri Lanka. *Int J Hypertens.* 2019; **2019**: 1-8.
13. Kumanan T. Two minutes Talk Therapy (TTT): A tool to improve medication adherence of Sri Lankan hypertensives. *Jaffna Med J*. 2019; **31**(2): 32-4.
14. Selvaskanthan K, Ghetheeswaran S, Kumanan T, Rajeshkannan N. A descriptive study on prescription pattern of antihypertensive medications in a tertiary care hospital in Northern Sri Lanka. *Sri Lanka J Med.* 2021; **30**(2): 156.
15. Pirasath S, Kumanan T, Guruparan M. A Study on Knowledge, Awareness, and Medication Adherence in Patients with Hypertension from a Tertiary Care Centre from Northern Sri Lanka. *Int J Hypertens.* 2017; **2017**: 1-6.
16. Kumanan T, Guruparan M, Mohideen MR. Non-adherence of antihypertensive therapy: A serious public health issue in Sri Lanka. *J Ceylon Coll Physicians.* 2016; **47**(1): 50.