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Review

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Telemedicine for hypertension management: where we stand, where we are headed

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Abstract

Hypertension is the leading cause of cardiovascular disease worldwide. Telemedicine may support doctors and health care professionals to raise awareness, increase detection, and improve the management of hypertension, by enhancing the connection with their patients. Given the growing popularity of telemedicine, the objective of the present review paper is to present the typical applications of telemedicine in hypertension management and available recommendations for use and summarize the evidence of their clinical efficacy before and during COVID-19 and the future trends and perspectives. Blood pressure telemonitoring (BPT), which enables remote transmission of BP and additional information on a patient's health status from different settings to a healthcare facility, is the most common application of telemedicine for hypertension management. BPT is an integral component of a complex and multifaceted intervention, which includes video consultation, education on lifestyle and risk factors, antihypertensive medication review and management, and multidisciplinary team care. Several randomized controlled studies documented larger BP reduction and enhanced BP control with telemedicine compared to usual care. Telemedicine also helps optimize antihypertensive medications, improve treatment adherence, reduce office visits and resort to laboratory tests, and improve quality of life. At the time of COVID-19, telemedicine has helped to maintain adequate BP control in hypertensive patients under home confinement. Consequently, telemedicine is generally recommended to ensure continuity of care for hypertensive patients with uncontrolled BP, older patients, those at high risk of developing cardiovascular diseases, those with multiple comorbidities, medically underserved people, or patients isolated due to pandemics or national emergencies. Telemedicine applications relying on smart wearables, cuffless BP monitors, multiparametric devices, ambient sensors, and tools integrated with machine learning algorithms are particularly promising for telemedicine's future development and diffusion since they may provide continuous surveillance of patients and remarkable support decision tools for doctors.

Keywords: Hypertension, blood pressure, telemedicine, telehealth, telemonitoring, mobile health, machine learning, smart wearables, cuffless blood pressure monitors, ambient sensors

INTRODUCTION

Telemedicine (or telehealth) means *"healing at a distance"* and is the most popular and longstanding digital health application. Telemedicine, as defined by the World Health Organization, is *"the delivery of health services, where distance is a critical factor, by all health professionals using information and communication technologies for the exchange of valid information for the diagnosis, treatment, and prevention of diseases and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities"*[1].

Telemedicine represents a revolutionary approach to patient management by combining various types of information communication technology (ICT) for remote delivery of care, consultation, medical education, various healthcare and clinical services, and monitoring of multiple patients' vital and non-vital parameters at a distance[2]. Telemedicine services are typically provided through the Internet: the most common applications are those allowing remote patient examination (televisit) or surveillance (telemonitoring). The typical telemedicine model follows a closed-loop scheme, also defined as *"Internet-of-Medical-Things (IoMT)"*, where a web-based shared platform is used to favor collaborative care and create a connected infrastructure of health systems and services between patients and caregivers or among different healthcare professionals[3]. Telemedicine has proved to be more clinically effective than usual care in several medical disciplines[4]. The most popular telemedicine applications are those used for chronic disease patients, with cardiovascular disease (e.g., heart failure, hypertension, diabetes) representing an ideal target for telemedicine[5-8].

Untreated or treated but uncontrolled hypertension is the most important contributor to cardiovascular disease worldwide[9]. Approximately 50% of people with hypertension remain undiagnosed, 40% are treated, and only 20% have controlled blood pressure (BP) globally[10]. In the past four decades, a shift in the highest BP levels has been observed from high-income to low-income countries[10]. Given the widespread prevalence of hypertension in the population worldwide, telemedicine may help increase the reach of remote or underserved communities and support doctors and health care professionals to raise awareness, increase detection, and optimize the management of hypertension.

The objective of the present review paper is to update the reader about the typical applications of telemedicine in hypertension management, the available evidence for clinical efficacy, and current recommendations for use, particularly in light of the disruptive impact of COVID-19 on traditional healthcare models. The paper will also introduce new solutions that emerged in recent years, including smart wearables, cuffless devices, ambient sensors, and applications relying on machine learning, and will provide perspective for the future of telemedicine in the field of hypertension.

TELEMEDICINE SOLUTIONS FOR HYPERTENSION MANAGEMENT

The most common application of telemedicine for hypertension management is BP telemonitoring, which enables remote data transmission of BP and additional information on a patient's health status from different settings (e.g., patient's home, community pharmacy, primary care clinic, community kiosks, outpatient clinics, etc.) to the doctor's office, a hospital, or another remote healthcare facility[11]. BP telemonitoring is an integral component of a complex and multifaceted intervention, which includes video consultation, education on lifestyle and risk factors, antihypertensive medication review and management (encompassing tracking of medication adherence), and multidisciplinary team care (specialist, primary care physician, nurse, pharmacist, dietician, etc.).

Patient data are usually collected at remote sites and exchanged with a centralized healthcare facility with specific devices[12]. A camera, a microphone, and speakers for audio-video exchange are used during a televisit. Cuff-based or cuff-less BP monitors, smart wearables, and multiparametric devices collect vital or non-vital parameters and exchange them through wired or wireless connections with specific interfaces that transmit the data remotely. Telemedicine services commonly rely on websites and, more recently, smartphone apps (so-called *"m-health"*) to allow communication between the end-user and the healthcare manager. Text messaging (SMS) or e-mails represent other simple and popular ways of communication.

