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Review

Hypertension in Developing Countries

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ABSTRACT

The past 2 decades have seen a considerable global increase in cardiovascular disease, with hypertension remaining by far the most common. More than one-third of adults in Africa are hypertensive; as in the urban populations of most developing countries. Being a condition that occurs with relatively few symptoms, hypertension remains underdetected in many countries; especially in developing countries where routine screening at any point of health care is grossly underutilized. Because hypertension is directly related to cardiovascular disease, this has led to hypertension being the leading cause of adverse cardiovascular outcomes, as a result of patients living, often unknowingly, with uncontrolled hypertension for prolonged periods of time. In Africa, hypertension is the leading cause of heart failure; whereas at global levels, hypertension is responsible for more than half of deaths from stroke, just less than half of deaths from coronary artery disease, and for more than one-tenth of all global deaths. In this

RÉSUMÉ

Les 2 dernières décennies ont été marquées par une importante augmentation des maladies cardiovasculaires dans le monde, dont l'hypertension artérielle demeure de loin la plus fréquente. Plus d'un tiers des adultes de l'Afrique sont hypertendus, comme dans les populations urbaines de la plupart des pays en voie de développement. Étant une affection qui présente relativement peu de symptômes, l'hypertension est sous-dépistée dans plusieurs pays, particulièrement dans les pays en voie de développement où le dépistage systématique à tout point de service est très largement sous-utilisé. Puisque l'hypertension est directement liée aux maladies cardiovasculaires, elle est la cause principale des résultats cardiovasculaires négatifs du fait que les patients vivent souvent sans s'en apercevoir avec une hypertension non contrôlée durant de longues périodes de temps. En Afrique, l'hypertension est la cause principale de l'insuffisance cardiaque, alors qu'à l'échelle mondiale, l'hypertension est responsable de plus

Recent efforts from the Global Burden of Disease Study show that blood pressure, alongside tobacco use and household air pollution to be the leading risk factors for global burden of disease.[1] In the past decades, hypertension, once considered to be of low prevalence in the developing world, has become the fifth most important risk factor for adverse health in developing countries. It follows that, despite higher prevalence of hypertension in the developed world, the greater proportion of the world's population living in developing countries results in a higher absolute number of hypertensive patients in these poorer societies. This is concerning, in view of the struggle developing countries have endured since the onset of their existing dual burden of disease; that of communicable and emerging chronic diseases. Amid these chronic diseases, however, the disproportionate surge of hypertension in developing societies appears to come with increased risk for adverse outcomes compared with developed societies, primarily because of the lower levels of awareness and control of hypertension. Yet, contributing to this increased risk in developing countries is the younger age of onset, and potentially more aggressive disease course observed in younger persons, with hypertension in persons of black African ancestry reportedly occurring from younger ages, and being more aggressive.[2,3] In this review, we attempt to discuss the escalating occurrence of hypertension in developing countries, before exploring the strengths and weaknesses of different measures to control hypertension.

The assessment of hypertension in developing countries is a not an easy task. One reason for this is the laxity in terminology used to define a developing country. The World Bank defines developing countries as those with a Gross National Income (GNI) per capita less than USD$12,616.[4] This includes low-income countries, defined by a GNI of <$1026, but, interestingly, also includes the vast group of the upper- and lower middle-income countries, each defined by GNIs of $4036-$12,475 and $1026-$4035, respectively.[4] This means that within the single category of developing countries, we are pooling the poorest countries, having GNIs in the order of $400, with the wealthiest of middle-income countries, with GNIs up to 20- to 30-fold greater. Across such diverse economies, it is almost impossible to generalize the circumstances under which hypertension occurs. Ironically, these are exactly the countries where, due to resource

