A prospective study to assess the medication adherence pattern among hypertensives and to evaluate the use of cellular phone text messaging as a tool to improve adherence to medications in a tertiary health-care center

Garima Shukla1, A. Tejus1, R. Vishnuprasad1, Sapna Pradhan1, M. S. Prakash2

Abstract:
AIM: The aim of the study was to assess improvement in adherence to medications using mobile phone text messaging (short message services [SMSs] and social media).
OBJECTIVES: The objective was to assess the pattern of adherence to medication in hypertensives and to assess the improvement in adherence pattern to antihypertensive medications using mobile phone text messaging as a tool.
METHODOLOGY: After obtaining informed consent, the study participants' blood pressure was recorded, and their adherence to medications was graded as high, medium, and low using the Medication Adherence Questionnaire. Then, messages in the form of either SMSs or WhatsApp were sent regularly (once every 3 days) reminding them of the importance of regular medicine intake. After 2 months of follow-up, again blood pressure was recorded and adherence graded. Data were tabulated and statistically analyzed.
RESULTS: Majority of study participants in who were initially placed in medium to low grading of adherence (65.2%) moved toward high adherence (88.4%) at follow-up after receiving messages for 2 months. A statistically significant decrease was noted in systolic (8.3 mmHg, \( P < 0.001 \)) and diastolic blood pressure (2.4 mmHg, \( P < 0.002 \)) at the end of follow-up.
CONCLUSION: Nonadherence to medication is a global phenomenon to be tackled at the earliest. Our study clearly brings out the importance of improving adherence by regular reminders as messages. Hence, there is a wide scope to avail means to improve the adherence pattern and maximize the health benefits.

Keywords: Hypertension, medication adhesion questionnaire, messages, nonadherence

Introduction
Hypertension is a global health problem affecting approximately 30% of adults and a major risk factor for cardiovascular diseases and premature deaths worldwide.\(^{[1,2]}\) In comparison to high-income countries, a higher prevalence has been noted in low- and middle-income countries.\(^{[3]}\) It contributes to approximately 14% of total deaths and almost a loss of 143 million disability-adjusted life years.\(^{[1,3]}\) As
suggested by The Chennai Urban Rural Epidemiology Cohort study one in five Indians are hypertensive and is responsible for almost 10.8% of total deaths occurring in India. The prevalence in India varies from as high as 33% in the urban population to 25% in the rural population.\(^[1-4]\)

The American Heart Association in its latest 2017 guidelines has defined hypertension as systolic blood pressure (SBP) ≥ 130 mmHg and diastolic blood pressure (DBP) ≥ 90 mmHg.\(^[3,6]\) There has been a constant change in the definition of hypertension by various guidelines. The Joint National Committee 7 guidelines defines normal blood pressure as < 120/80 mmHg, while labeling SBP of 120–139 mmHg and DBP of 80–89 mmHg as prehypertension and > 140/90 mmHg as hypertension.\(^[4,6]\) These changes significantly contribute toward the prevalence of hypertension.\(^[6]\)

The management of hypertension includes various nonpharmacological measures such as restricted sodium intake, promoting physical activity and weight loss, supplementing potassium, and restricting alcohol intake.\(^[5,6]\) The pharmacological measures must be resorted to in all individuals with blood pressure > 140/90 mmHg and in those with high cardiovascular risk; medications are started early at blood pressure > 130/90 mmHg.\(^[3,4,6]\) There is a wide armamentarium of medicines against hypertension, but as suggested by various guidelines, calcium channel blockers (CCBs), thiazide diuretics, angiotensin convertase enzyme inhibitors (ACEIs), and angiotensin receptor blockers (ARBs) remain first-line drugs.\(^[3,6]\)

The World Health Organization (WHO) suggests the suboptimal control of blood pressure as a major factor for hypertension-related complications.\(^[7,8]\) One of the main reasons for uncontrolled hypertension is noncompliance to the prescribed medication regimen, seen in almost half of the cases.\(^[7]\) Improving adherence to medications will have a greater impact compared to improving specific medical treatments as emphasized by the WHO.\(^[7,8]\)

Various measures have been proposed to improve adherence to medications that are either subjective (clinical assessment or self report in the form of structured interviews, online assessments, written questionnaires, and voice response system) or objective measures such as counting of pills, electronically monitoring medicine intake, analyzing secondary database, and biochemical estimation.\(^[8]\) Each of the above measures carries their own advantages and disadvantages. Hence, to improve the overall adherence pattern, a multimeasure approach is the need of the day.\(^[9,10]\)

Cellular phones have revolutionized the communication arena and studies demonstrate an increase in adherence to medication using text messages.\(^[11,12]\) The social networking sites are no longer restricted for socialization, but many users use it to gather health information and also for its dissemination.\(^[12,13]\) A revolution in interpersonal communication has been brought by both short message services (SMSs) and social media, which have presented unique opportunities to disseminate various behavioral interventions.\(^[12,13]\) Hence, the present study was planned to assess medication adherence and any improvement of the same by the use of text messages either in the form of SMS or through online social media.