The interaction between patients and healthcare professionals may be immediate (synchronous) or periodic (asynchronous). A typical form of synchronous interaction occurs during a live audio-video conferencing between the patient and a healthcare professional (televisit) or during real-time transmission of vital signs (e.g., electrocardiogram or BP) from the patient's home to an emergency care unit. A remote interpretation represents a typical example of asynchronous interaction by a physician (tele-reporting) of data previously transmitted by the patient (e.g., telemonitoring of home BP). The asynchronous approach may be particularly helpful in managing large numbers of patients: messages confirming normality (e.g. of BP levels) can be forwarded in real-time and automatically on a large scale through specific interpretative algorithms running on the telemedicine web platform, limiting live communication where parameters are abnormal, and the patient needs to be managed promptly.

CLINICAL EFFICACY AND MANAGEMENT MODELS

In the last decade, numerous randomized controlled studies have documented more considerable BP reduction and enhanced BP control when a telemedicine approach is employed instead of usual care[13-23]. Some of the studies also addressed the efficacy of telemedicine beyond improvement in BP control, showing some benefits in terms of optimization of the use of antihypertensive medications, improved adherence to treatment (mainly when using mobile apps), reduced frequency of office visits and resort to laboratory tests, improved quality of life. Recent evidence from several studies suggests that important secondary effects of telemedicine leading to improved BP control are enhanced patient engagement, improved adherence to the care plan, better knowledge about BP, and patient satisfaction with the intervention[24,25]. However, the evidence of the strength of these effects is, at the moment, less solid than that for BP reduction and normalization. The results of these studies were summarized in a few meta-analyses [Figure 1].

Unfortunately, there is still high heterogeneity of interventions, technologies, and study designs, which makes identifying the best solution challenging and the sustainability and long-term clinical effectiveness of these interventions unclear. According to the current evidence, solutions based on BP telemonitoring and tracking of additional vital and non-vital signs with data exchanged between patients and a healthcare professional (for instance, a pharmacist or a nurse under the supervision of a clinician) through the web, text messaging, e-mails, or remote video consultation, supplemented with education on lifestyle, risk factors and correct use of antihypertensive drugs seem to be the most effective ones. The greatest effect is observed when the delivery of the intervention is proactive and not passive; namely, it requires the patient to take some actions under the guidance of the healthcare professional (e.g., increase medication dosage or change the type of medication, change lifestyle, increase physical activity, etc.).

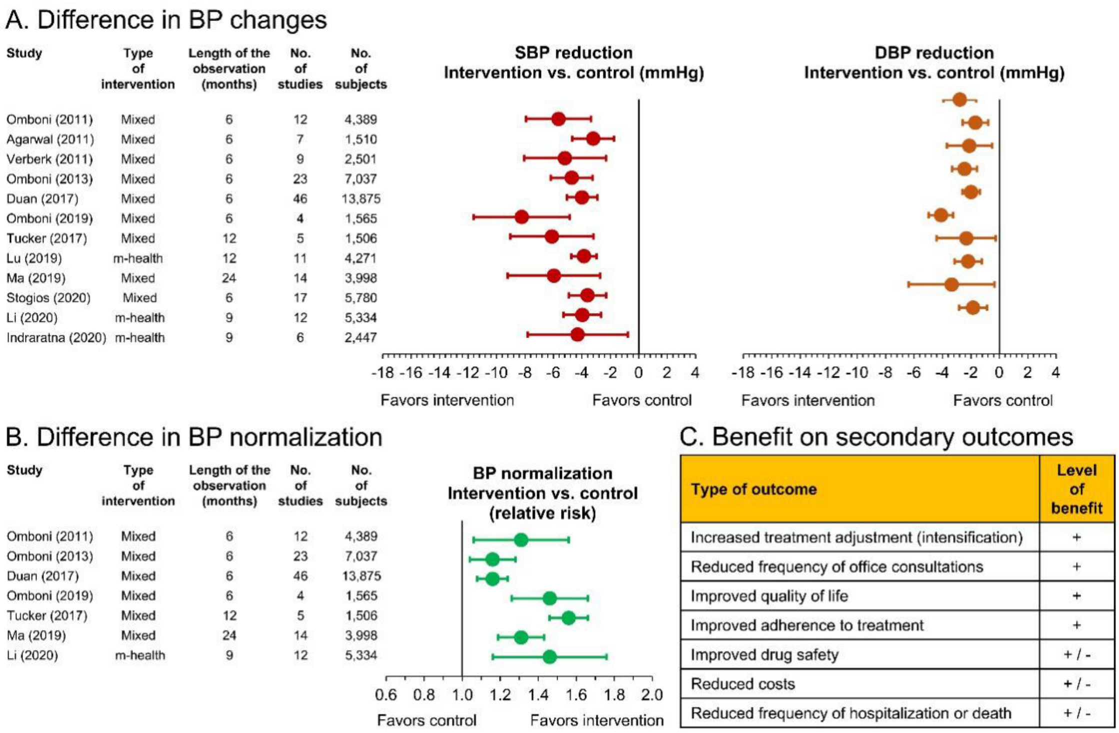

Figure 1. (A) Difference in systolic and diastolic blood pressure changes; (B) frequency of blood pressure normalization; and (C) impact on secondary outcomes of home blood pressure telemonitoring compared to usual care in different meta-analyses of randomized controlled studies. Data are shown as mean difference or relative risk and corresponding 95% confidence interval. The type of intervention in the various meta-analyses was commonly mixed, though a few publications focused on interventions relying exclusively on m-health. The length of the observation was always greater than 6 months. SBP: Systolic blood pressure; DBP: diastolic blood pressure; BP: blood pressure. Updated and redrawn with permission[11].