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review, we discuss the escalating occurrence of hypertension in developing countries, before exploring the strengths and weaknesses of different measures to control hypertension, and the challenges of adopting these measures in developing countries. On a broad level, these include steps to curb the ripple effect of urbanization on the health and disease profile of developing societies, and suggestions to improve loopholes in various aspects of health care delivery that affect surveillance and management of hypertension. Furthermore, we consider how the industrial sectors' contributions toward the burden of hypertension can also be the source of the solution.

de la moitié des décès dus aux accidents vasculaires cérébraux, d'un peu moins de la moitié des décès dus à la coronaropathie et de plus d'un dixième de tous les décès dans le monde. Dans cette revue, nous discutons de la survenue de plus en plus fréquente de l'hypertension dans les pays en voie de développement avant d'examiner les forces et les faiblesses des différentes mesures pour maîtriser l'hypertension, et des difficultés liées à l'adoption de ces mesures dans les pays en voie de développement. Sur une vaste échelle, ces dernières incluent des étapes pour limiter l'effet d'entraînement de l'urbanisation sur la santé et le profil des maladies des sociétés en voie de développement, et des suggestions pour combler les lacunes des divers aspects de la prestation des soins de santé qui nuisent à la surveillance et à la prise en charge de l'hypertension. De plus, nous examinons comment le secteur industriel qui contribue au fardeau de l'hypertension peut également être la source de la solution.

constraints and a historic sense of health prioritization, data on hypertension are more difficult to find. This provides the second hindrance to evaluating the scope and effect of hypertension in developing countries: the lack of reliable clinical and epidemiological data on hypertension in these countries. In conducting this review, we searched MedLine for articles about hypertension in developing countries that were published between the year 2000 and September 2013. We used the key terms "hypertension," "developing countries," "prevalence," "incidence," "treatment," "control," "risk factors," and "salt." We also searched references of relevant publications.

The Epidemiological Transition of Hypertension in the Developing World

It is important to highlight the transformation that has occurred within developing countries, from almost nonexistent reports of hypertension 40 years ago,[5] to the statistics described herein, to current predictions that by 2025, almost 75% of the world's hypertensive population will be found living in developing countries.[6] Landmark reports such as those of Donnison early in the 20th century state that while attending to more than 1800 patients over a 2-year period of clinical activity in rural Kenya, not a single high blood pressure reading was made.[7]

In particular, the past 2 decades have seen a considerable global increase in cardiovascular disease, of which hypertension remains by far the most common across the world. For example, more than one-third of adults living in Africa are hypertensive.[8] Being a condition that occurs with almost no symptoms to the patient, hypertension remains underdetected in many countries. This is especially true in developing countries, where routine blood pressure screening at any point of health care is grossly underutilized. It is only recently that more consistent epidemiological data have emerged from developing countries on hypertension; particularly data generated by the wide use of the World Health Organization (WHO) **Step**wise Approach to **S**urveillance (STEPS).[9-11]

Much of the data remain insufficient to clearly delineate population-based trends in blood pressure readings over the past 20 years. This said, it does suffice to show rapidly increasing prevalence and incidence of hypertension; not only in most urban areas of these countries, but also in more remote areas. For example, in rural China, the incidence of hypertension, analyzed during the period 2004-2008 was 11.4% compared with an incidence of 3.7% found in the previous decade.[12] Another such study compared the prevalence of hypertension in a rural community of northern China at 2 different points in time: 1991 and 2011. Within this 20-year period, the authors showed a 30% increase of prevalence of hypertension from 39.9% to 51.7%[13]; with this increase being more marked in young women. During this same period, it was noted that although there was a 10-fold increase in the levels of control of hypertension (0.3% to 3.2%), hypertension was still very poorly controlled. In another study done across the rural, urban, and slum areas of North Kerala in India, the weighted prevalence of hypertension was 29%, with no statistical difference between sex or residential area.[14] In an Indonesian study that adopted the WHO STEPS approach, a prevalence of 22% (95% confidence interval [CI], 21%-24%) was found in a population of urban and rural origins. In this study, hypertension was more prevalent in the urban setting, and the richest quintile of the rural setting had a 1.5-fold greater risk of being hypertensive when compared with the poorest quintile of the same setting.[15]

