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Telemonitoring for Hypertension Management: The Time is Now

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**Introduction**

Over the past two years, the Covid-19 pandemic has challenged our beliefs about the optimal way to deliver healthcare and has also revealed major deficiencies in the traditional healthcare model centered around fee-for-service structures (1). The pandemic also led to disruptive innovation by increasing exponentially the use of telemedicine to serve isolated patients. Furthermore, telehealth has indirectly allowed underserved populations, such as patients in rural areas and those with impaired mobility, to have access to services that were not readily available. In that regard, changes in healthcare delivery have the potential to benefit patients with hypertension, the most common and important risk factor for cardiovascular disease worldwide (2). However, the potential benefits of telehealth strategies for the management of hypertension are not only limited to improving access and accessibility and were highlighted before the pandemic by the 2017 Hypertension Clinical Practice Guidelines, which suggest that telehealth can be a useful adjunct to interventions shown to reduce blood pressure (BP) for adults with hypertension (3). In fact, of common chronic conditions, hypertension may be best suited to telemonitoring and telehealth (2).

**Telemonitoring for hypertension**

Telemonitoring for hypertension involves the remote measurement and transmission of BP, heart rate, and weights (2). Telemonitoring is just one aspect of a comprehensive telehealth program. Comprehensive telehealth for hypertension involves the provision of services via information communication technology including phones, video visits, web-based technology, and email. Telehealth services can be multidisciplinary and include assessment of medication adherence, provision of education regarding diet and exercise, and one-on-one consultations (see Figure(2)). Studies of telehealth-based hypertension management report a high average patient adherence and were very well-
received with excellent acceptability (4). As discussed below, comprehensive telehealth programs are associated with treatment intensification and improved blood pressure control.

**Utility of out of office Blood Pressure measurements and transmission using Telemonitoring**

Telemonitoring is ideally suited for hypertension. The rationale for using BP measurements outside of the traditional clinical setting is highly relevant for both the diagnosis and the management of hypertension as pointed out by the U.S. Preventive Services Task Force (USPSTF) which recommends obtaining measurements outside of the clinical setting for diagnostic confirmation before starting treatment (5). The limitations of diagnosing hypertension solely in the office setting are well-known and include measurement errors, the limited number of measurements that can be made, and the non-negligible prevalence of white-coat (WCH) and masked hypertension (MH) (6). In an international database of patients with CKD, the prevalence of MH was found to be 16% while that of WCH was 20% (7). Relative to patients with sustained elevation in clinic and out-of-office blood pressure, WCH appears to be a relatively low-risk condition (8). On the other hand, patients with MH are at increased risk for adverse cardiovascular and kidney events. This increased risk is seen in those with and without chronic kidney disease (CKD). It is nonetheless important to note that WCH and MH definitions based exclusively on daytime ABPM BP values seem to be the most valuable parameter to discriminate mortality in CKD (9). Moreover, self-monitoring is important as it empowers the patients and promotes patient engagement and commitment to care (10).

Beyond the location and the number of measurements, using the correct technique is key (11) and has been described in detail by all the major bodies issuing hypertension guidelines (3, 12-15). Specific training is therefore important to ensure proper measurement technique and seems to be done so far in a
minority of cases (16, 17). Passive measures that include posters, handouts, information booklets, and other educational tools are of limited value (18); teaching patients to properly perform self-measurements during office visits could be most effective. Video visits and adequacy of number of readings may be utilized to assess and monitor proper technique (19). The use of validated and calibrated upper arm devices is critical for obtaining accurate blood pressure measurements both in clinic and at home. Fortunately, several online listings of validated devices issued by national and international scientific societies are freely available and easily accessible (20-23).

Timely communication of results with healthcare providers is important. Transmission of home blood pressure recordings directly into electronic health records (EHR) is now feasible directly from some home BP monitors or via mobile smartphone apps. Direct transmission of BPs into the EHR simplifies data collection but whether it is associated with better outcomes is unknown.