Few randomized controlled trials and meta-analyses have focused on evaluating the benefit of telemedicine interventions compared to usual care in specific subgroups of hypertensive patients. Hypertensive patients with uncontrolled BP, those at high risk of developing cardiovascular diseases, or those with multiple comorbidities (e.g., obesity, diabetes, previous stroke) appear to benefit most from telemedicine interventions[12].

THE ROLE OF TELEMEDICINE DURING COVID-19

During the recent coronavirus pandemic, telemedicine has emerged as an indispensable tool to improve the surveillance of patients with COVID-19, stem the spread of disease, make prompt identification and management of ill people easier, and, most importantly, ensure the continuity of care of patients with multiple chronic diseases[26]. The potential importance of telemedicine to improve BP control has been emphasized by the difficulties in managing hypertensive patients due to social distancing and isolation. Traditional ambulatory care and access to hospital facilities were disrupted: many patients delayed or deferred necessary care, including preventing care. According to a survey of the World Health Organization, including 155 countries, during the pandemic, hypertension services have been partly or wholly disrupted in 53% of countries, diabetes-related services in 49%, cancer-related services in 42%, and cardiovascular emergency services in 31%[27]. In most (94%) of the surveyed countries, healthcare staff working in the area of non-communicable disease was partially or fully reassigned to support COVID-19. As a consequence of this compromised care, a rise in BP was observed in the population during the outbreak. In 464,585 US adults, annual BP increase was significantly higher from April to December 2020 than in 2019: mean monthly increases ranged from 1.10 to 2.50 mmHg for SBP and 0.14 to 0.53 mmHg for DBP[28]. In a study conducted in Argentina involving 12,144 patients in the period corresponding with the lockdown implementation, a reduction in the frequency of hypertensive patients admitted to the emergency department was observed (54% less than in the pre-lockdown period)[29]. However, admission to the emergency department during the mandatory social isolation period was linked with a 37% increase in the odds of having high BP (≥ 160/100 mmHg). Similarly, a retrospective Spanish study involving 288 primary care practices showed a significant worsening of BP control[30].

During the pandemic, changes in practice characteristics for managing hypertension were observed. In a survey involving 1502 primary care providers, obstetricians-gynecologists, and nurse practitioners/physician assistants, conducted during fall 2020, implementation or increase in the use of telemedicine was observed in 47% of participants[31]. When hypertensive patients could be managed remotely with telemedicine, an improvement in BP control was observed in two different studies, one conducted in the US and one in France. In the first study, during the first 12 months of the pandemic (March 2020 through February 2021), 77% of 569 hypertensive patients managed with telemedicine video visits and home BP monitoring experienced an improvement in BP control with mean SBP and DBP reduction of 9.7 and 6.8 mmHg, respectively[32]. No differences in BP improvements were observed according to age, sex, or geographic area of residence (rural *vs.* urban). The patient survey indicated a high degree of patient satisfaction, with 97% of patients rating the visit 4 or 5 on a scale ranging between 1 and 5. In the second study, 2273 hypertensive patients were monitored with a connected BP measuring device during the 2020 lockdown[33]. A significant decrease in SBP and DBP (3.0 and 1.5 mmHg, respectively) was observed during confinement. The decrease was more significant in subjects presenting initial higher BPs.

In Italy, we performed two separate analyses on BP data collected through ambulatory BP telemonitoring in community pharmacies or general practices and at home with self BP telemonitoring[34]. We compared the rates of BP control in the 2 months preceding the lockdown (January to March 2020), during the 2-month lockdown period (March to May 2020), and in the 2 months following the lockdown (May to July). Data collected during 2020 were also compared to those obtained in the corresponding periods in 2019 in the absence of COVID-19. The number of subjects presenting to community pharmacies or general practices to carry out an ABPM dramatically dropped during the pandemic and compared to the same periods of 2019, while the number of home users and the quantity of data exchanged between patients and doctors from home increased during the containment period and compared to 2019. During the pandemic 24-hour BP control improved and was much better than that observed in the same period of 2019 [Figure 2A]. This figure also held for home BP [Figure 2B]. The evidence of improved BP control during and after the lockdown confirms that remote patient monitoring through telemedicine helped doctors connect with their patients and maintain their BP under control.