Overall, most epidemiological studies show the prevalence of hypertension to be greater in urban areas when compared with the rural areas of the same country. Areas that have been urbanized for longer periods of time appear to have greater prevalence of obesity and diabetes, in addition to higher stress levels; all of which contribute to an increased prevalence of hypertension.[16] The chaotic fashion in which the process of urbanization unfolds within developing nations is further characterized by the progressive disappearance of open areas where natural forms of exercise can be done. Parks and other publically open terrains that would previously form grounds for recreational sports or convenient footpaths along which to walk across villages and towns continue to be replaced by "development projects" that span from the construction of new buildings and car parks, to informal markets and settlements. In this manner, folk that were previously accustomed to walking or cycling long distances, to work in agricultural fields or semirural towns, have become increasingly reliant on motorized transport, thereby predisposing them to obesity through reduced daily exercise and activity. Across the world,

urbanization has thus been accompanied by an increase in obesity that is directly related with hypertension.

Causes for the Increase in Hypertension in Developing Countries

The extent of blood pressure increase with age, and hence the development of hypertension, reflects a complex and dynamic interaction between genetic and environmental causal factors; the former accounting more for intraregional variation.[17] Other major determinants of blood pressure levels in the population are overweight and obesity, physical inactivity, high alcohol consumption,[17,18] and diabetes,[19] which all intercorrelate, but of which obesity remains by far the greatest risk factor for developing hypertension, and for poor control of hypertension.[16,20] In keeping with these observations, most differences in the reported prevalence of hypertension across developing countries do appear to be explained by the levels of obesity between the respective populations.[21] A more recent evaluation of 6 middle-income countries also showed hypertension to correlate with obesity.[22] Some reports even go as far as to suggest that, in developing countries at least, the presence of hypertension is essential for obesity to be a risk factor for cardiovascular mortality.[23] However, more thorough assessments of these associations are required in developing countries, because there are a number of confounding factors, including HIV and AIDS, which in itself carries risk of adverse cardiovascular outcomes, but which brings low body mass index[23] and obesity, particularly with the use of certain antiretroviral regimens.

Westernization of developing countries is a terminology that refers not only to high levels of physical inactivity and obesity, as described herein, but also to the consumption of processed, high-salt/high-fat foods in urban areas. Cardiovascular disease, most notably stroke, are on the increase with Westernization, and with increased rates of hypertension and diabetes, although truly rural populations are still relatively protected.[16] Although the technological revolution, industrialization, and subsidized agriculture[23] are to blame for much of the global epidemic of obesity, additional contributors in developing countries include the by-products of their growing economies, namely, urbanization, affordable motorized transport, and more reliable food supplies. From a dietary perspective, contributions toward obesity include an increased caloric intake of traditional foods, in addition to shifts toward Westernized diets containing more sugar and salt, most of which are provided and promoted by large multinational companies.[23] It also includes the decreasing proportions of food costs from the share of household expenditure.[18] Most importantly, the surge in obesity is fueled by the overwhelming availability of affordable highly processed and "fast" foods, together with highly refined fats, oils, and carbohydrates compared with those in healthier natural foods, across urban areas of developing countries.

As our understanding of the influence of dietary factors on the development and sustenance of hypertension improves, it becomes apparent that, at least in certain developing regions of the world such as Africa, the routine use of high concentrations of salt in the preparation and preservation of food, where refrigeration and modern gustatory ingredients were often not available, might have contributed to the development of hypertension. This would also partly account for the younger age of onset of hypertension in such populations, compared with other societies, for the respective waist size. In virtually all mammals, high blood pressure is caused or aggravated by high salt intake; yet this is also reversible on reduction of salt intake.[17] Large studies have showed positive associations between urinary sodium excretion (a marker of salt intake) and blood pressure within and between populations, and that children are especially vulnerable to the adverse effects of high salt intake.[17]