It is however important to note that self-monitoring alone is not associated with meaningful changes in mean clinic or ambulatory BP or the proportion of patients with controlled BP. Co-interventions are required to achieve BP control and include systematic medication titration, education, pharmacist co-management, and lifestyle counselling (24). An illustrative example is the HOME BP randomized trial where a digital intervention comprising self-monitoring of BP with reminders and predetermined drug changes combined with lifestyle change support resulted in better control of systolic BP compared to usual care, with low incremental costs (25). Reorganizing care with integration of allied health professionals for a team-based approach and empowerment of nurses and pharmacists to adjust antihypertensive therapy improves BP control (26).
In the Hyperlink study (27, 28), using a cluster randomized trial design, investigators evaluated the effect of a telehealth intervention on blood pressure control. The 12 month telehealth intervention included a) home blood pressure monitoring with transmission of blood pressure data to a secure website and b) pharmacist co-management including hypertension and lifestyle education, medication review, and management of antihypertensive drug therapy. From a baseline of 148 mm Hg, the telehealth intervention resulted in lower blood pressure at 12 months (126 mm Hg vs 135 mm Hg in the usual care group) and at 18 months (127 mm Hg vs 133 mm Hg in the usual care group). This improvement in blood pressure in the telehealth arm was achieved through increased number of medication classes and a reduction in the proportion of participants who added salt to their food (28). Key components of the intervention included automated transmission of blood pressure data, co-management by a multidisciplinary team, and a multifaceted intervention including education and medication review. Moreover the intervention had sustained effects for up to 12 months after the intervention ended, however such effects were not sustained at 54 months, suggesting that long-term maintenance of BP control is likely to require continued monitoring and resumption of the intervention when needed (28). Finally, despite a cost of $1511 per patient, the Hyperlink telemonitoring intervention ended up with a net cost saving of $1900 per patient over 5 years due to a reduction in cardiovascular events (29). In addition to Hyperlink, a number of other randomized controlled trials have demonstrated that telemonitoring combined with lifestyle interventions and multidisciplinary care improves BP control (25, 30-32). These studies should inform multilevel implementation of telehealth and telemonitoring for BP control in routine clinical practice.

Conclusion
The expansion of telemonitoring is a welcome adjunct to the multiple strategies already implemented for the control of the hypertension. The importance of acquiring longitudinal BP data outside the office for diagnosis and control makes hypertension an ideal candidate for telemonitoring. The plethora of available tools rendering the transmission of data feasible and accessible in a multitude of settings calls for further expansion of this modality. Recent changes in reimbursement policies provide coverage for self-measured BP monitoring (19). Telehealth programs should ensure accurate and reliable BP measurements using techniques adherent to guideline recommendations. Implementation of telehealth and telemonitoring programs need to account for the digital divide and avoid worsening inequities in communities that may not be digitally literate or financially capable of acquiring devices and the required technologies necessary to transmit home BPs. Telemonitoring should by no means replace in person visits as this modality is not appropriate for all types of encounters. As is the case for any chronic disease, in person interaction with providers is important for an optimal exchange of emotions and empathy and constitutes an essential therapeutic tool. In the future, determining the ideal ratio of in-person visits to virtual visits, the optimal use of remote device monitoring, and the right mix of health professionals will be important to optimizing hypertension care.

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**Author Contributions**

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**References**


Figure 1. Components of a comprehensive telehealth program for hypertension management

Multidisciplinary healthcare team

- Telemonitoring of vital signs
- Medication tracking
- Lifestyle education
- Video consultation

Suspected or established hypertension
- Older adults
- Medically underserved people
- High-risk patients
- Patients with multiple comorbidities
- Isolated patients due to pandemics (e.g. COVID-19)

Improved blood pressure control
- Treatment intensification +
- Reduced frequency of office visits +
- Improved quality of life +
- Improved medication adherence +/-
- Improved drug safety +/-
- Reduced management costs +/-
- Improved outcomes (hospitalization or death) +/-