CURRENT RECOMMENDATIONS

Before the COVID-19 pandemic, the use of telemedicine for hypertension management was incompletely and partially recommended by major hypertension guidelines. Only the 2017 high BP clinical guidelines issued by the American Heart Association and American College of Cardiology specifically recommended telehealth strategies to reduce BP in adults with hypertension[35]. Following the increased implementation of telemedicine for monitoring patients at home during the COVID-19 pandemic, few position papers have been published, reporting more detailed indications and recommendations. The first comprehensive publication originated from a pool of international experts and was published in November 2020[12]. The paper presented an updated review of the technologies, clinical usefulness, and application of telemedicine

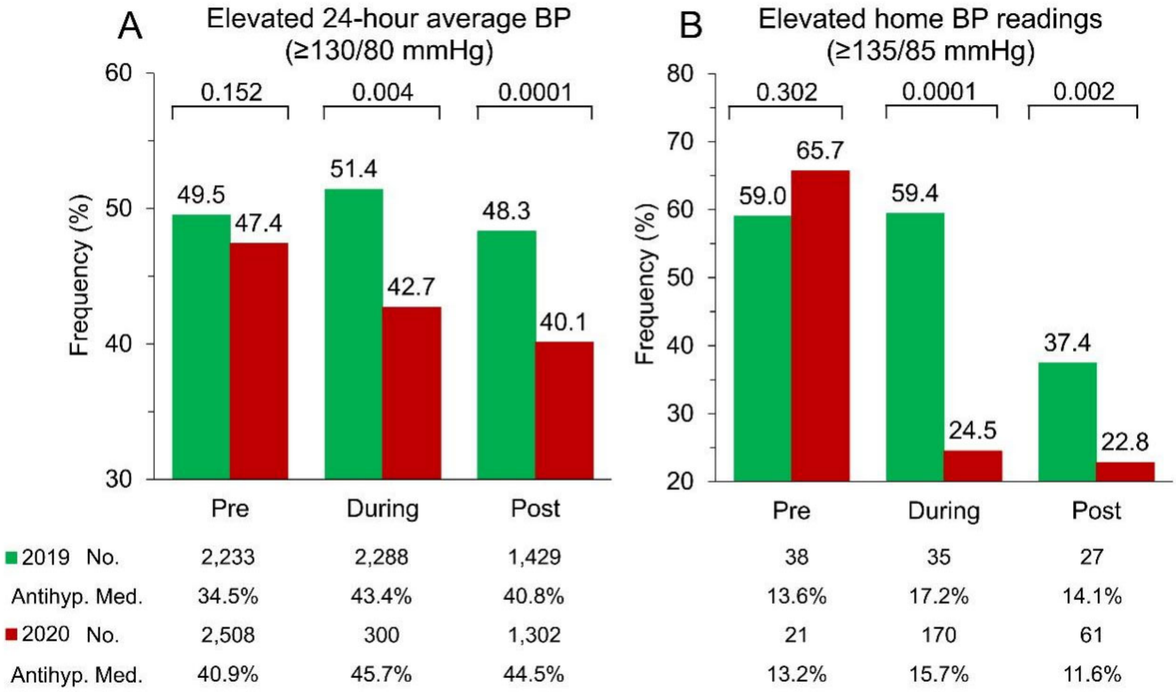

Figure 2. Frequency (%) of uncontrolled BP as assessed by ambulatory telemonitoring in community pharmacies or general practices (A) and by home telemonitoring (B) before (January to March), during (March to May), and after (May to July) the 2020 general lockdown in a large Italian cohort of subjects. Data are shown and compared for matching periods of 2019 (non-pandemic year). The *P* values for the comparison between 2020 and 2019 are reported on top of each pair of bars. Uncontrolled BP is defined by a 24-hour average SBP ≥ 130 and/or DBP ≥ 80 mmHg in the case of ambulatory telemonitoring and by SBP ≥ 135 and/or DBP ≥ 85 mmHg in the case of home telemonitoring. For further details, see the main text. Redrawn with permission[34].

and ultimately provided practical recommendations for telemedicine tools in hypertension management [Figure 3].

More recently, a position paper of the European Society of Hypertension on home BP monitoring, published in September 2021, provides a section discussing the role value of home BP telemonitoring. Although the experts agreed on the intervention's potential to enhance BP control, increase patients' adherence to treatment, and improve the doctor-patient relationship, they did not provide any practical recommendations on telemedicine for hypertension management[36].

A Spanish Society of Hypertension position paper published in April 2021 entirely focused on the detailed description of a telematic care and communication model for patients with hypertension and cardiovascular risk [Figure 4][37]. According to the proposed patient-centered care model, telemedicine is used to interact with multiple health agents and with primary and hospital care through the patient platform, which should be multidirectional and fed by clinical and laboratory data stemming from the patient's medical record.

A recently published position paper led by experts of the International Society of Hypertension provides practical guidance on the virtual management of hypertension following COVID-19[38]. The authors propose three different models tailored according to available resources and patient's features: (i) basic care in case of fewer resources or limited patient capacity or engagement with intervention-based telephone support and recording of home BP values at home with a device with automatic memory; (ii) advanced care in case of moderate resources or sufficient patient capacity or engagement and with asynchronous home BPT with