In accounting for the younger age at which the burden of hypertension commences in developing countries, it is equally essential to note that many developing countries also observe the onset of obesity from early childhood. Because of its strong association with the incidence and prevalence of hypertension, obesity in childhood might serve to be the most convenient of early measureable risk factors for the development of hypertension in the youth. The China Health and Nutrition Survey showed that not only are 11% of Chinese children are overweight, but 42% of children from this population have at least one cardiometabolic risk factor; one of these being hypertension.[24]

Other concerns for the development of hypertension in childhood or earlier on in life have emerged through the various theories on fetal "programming," suggesting that infants born preterm or with very low birth weight display modestly higher systolic blood pressure later in life, and that they are at increased risk of developing hypertension and its sequelae[25] earlier in adult life, or even in their teens. This bears grave implications for developing countries, where low birth weight continues to prevail in societies ravaged by malnutrition as a common consequence of poverty, substance abuse, AIDS, and other infectious disease. This might at least in part explain the growing burden of hypertension in developing countries, and its prominence and apparent severity in youths.[26]

Aside from the causes of low birth weight described herein, underdevelopment of the fetal kidney, measured according to reduced glomerular size and nephron number, has been directly associated with sodium retention and increased blood pressure in adult life,[27] and the development of chronic kidney disease later in life, which further perpetuates sodium retention and hypertension. Such renal underdevelopment occurs in conditions of food restriction, and in diabetic mothers, with varying degrees of renal underdevelopment resulting from different timing of the prenatal insult.[27] Again, this bears grave implications on our understanding of the origins of hypertension in developing countries, where intrapartum malnutrition and diabetes are still rampant. Chronic kidney disease strongly predisposes to hypertension and cardiovascular disease.[28] In turn, diabetes, hypertension, and cardiovascular disease are all major causes of chronic kidney disease.[16,28] However, the direct effect of these mechanisms on the epidemiology of hypertension are yet to be quantified, because at least one community in North-East India has demonstrated a high prevalence of childhood hypertension not fully accounted for by weight or kidney disease.[29]

Awareness, Treatment, and Control of Hypertension

Levels of awareness, treatment, and control of hypertension are alarmingly low in developing countries. Most studies of

awareness in low-income countries report only approximately one-third of their prevalent hypertensive population being aware of their hypertensive states at the time of study[20,21,30]; although some areas have as little as 18% awareness rates.[10] Interestingly, however, awareness of one's hypertensive state appears to remain a challenge across the world, where, despite the beginning of an early downward trend in the occurrence of hypertension because of better access to screening, poorer parts of countries such as Australia still report only one-third of prevalent hypertensive patients being aware of their status.[17] To further complicate matters, the proportion of known hypertensive individuals with controlled hypertension in developing countries continue to be low[16]; with 1 study involving 6 middle-income countries showing particularly low levels of control in adult men. In African countries, the percentage of patients with controlled hypertension seldom exceeds 5%, reaching 5.6% in Gabon,[31] and another survey from Tanzania showing only 1% of hypertensive patients to have had blood pressure readings less than 140/90 mm Hg.[32]

One possible reason for the low levels of awareness and control may be that governments and policy-makers in many developing countries continue to underestimate the new epidemic of noncommunicable diseases. Although this is partly due to overt resource constraints, at times less efficient prioritization and foresight might have been the bigger culprit. As a consequence, fundamental steps to the detection and monitoring of hypertension at the primary care level are missed because of the absence of basic instruments such as a simple, but functional, sphygmomanometer. In many parts of the poorer world, even if a sphygmomanometer was available, the measurement of blood pressure is routinely done during primary health care consultations. This might most often be because of the practitioner's tendency to focus on the more dramatic complaints of the numerous patients with infectious disease, obstetric illness, or trauma before them. However, primary care practitioners' thresholds for measuring blood pressure in low and middle-income countries has been known to be very low.[33]

Ground-breaking data emerging from intercontinental collaborative surveys across Africa and South-East Asia[34] show that the bulk of reasons behind poor compliance to treatment stem from poor insight into the chronicity of the condition, aggravated by the asymptomatic nature of hypertensive disease, in addition to poor social circumstances, led primarily by the cost of treatment and health care visits, the complexity of treatment regimens, and the cumbersome ways of the inefficient and inequitable health services.