**Methodology**

It was an observational study conducted at a multispecialty tertiary care hospital to determine adherence pattern to medications in hypertensives and to assess whether the use of text messages would improve the same. After the approval of the institutional ethics committee, known hypertensives on medication for at least 1 year (based on treatment record) attending the medicine outpatient department and also those receiving medicines at the hospital dispensary were approached. The importance of the conducting the study was briefed and written informed consent was taken from all those agreeing to participate in the study.

Two hundred and fifty hypertensives were enrolled in the study by simple random sampling. Patients aged 18 years and above, of either sex, prescribed one of the antihypertensives were included in the study. Patients declining informed consent, with a known history of neurodegenerative disorders and with any acute medical conditions such as myocardial infarction, strokes, or renal failure were excluded from the study.

**Investigational plan**

Patients signing the informed consent were enrolled in the study and were given a unique ID number which was stated on the entry case report form (CRF). The entry CRF contained demographic details, blood pressure levels, treatment regimen, and questions regarding the use of mobile and social media, willingness/unwillingness to receive text messages either as SMS or WhatsApp messages. Morisky, Green, and Levine Adherence Scale also known as Medication Adherence Questionnaire (MAQ) was filled up at the same time to determine the level of adherence to their antihypertensive medications.\(^[14]\)

Based on their willingness to receive messages either as SMS or WhatsApp messages were sent reminding them to take medications at the appropriate time thrice a week. Thereafter, the study participants were asked to report to the study site every month for the next 2 months, while visiting the hospital for the collection of medicines. The blood pressure was recorded at each visit. At the end of 2 months, MAQ was again filled up.
Outcome variables
1. Blood pressure levels: Blood pressure level will be checked at every monthly visit using electronic sphygmomanometer
2. Level of adherence to prescribed antihypertensives: Assessed using Morisky, Green, and Levine Adherence Scale. The grading of the adherence will be done as below:
   a. Low adherence: Those answering “Yes” to all four questions
   b. High adherence: Those answering “Yes” to none
   c. Medium adherence: Those answering “Yes” to one to three questions.

Statistical analysis
All the data obtained were presented as mean ± standard deviation and percentages in case of continuous and categorical variables, respectively. Tests of normality were conducted initially and for all continuous variables, paired student t-test and Mann–Whitney U-test were done to compare statistically significant difference in means. For all categorical data, the Chi-square test statistic and MCNemar test were used for testing statistical significance. For all statistical comparisons, $P < 0.05$ was considered statistically significant. Statistical Analysis was carried out using Statistical Package for Social Sciences (SPSS) version 21.0 by International Business Machines Corporation (IBM), Armonk, New York.

Results
Majority of the study participants were in the age group of more than 60 years (44.4%) with a mean age of 57.7 ± 12.3 years among the study participants. Most of the study participants were male (75.6%) compared to females (24.4%). More than 60% of our study participants were from urban nativity compared to rural nativity (33.2%). Majority of the study population had an educational qualification only up to high school (54.8%), followed by graduates (20.8%). Majority of our study participants were using basic phone (60%), followed closely by smartphone users (40%) [Table 1].

Majority of the study participants had a history of missing their medications (65.2%). The most common reasons for missing medications were carelessness and forgetfulness [Table 2]. Maximum study participants were graded as having medium to low adherence (65.2%) for their antihypertensive medicine consumption based on the Morisky medication adherence scale. After 2 months of receiving messages either as SMS or WhatsApp, majority study population were graded as having high adherence to antihypertensive medication (88.4%).

A high adherence to medications was seen in individuals aged 15–30 years (50%), followed by more than 60 years (38.7%). Maximum low adherence was seen in individuals <45 years of age. However, no significant statistical difference in grading of adherence was noted among various age groups. Males were slightly more adherent to their medications (37%) compared to females (27.9%), but the difference was not statistically significant. About 42.6% of female participants were graded as having low adherence compared to males (33.3%). There was hardly any difference in those with urban or rural nativity. After 2 months of follow-up, no significant difference was noted among either of the age group, sex, or nativity [Table 3].

A statistically significant fall was noted in both SBP and DBP after 2 months of follow-up [Table 4].
A significant difference in adherence pattern was not noted between basic mobile phone users (receiving SMS) and smartphone users (receiving WhatsApp messages) at the end of 2 months of follow-up [Table 5]. Similarly, there was no statistically significant difference between the type of phone usage and SBP and DBP at initial assessment and follow-up after 2 months [Table 6].