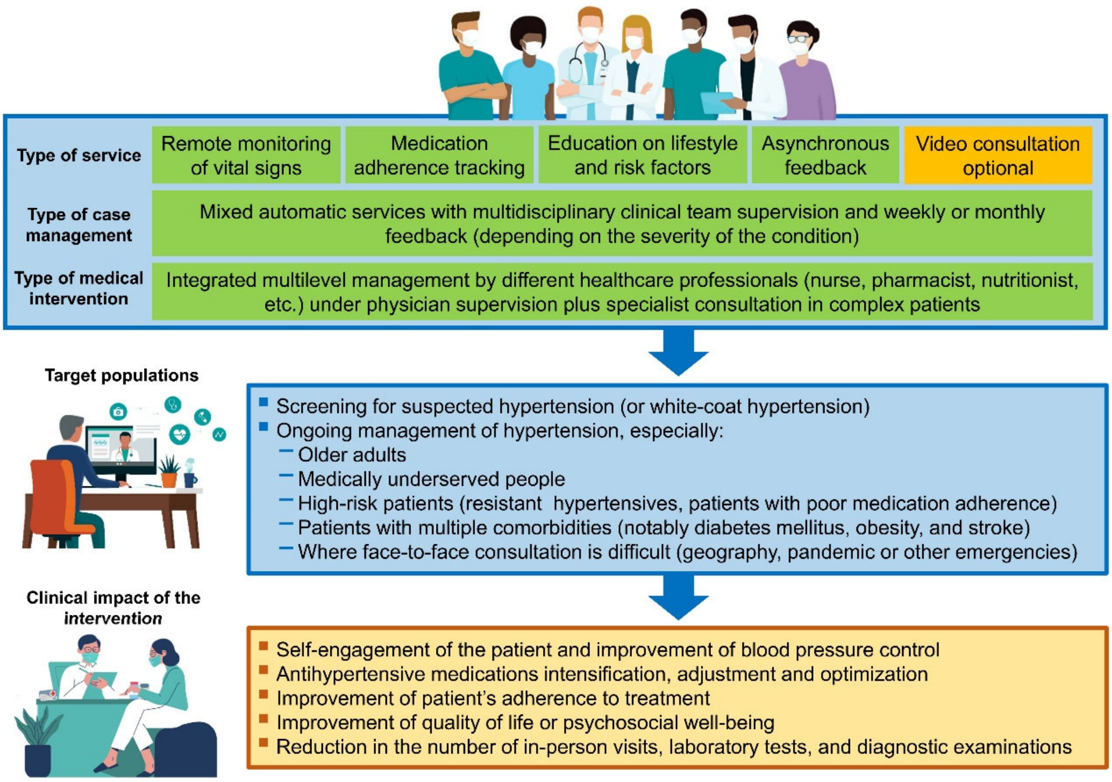

Figure 3. Healthcare model for hypertension management with telemedicine according to an international expert position paper. The top box summarizes the type of services, case management, and medical intervention defining an optimal telemedicine intervention. The mid box refers to the subjects to whom telemedicine should be targeted. The bottom box indicates the typical benefits of the telemedicine intervention. Redrawn with permission[12].

automatic transmission and telephone, online or video support with the care provider team; (iii) complete virtual care for high resource or when patient capacity and engagement are appropriate. In the last case, asynchronous home BPT with automatic transmission is complemented with multidisciplinary team-based education (pharmacist, nursing, healthcare community worker) and interactive digital tools. The complexity of the intervention varies according to the resource and patient engagement, from antihypertensive treatment adjustment and monitoring of non-adherence for the entry-level to psychological counseling, medication management by the pharmacist, or even self-titration using a simple self-management algorithm for selected patients in the complete virtual model.

FUTURE TRENDS

During the recent COVID-19 pandemic, telemedicine has boomed due to the high demand for increased accessibility to care, the need to reach frail patients isolated at home, and the potential for eradicating delays in the delivery of care. COVID-19 represented the beginning of a new era for digital health and telemedicine and paved the way for future development, hopefully leading to the integration of digital health solutions in clinical practice. Major future trends for technological development and further diffusion of digital health and telemedicine in the care of hypertensive patients are summarized in the following sections.

Artificial intelligence and machine learning

Artificial intelligence will represent one of the most critical keys to digital health transformation. The inclusion of artificial intelligence in telemedicine for hypertension management can improve patient risk