Consequences of High Blood Pressure

Because hypertension is directly related to cardiovascular disease,[31] this has led to hypertension being the leading cause of adverse cardiovascular outcomes. In developing countries, this is most likely a result of patients living, often unknowingly, with uncontrolled hypertension for prolonged periods of time. For example, in Africa, hypertension continues to be the leading cause of heart failure.[35] At global levels, hypertension is responsible for more than half of deaths from stroke, and 45% of deaths from coronary artery disease,[8] and, alarmingly, for more than one-tenth of all global deaths.[8] In a prospective study done in Tanzania, hypertension-related diseases were found to be the second cause of hospital admission immediately after HIV disease, and accounted for 15% of all deaths.[36] Of key importance is that more than half of these deaths occurred in patients aged younger than 65 years, showing the negative effect that hypertension has on shaping the population life expectancy and productivity in such poor countries. Preliminary reports from the INTERSTROKE study, reveal how a self-reported history of hypertension or a blood pressure greater than 160/90 mm Hg was associated with almost a 5-fold increased occurrence of stroke in South-East Asia (odds ratio [OR], 4.49; 95% CI, 3.54-5.70), a 4-fold increase in India (OR, 4.36; 95% CI, 3.34-5.69), and almost a 5-fold increase in Africa (OR, 4.96; 95% CI, 3.11-7.91), respectively, compared with an odds ratio of 2.79 (95% CI, 1.83-4.25) in the high-income countries.[37] This highlights the importance of hypertension and its poor control in the incidence of stroke in developing countries.[38]

Just over a decade ago, hypertension was estimated to have caused 9% of all deaths in South Africa.[34] This report showed that, overall, 50% of stroke, 42% of ischemic heart disease, and 22% of other cardiovascular disease burdens in men and women aged older than 30 years were attributable to high blood pressure.[34] Although in South Africa, the burden of disease, defined as total disability adjusted life years lost, that was attributable to hypertension was 2.4% across both sexes, this figure reached 5.5% in Thailand.[34]

Hypertension also accounts for up to one-fifth of end-stage renal disease in developing countries,[28,31] and for chronic kidney disease affecting 7% of the world's population, and at even greater proportions in developing countries.[28]

Tackling Hypertension in Developing Countries

We have described how hypertension is as much a disorder of populations as of individuals.[17] This, together with its frequent concurrence with other major chronic diseases of lifestyle, means that interventions targeting populations and individuals need to be considered to reduce the burden of hypertension. However, from our analysis herein, it is clear that no single-blanket approach will be possible in addressing hypertension, because, for example, some of the risk factors for the development and for worse outcomes of hypertension appear to be those of overnutrition, and others are of undernutrition. Unfortunately, the complexities of many developing societies undergoing urban transitions is that both of these 2 forms of malnutrition will coexist within the same population.

The initial step in addressing the burden of hypertension in any society is to be conversant with the epidemiology and natural history; both of which remain underdescribed in many developing countries, especially sub-Saharan Africa. For areas that are only just commencing systematic surveillance of hypertension, they must still overcome the initial overestimates that might reflect not only increased incidence, but also increased awareness, which permits detection of hypertension, and the greater number of people living with hypertension because of better control methods.[39]