**Discussion**

In this study, the adherence pattern of hypertensives to their antihypertensive medications was graded using the Morisky medication adherence scale, and the improvement in adherence to their medications after testing them messages about the importance of regular intake of medicines periodically either as SMS or WhatsApp was assessed. The pattern of prescription of antihypertensive was also analyzed.

A majority of the study participants (65.2%) reported a history of missing their medicines. In concurrence with our results, Abegaz *et al*. in their systemic review and meta-analysis have reported that 45.2% of hypertensives were nonadherent to their medications. Adidja *et al*. in their community-based cross-sectional study reported a prevalence of nonadherence to medication as 67.7%, and Koole *et al*. in their study found that 29% of their study participants missed their antiretroviral medicines.

Nonadherence is an important public health-related problem, especially for chronic illnesses. The WHO has enlisted five key determinants of nonadherence such as socioeconomic (includes the cost of treatment), related to the health system (includes the provision of health care, interaction among patient and prescriber, follow-up, and option of providers), related conditions like disease characteristics (its severity whether acute/chronic), related to therapy (polypharmacy and adverse drug reactions), and patient related (literacy, cognition, motivation, social support, and individuals view on treatment).

In our study, we tried to figure out the possible reasons for missing medicines. About 46.6% of those missing medicines attribute it to their carelessness, 39.2% were due to their forgetfulness, and the rest attributed it to the nonavaiability of medicines. These results were concurrent with Koole *et al*., who in their study reported that the most common reason for missing ART medicines by patients was simple forgetting (53%).

Nonadherence significantly contributes to the morbidity and economic burden. Suboptimal control of blood pressure significantly contributes to cerebrovascular and ischemic heart diseases. The economic burden is expected to be between 100 and 300 million dollars in the USA and costing €125 billion annually to the European governments. The cost equates to 14% of the total health expenditure of the National Health Service in the United Kingdom and a report suggests that 8% of

### Table 3: Level of adherence based on the demographic characteristics (age, sex, and nativity) and their associations after follow-up

| Adherence on follow-up | High, n (%) | Medium, n (%) | Low, n (%) | Total, n (%) | P |
|------------------------|-------------|---------------|------------|--------------|---|
| Age 15-30              | 6 (100.0)   | 0 (0.0)       | 0 (0.0)    | 6 (100.0)    | 0.103 |
| 31-45                  | 34 (89.5)   | 2 (5.3)       | 2 (5.3)    | 38 (100.0)   |   |
| 46-60                  | 86 (90.5)   | 8 (8.4)       | 1 (1.1)    | 95 (100.0)   |   |
| >60                    | 95 (85.6)   | 16 (14.4)     | 0 (0.0)    | 111 (100.0)  |   |
| Gender Male            | 166 (87.8)  | 20 (10.6)     | 3 (1.6)    | 189 (100.0)  | 0.600 |
| Female                 | 55 (90.2)   | 6 (9.8)       | 0 (0.0)    | 61 (100.0)   |   |
| Nativity Rural         | 74 (89.2)   | 8 (9.6)       | 1 (1.2)    | 83 (100.0)   | 0.962 |
| Urban                  | 147 (88.0)  | 18 (10.8)     | 2 (1.2)    | 167 (100.0)  |   |
| Total                  | 221 (88.4)  | 26 (10.4)     | 3 (1.2)    | 250 (100.0)  |   |

### Table 4: Comparison of means of systolic and diastolic blood pressures during initial assessment and after 2 months of follow-up

| Blood pressure | Mean±SD | Difference in mean (95% CI) | P* |
|----------------|---------|-----------------------------|----|
| Systolic (mmHg)| 132.8±22.5 | 124.5±9.6 | 8.3 (5.9-10.6) | <0.001 |
| Diastolic (mmHg)| 82.9±12.1 | 80.5±7.2 | 2.4 (0.9-3.9) | 0.002 |

*Paired t-test was applied for comparison of means

### Table 5: Association between type of mobile phone usage and level of adherence at the end of follow-up

| Type of mobile phone | Adherence on follow-up | Total, n (%) | P* |
|----------------------|------------------------|--------------|----|
|                      | High, n (%) | Medium, n (%) | Low, n (%) |             |
| Basic phone          | 132 (88.0) | 17 (11.3)    | 1 (0.7)    | 150 (100.0) | 0.546 |
| Smartphone           | 89 (93.0)  | 9 (9.0)      | 2 (2.0)    | 100 (100.0) |   |
| Total                | 221 (88.4) | 26 (10.4)    | 3 (1.2)    | 250 (100.0) |   |