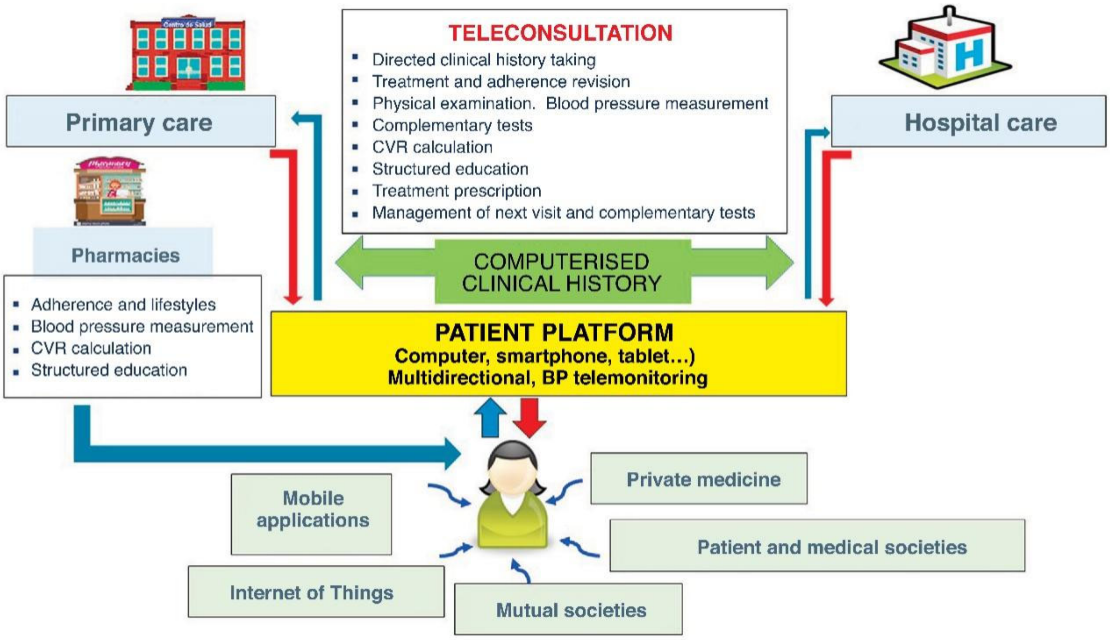

Figure 4. Proposal for a telemedicine and telematic care and communication model for patients with hypertension and significant cardiovascular risk. A computerized patient platform, usually resident on the web and accessible through a PC, smartphone, or tablet, is fed with clinical data primarily obtained through a teleconsultation in primary or hospital care. Healthcare professionals at these facilities can interact with the patient through the platform for providing care and treatment management. Pharmacies can act as important members of the team by providing education on lifestyle and risk factors, monitoring adherence to medication, measuring blood pressure, and assessing the patient's cardiovascular risk level. Data collected by the patient through mobile applications, various sensors (e.g., blood pressure monitors), or during in-person visits in private facilities can be entered into the platform and shared with the healthcare team, supplementing and integrating the data collected through teleconsultation. BP: Blood pressure; CVR: cardiovascular risk. Redrawn with permission[37].

stratification, predict BP levels and health outcomes, and ultimately favor precision medicine centered on the person and his/her clinical condition[39]. Artificial intelligence is not meant to replace the physician's decision and intervention, but it will improve physicians' efficiency, clinical efficacy, and diagnostic accuracy. A typical application of artificial intelligence to cardiovascular and hypertension care is machine learning, which identifies input data patterns and features and performs the prediction of generated output[40]. When based on a large amount of reliable data, machine learning can estimate BP and other parameters from a continuous pulse wave with no need for calibration over time[41]. Machine learning can also estimate vascular age by pulse wave analysis and detect artifacts and reduce uncertainty in BP detection[11]. Although promising, the major drawback of machine learning is that even a perfect model is limited in its predictive power by the quality and magnitude of the signal in the dataset from which it is trained: an excessive *"noise"* in the training data can negatively impacts the performance of the model on new data and lead to overfitting[39,40].

Two examples of possible machine learning applications for telemedicine for hypertension management are depicted in Figure 5.

Smart wearables and cuffless BP monitors

Smart wearables are consumer-level sensors that can be worn as accessories or embedded into clothing. This term includes a vast range of devices such as smartwatches, rings, wristbands, fitness trackers, and pedometers. Less common wearables are sensor patches, clothes made with smart textiles, and even