Salt is a high priority in tackling hypertension,[17] and, other than obesity, remains one of the few reversible causes of hypertension that directly decreases blood pressure when its intake is limited.[40] Of added benefit is the effectiveness of

restricting salt intake at the individual level, through individual patient counselling, and at the population level, as through policies restricting industrial salt content of processed foods, including bread.[40,41] Both are successful in the long run because of the ability of the taste buds to be 'trained' to become accustomed to a wide range of salt levels in food; although habituating the mouth to decremented salt concentrations is far more difficult than to increments, thereby rendering control of salt intake a major public health challenge.[17] The evidence remains, however, that salt taste thresholds decrease with decreasing intake, because food with a high salt content becomes unpalatable within 4-6 weeks of adopting a low-salt diet.[17] This has made population-level salt reduction more cost-effective to date than clinically-oriented interventions.[17] The WHO Global Burden of Disease Study suggests that societal-level action to stimulate a reduction in salt content of processed foods could avert more than 21 million total disability adjusted life years per year worldwide.[42] Aside from salt, however, is evidence of the beneficial effects of potassium, magnesium, and fibre from fruit and vegetables, and calcium and potassium derived from low-fat dairy products on blood pressure.[17,18]

Tackling obesity in the fight against hypertension requires measures to address physical inactivity from young ages and onward, and reducing caloric intake. Numerous success stories have emerged from industrialized countries that have observed reductions in the risk of cardiovascular diseases from the reversal of high-fat, energy-dense diets at the population level; yet few such success stories exist from developing countries. One such report has emerged from Iran, where a community-based program designed to promote healthy lifestyle behaviours using population and high-risk strategies, significantly reduced the prevalence of abdominal obesity, hypertension, hypercholesterolemia, and hypertriglyceridemia.[43] At the individual level, encouraging walking continuously for at least 10 minutes has been suggested to improve hypertension[21]; this should be quite feasible even in urban parts of developing country settings.

Clinically oriented approaches to reducing hypertension in developing countries will remain challenging for a number of different reasons. Many developing countries have no clear-cut guidelines on the management of hypertension in their setting, and although there will be practitioners who look to international guidelines for their daily management of patients, the investigations or medications stipulated in these guidelines are not always available in the developing country. Furthermore, without local guidelines to steer practitioners, there is variation in which the international guidelines are adopted in the various practices, and to the extent they follow the guidelines before improvizing.

Satisfactory treatment of hypertension requires not only adherence of practitioners to some form of orderly protocol, including those permitting early detection, but also patient adherence to taking their medication. Even in countries where national guidelines have been rolled out and advertised across the professional clinical community, practitioner adherence levels to the guideline protocol was found to be low,[33] and, level of awareness of the guidelines left much room for improvement. Although there will be a proportion of patients with varying degrees of resistant hypertension, noncompliance to medication remains the single most common reason for poor control of hypertension, for reasons described herein. Among the immediate complications of poorly controlled hypertension, mortality from stroke and reports in South Africa that show hypertensive patients of African descent to be twice as likely to die of stroke than their counterparts of European descent[16] most likely reflect the marred interplay of a disadvantaged education, inequitable access to good health services, and poor patient compliance. From the patient's perspective, encouraging compliance is best achieved through patient education and simplification of medication regimens. One study conducted a treatment adherence trial in more than 500 treatment-naive hypertensive patients in rural and urban Nigeria.[44] A nurse-led treatment program with a backup doctor was established and a simple thiazide diuretic and β-blocker treatment administered free of charge to patients, who were followed-up monthly for 6 months. At the end of 6 months an impressive 81% treatment adherence was achieved, with 66% having controlled hypertension. These very good results are probably the result of good patient education, in conjunction with a simple medication regimen, and the free service given to these participants during hospital visits.

Studies from Africa have shown factors associated with high self-reported compliance to include regular clinic attendance, not using non-Western prescription medication, and having social support.[45] Interestingly, beliefs about the cause of hypertension were not associated with compliance. Furthermore, although many respondents believe in the efficacy of treatment (be it orthodox or traditional), as in other parts of the world, many patients appear to have the misconception that they can stop their antihypertensive medication when they feel well.[45] However, data from other developing societies portray the extent to which persons with hypertension, a relatively silent disease, continue to seek informal health care for answers and for treatment. In Bangladesh, the importance of working together with informal allopathic practitioners in the public sector's fight against the chronic disease epidemic, and interventions aimed at standardizing informal allopathic practitioners' knowledge and practice[46] have been acknowledged.