*Chi-square test was applied to test statistical difference in proportions

### Table 6: Comparison between type of mobile phone usage and difference in systolic blood pressure and diastolic blood pressure at initial assessment and after follow-up

|                  | Mean±SD | Difference in mean (95% CI) | P* |
|------------------|---------|-----------------------------|----|
| Basic phone      | 8.7±18.4 | 7.6±18.5 | 1.06 (−3.6-5.8) | 0.491 |
| Smartphone       | 2.5±12.6 | 2.2±11.5 | 0.3 (−2.7-3.4) | 0.885 |

*Mann-Whitney U-test was applied for comparison of means. SD=Standard deviation, CI=Confidence interval, SBP=Systolic blood pressure, DBP=Diastolic blood pressure
global health expenditure could be saved by improving adherence to medications.\(^{[21]}\)

In our study, participants either <30 years or >60 years were relatively more adherent to medications compared to other age groups. After intervention (receiving messages either as SMS or WhatsApp), all the age groups were having high adherence to medications. This is in concurrence with Venkatachalam et al.\(^{[7]}\) (2015) who in their study reported a higher adherence to antihypertensive medications in 30–39 years’ age group (27%) and >60 years’ age group (27.1%) compared to other age groups.\(^{[21]}\) Females were relatively less adherent to their antihypertensive medication compared to males. The results improved greatly after follow-up, wherein only 1.6% of males and nil females were graded as having low adherence to their medications. This is in concurrence to Manteuffel et al.\(^{[22]}\) (2014) who concluded that women were less adherent for using chronic medications and suggested more personalized selection of medicines and management for better clinical outcomes.\(^{[22]}\)

A summary of various randomized controlled intervention studies brought out by Marcum et al. to tackle the menace of nonadherence.\(^{[21]}\) The behavioral/educational intervention included cognitive behavioral therapy to facilitate decision-making process, improve health awareness, and interviews by trained personnel. The pharmacist-led intervention included counseling, reminders to explain misconceptions, and to improve adherence. The final intervention is the telephonic reminders.\(^{[21]}\)

Majority of the study participants (65.2%) were graded according to the MAQ as having medium to low adherence to their antihypertensive medications. After a follow-up of 2 months along with periodic reminders to take medications regularly, the level of adherence significantly improved, and majority of participants (88.4%) were graded as having high adherence to their medications. This is in concurrence to Varleta et al. who in their study reported an improvement in adherence of antihypertensive medications from 49% at baseline to 62.3% after educating participants through SMS for a period of 6 months.\(^{[12]}\)

There was a significant decrease in the mean of SBP by 8.3 mmHg (\(P < 0.001\)) and the mean of DBP by 2.4 mmHg (\(P < 0.002\)) at the end of 2 months of follow-up. This clearly demonstrates that by ensuring adherence to medications, a significant improvement in blood pressure control could be achieved. The difference in improvement in adherence pattern or fall in SBP or DBP among users of basic phone (60%) receiving SMS or smartphone (40%) receiving messages using social media like WhatsApp was not statistically significant. Vargas et al.\(^{[23]}\) (2017) in their systematic review of using SMS for the management of hypertension have reported that interventions directed through SMS for managing hypertension hold strong potential and help in bringing innovation to health care.\(^{[23]}\) Omboni in their review of connected health in the management of hypertension has brought out that mobile health is a popular e-health tool utilized by health-care consumers and professionals.\(^{[24]}\)

ACEIs were the most commonly prescribed antihypertensive medication, followed by ARBs and CCBs. This is concurrence with Adejumo et al. who in their study of prescription pattern of antihypertensives in Nigeria, demonstrated that the most commonly prescribed medicines were thiazides, CCBs, and ACE inhibitors. This pattern of antihypertensive use is in line with the Eighth Joint National Committee guidelines.\(^{[25]}\) The study clearly demonstrates an improvement in adherence pattern to antihypertensive medications following regular reminders in the form of messaging (either as SMS/WhatsApp) about the importance of regular intake of medicines. It also brought out an improvement in blood pressure control. Such interventions with automated messaging system as a reminder for medication adherence, to ensure a better clinical outcome, shall form an integral part of the health system, especially in chronic diseases.

**Conclusion**

Nonadherence to medication is a global phenomenon and an important public health problem that has to be tackled at the earliest. Worldwide, there are ongoing health reforms in the public health sector to reduce the burden of expenditure on health care and to maximize health outcomes. Adherence to prescribed medications is a challenging issue; improvement in the same helps to reduce not only economic burden on health care but also morbidity. The lack of clear universal guidelines regarding the same further worsens the scenario.

Our study clearly brings out the importance of maintaining adherence by regular reminders as messages in the form of reduction in blood pressure. Hence, there is a wide scope to avail various means and measures (e.g., mobile applications) to improve the adherence pattern and maximize the health benefits.

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**Conflicts of interest**

There are no conflicts of interest.
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