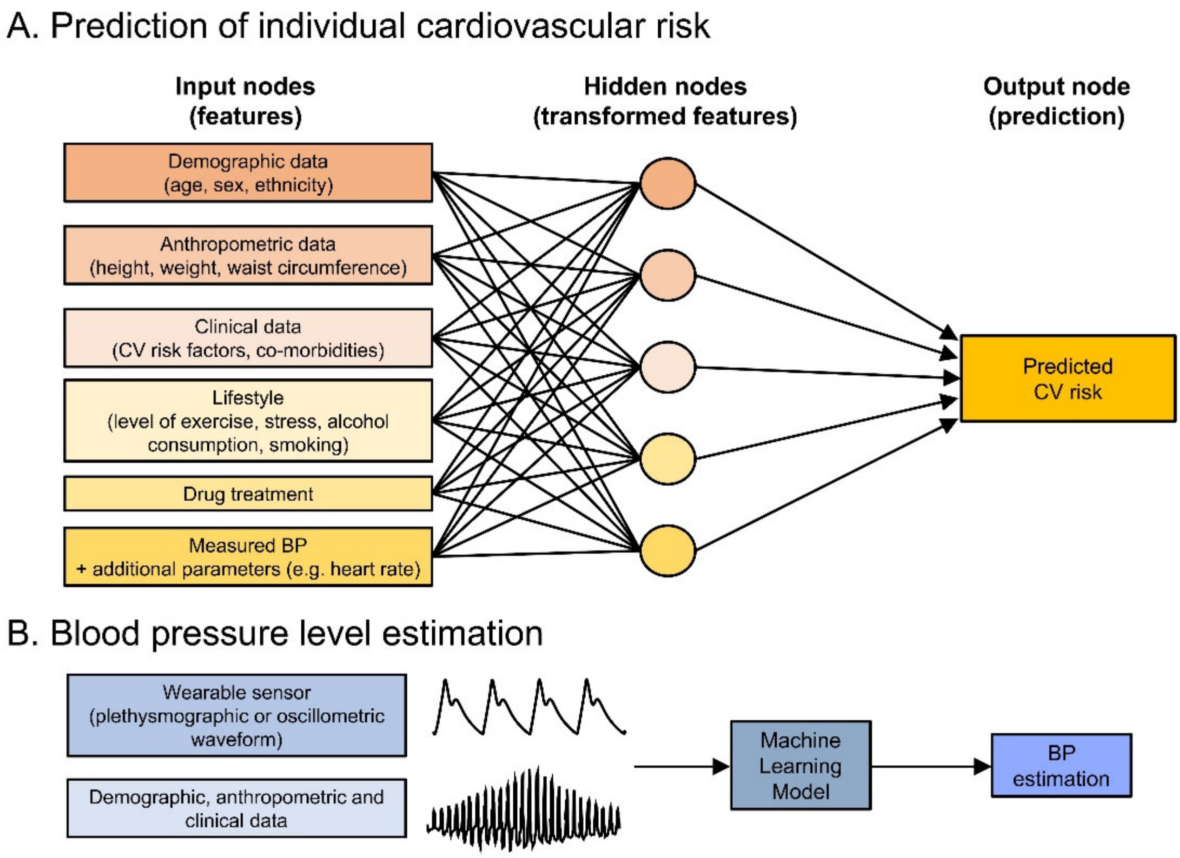

Figure 5. Operating scheme of two typical machine learning applications for blood pressure and hypertension monitoring. In the example of panel A, the patient's features and measured blood pressure are fed to a machine learning algorithm, usually based on deep learning, and the system predicts the patient's cardiovascular risk. In the example of panel B, the pulse wave recorded with a wearable sensor is entered together with the patient's demographic, anthropometric, and clinical data into a machine learning model, and the blood pressure level is predicted. CV: Cardiovascular; BP: blood pressure. Redrawn with permission[11].

ingestible sensors in the form of pills. Generally, wearables are linked through smartphone apps to the cloud to allow clinicians to monitor BP and health status. Techniques used by wearables to measure BP include i) devices that require the use of a cuff that applies a given pressure on the body segment during the measurement (full arterial occlusion), as for arm or wrist cuff-based oscillometric devices; ii) devices that apply a partial arterial occlusion, like those based on volume-clamp or applanation tonometry; iii) cuffless devices that do not create any artery occlusion[42]. Cuffless BP monitors usually rely on photoplethysmography and the measurement of pulse wave velocity (pulse arrival time, pulse transit time, etc.) or pulse wave analysis (it extracts features from the arterial waveform, usually with a data-driven method based on machine learning), and they also encompass non-wearable tools[42]. More recent cuffless technologies, based on facial video processing, can estimate BP with transdermal optical imaging and artificial intelligence and may have great potential when integrated into smart city solutions for the surveillance of many individuals[43].

Wearables and cuffless devices can measure BP over a long period and integrate it with the measurement of additional functional parameters, such as heart rate, oxygen saturation, physical activity, posture, sleep, etc. Unfortunately, since these devices were initially targeted at the consumer, they have often been introduced on the market before or even without validating their accuracy, safety, and reliability for health care purposes. Indeed, a large proportion of wearable BP monitors on the market are unvalidated: a recent survey of the online marketplace in Australia has found that of the 532 wristband wearables available for purchase, none was clinically validated according to internationally accepted standards[44]. In the case of validated and accurate devices, it must be noted that current validation standards do not fully apply to cuffless devices and are unable to determine the ability of the devices (particularly those requiring periodic calibration) to predict BP across different people and to track short- and long-term BP changes within a given individual[45]. A recent meta-analysis of 16 validation studies documented a reasonable accuracy of the tested cuffless devices[46]. However, the authors highlighted that most of the devices were prototypes and not available commercially, used a wide range of different BP sensor technologies, and there was a lack of standardization of validation protocols that limited the comparability of findings across devices and the identification of the most accurate monitor.

The use of wearables, particularly cuffless BP monitors, is challenging given their potential inaccuracy due to i) the effect of hydrostatic changes on BP when the measuring site (wrist or finger) is not kept at the heart level during the measurement; ii) motion artifacts occurring during daily life activity; iii) need of regular calibration with a reference BP, usually taken at the upper arm with an oscillometric device. For these reasons, these devices should be ideally used under the supervision of a healthcare professional who can check the quality and reliability of the readings and provide timely instructions to the users. When clinically validated smart wearables are appropriately used by the patient in association with a smartphone app that forward BP values to the doctor, they have the potential to expand the use of remote monitoring and thus improve hypertension screening and management.