Overall, health education, personalized and at the population level, appears to be the most effective in improving compliance to medication, and to healthier lifestyles on the whole. Across a number of Asian communities and in Pakistan, the combined intervention of home health education together with a trained general practitioner has been shown to be potentially affordable and more cost effective for blood pressure control than usual care or either strategy alone in some communities. Outside of the clinic and the home, portable health information kiosks have been shown to be a powerful tool for promoting health education in communities in urban and rural settings.[47] In Tanzania, alliance of traditional health care with conventional health care, in general, has been attempted through the establishment of a formal institute traditional medicine under tertiary training centres and below. Such efforts as these and those described in Joshi et al.[47] are perceived to be a benefit in many other developing countries.

Slightly less informal practitioners are the pharmacists, to which many patients turn for monitoring of their blood pressure and instant advice on their medication. Reports on pharmacist-provided services that target patients suggest

benefit to improvement in blood pressure control and in quality of life; although this has only been proven significant in middle-income countries,[48] possibly because of the wider use of clear guidelines on the management of hypertension in such countries, and monitoring and regulation of pharmacist practice.

More innovative interventions that take into account the heavy reliance on electronic communications include the use of mobile phone technology to remind the patient to take their medication. When combined with home blood pressure monitoring, guided by written step-by-step instructions, automated telephone care management has been shown to improve outcomes for hypertension.[49] Data from 2 South American countries of low- and middle-income showed such a benefit using automated telephone management involving an automated calling system that telephoned the patient to remind them to take tablets, and to provide personalized self-care management based on their own blood pressure readings and diet.[49] However, they went beyond the patient to the health workers, who received automatic e-mailed alerts if their patients had reported having frequent high blood pressure readings, or if the patient self-reported levels of compliance that were considered suboptimal.[49] Last, weekly updates were also sent to a relative or close friend,[49] thereby addressing the weakness in compliance contributed by low levels of social support.[23] As expected, the benefit in blood pressure reduction was greatest among those of less literacy, and those needing more frequent communications about their blood pressure, both of whom are the most vulnerable to worse outcomes in conventional practice. In this manner, this intervention appears to have addressed the provider and the patient barrier to hypertension management. Yet, as with all interventions, gaps need to be filled on information regarding the long-term effects, acceptability, costs, and risks of such interventions.[50]

We have outlined the complex interrelationship between kidney disease, diabetes, and hypertension. To add to this complexity, major risk factors for diabetes, hypertension, and cardiovascular disease (such as obesity and smoking) also cause or exacerbate chronic kidney disease, and treatment interventions slowing progression of chronic kidney disease also reduce sequelae from these comorbidities. Because these are all among the most debilitating and expensive conditions to treat, usually for life, knowledge of the effectiveness of common treatment modalities is helpful in planning cost-effective interventions; at the population level, and at the individual level. It has been suggested that, in resource-scarce environments, the presence of chronic kidney disease, defined by reduced estimated glomerular filtration rate or proteinuria, identifies the subset of people with diabetes, hypertension, or cardiovascular disease who are at the highest risk of adverse outcomes; but who, because of resource constraints, are least likely to receive appropriate treatment.[28] This has led to the suggestion that, in such resource-limited settings, the presence of chronic kidney disease could be used to identify persons with diabetes, hypertension, and/or cardiovascular disease in whom intervention might be most beneficial and economically attractive.[28] Finally, the identification of local genetic variants with specific pharmacological targets, like the amiloride-sensitive Liddle variant present in the Kalahari region, might allow for the provision of inexpensive and effective local therapeutic interventions.[51]

Disclosures

The authors have no conflicts of interest to disclose.

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