Multiparametric devices and ambient sensors

An interesting potential application of telemedicine is the integration of multiple parameters, including BP, with data entered into a risk algorithm able to outline the individual's cardiovascular health and predict future risk. These so-called *"medical tricorders"* are usually handheld portable devices used by consumers to collect information on their medical condition and basic vital signs (BP, ECG, heart rate, SpO_2, body temperature). Such applications may also work through sensors disseminated in our homes, which may pick up potential diseases when the household individuals are at home[47]. Ambient sensors can be placed in different locations in a smart home to monitor human behavior and health status. Individual or combined ambient sensors, including passive infrared motion sensors, video sensors, pressure sensors, sound sensors, and radar sensors, often integrated with machine learning applications, can be used to detect movements, monitor physical activity, presence in chairs or beds, the occurrence of significant events (e.g., falls), toilet visits, use of internal and entrance doors, etc. Ambient sensors are usually disseminated in several sites inside and outside the house, but they can also be grouped in a mobile robot. Wearable sensors integrated into a smart home can monitor heart rate, BP, respiration, muscle movements, blood flow, oxygen saturation, temperature, etc. Preliminary evidence suggests that ambient sensors may be beneficial for the early detection of health deterioration, particularly in older patients[48]. Figure 6 shows a schematic of a smart apartment remotely connected to a caregiver and family and used to monitor an older adult's behavior and health status[47].

PERSPECTIVES AND CONCLUSIONS

Telemedicine can be a solution to the challenging problem of achieving optimal BP control and overcoming non-adherence to antihypertensive medication use. During the COVID-19 pandemic, telemedicine has been increasingly adopted and has been found helpful in reaching people confined at home and ensuring continuity of care. Doctors and patients are now aware that telemedicine represents a unique opportunity to improve hypertension control, and its use will not be abandoned after the pandemic. Telemedicine will

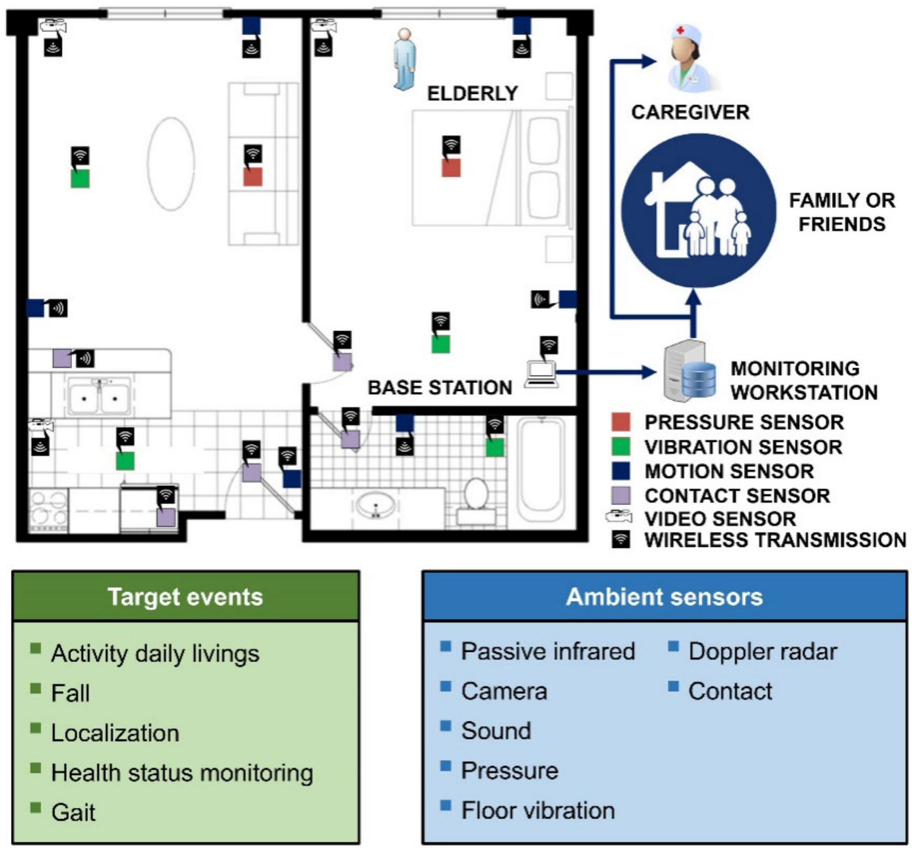

Figure 6. A simple schematic of a smart apartment for elderly care based on different ambient sensors. Pressure sensors are applied to detect the presence of residents on chairs, couches, or in bed. Vibration sensors placed on the floor, motion sensors installed on walls or ceilings, and contact sensors integrated into door handles or kitchen worktops are used to monitor different types of activity (e.g., movements within the apartment, stove use, use of water, opening of cabinets, etc.). Most commonly, the sensors are based on infrared or audio-video technologies. Data of specific activities are collected continuously and wirelessly transmitted to the caregiver of a user through a base station. Then, the collected data are interpreted to analyze trends to detect changes in daily activities and health status. Redrawn with permission[47].

become an integral part of the model of care for hypertensive patients, particularly those at higher risk of complications. It is forecast that telemedicine will be very popular due to the improvement in technology, simplification of use, and increased connectivity due to enhanced infrastructures, particularly in low- and mid-income countries, where proper care is accessible to a limited portion of the population. In order to improve hypertension screening and provide appropriate and sustainable care to all hypertensive patients, efforts must be devoted to managing data security issues, validating models of care, identifying digital biomarkers that may efficiently predict outcomes and ensure adequate care, breaking down cultural and social barriers, ensuring equitable and economically sustainable care to all subjects with established or at risk of hypertension.

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Author's contribution

The author contributed solely to the article.

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Conflicts of interest
The author is a scientific consultant of Biotechmed Ltd, a provider of telemedicine services.

Ethical approval and consent to participate
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Consent for publication
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