

WJC 6th Anniversary Special Issues (1): Hypertension

Asserted and neglected issues linking evidence-based and Chinese medicines for cardiac rehabilitation

Arthur de Sá Ferreira, Nathalia Gomes Ribeiro de Moura

Arthur de Sá Ferreira, Nathalia Gomes Ribeiro de Moura, Laboratory of Computation Simulation and Modeling in Rehabilitation, Postgraduate Program of Rehabilitation Science, Centro Universitário Augusto Motta/UNISUAM, CEP 21041-010, Rio de Janeiro, Brazil

Author contributions: Ferreira AS conceived the manuscript; Ferreira AS and Moura NGR revised the literature, drafted and approved the final version of the manuscript.

Correspondence to: Arthur de Sá Ferreira, PT, PhD, Laboratory of Computation Simulation and Modeling in Rehabilitation, Postgraduate Program of Rehabilitation Science, Centro Universitário Augusto Motta/UNISUAM, Praça das Nações 34, 3^o andar, Bonsucesso, CEP 21041-010, Rio de Janeiro, Brazil. arthur_sf@ig.com.br

Telephone: +55-21-38829797 Fax: +55-21-25642244

Received: December 28, 2013 Revised: March 28, 2014

Accepted: April 25, 2014

Published online: May 26, 2014

Abstract

High blood pressure is among the most prevalent chronic disease in adults that impacts on the quality of life of patients, which are often subjected to physical rehabilitation. Chinese medicine intervention in patients with hypertension presents promising albeit inconclusive results, mostly due to methodological issues. This paper discusses asserted and neglected issues linking evidence-based and Chinese medicines as related to systemic arterial hypertension, as well as their impact on the physical rehabilitation of those patients. On the one hand, natural history of hypertension, pulse palpation, and herbal therapy are among the asserted issues because of the scientific evidence collected about them, either in favor or against its integration to the current medical practice. On the other hand, anatomical variations of vessels and comparative physiology are among the most commonly neglected issues because previous researches on integrative medicine ignored the possible effects of these issues as related to the study's outcome. The asserted issues highlighted in this paper

stimulate the increasing use of Chinese medicine for health care and the continuity of research on integrative medicine in the cardiovascular field for rehabilitation. The neglected issues poses additional challenges that must not be overlooked in future research on this topic so that the integration of both traditional and current knowledge may be of benefit to the population with cardiovascular disease.

© 2014 Baishideng Publishing Group Inc. All rights reserved.

Key words: Cardiovascular disease; Hypertension; Chinese medicine; Rehabilitation; Integrative medicine

Core tip: Integrative medicine might provide better clinical results than evidence-based or Chinese medicines isolated for patients undergoing cardiac rehabilitation. The asserted issues highlighted in this paper (natural history of hypertension, pulse palpation, and herbal therapy) stimulate the increasing use of Chinese medicine for health care and the continuity of research on integrative medicine in the cardiovascular field. Conversely, some neglected issues (anatomical variations of vessels and comparative physiology) poses challenges that must not be overlooked in future research on this topic so that the integration of both traditional and current knowledge may be of benefit to the population with cardiovascular diseases.

Ferreira AS, Moura NGR. Asserted and neglected issues linking evidence-based and Chinese medicines for cardiac rehabilitation. *World J Cardiol* 2014; 6(5): 295-303 Available from: URL: <http://www.wjgnet.com/1949-8462/full/v6/i5/295.htm> DOI: <http://dx.doi.org/10.4330/wjc.v6.i5.295>

INTRODUCTION

High blood pressure is a major public health problem

worldwide. Hypertension is among the most prevalent chronic, non-contagious disease in adults^[1], despite the trend to decrease its prevalence in some countries^[2]. The natural history of this disease still needs elucidation: although most of its modifiable and non-modifiable risk factors are well known, the etiology of primary systemic arterial hypertension (SAH) remains uncertain^[3]. The long-term impact of hypertension on health is nevertheless evident. Small, middle and large-sized arteries are the earliest body structures affected by time-sustained levels of high blood pressure^[4]. Such arterial remodeling process contributes to the pathophysiology of this condition in target-organs others than the arteries such as the skeletal muscle^[5], heart, kidneys, brain, and eyes^[6]. Without early and proper intervention, organic functions start to deteriorate such that they are detectable by either laboratorial or imaging exams as a complement to the clinical examination of signs and symptoms^[3]. On a timely fashion, functional capacity may be compromised at the systemic level^[7] with possible impacts on the quality of life of these patients^[8], which often are subjected to physiotherapy and cardiac rehabilitation.

Chinese medicine comprises a phenomenological, philosophic, and systematic traditional health care system developed through almost five millennia^[9]. Because Chinese medicine was rooted in a sociocultural environment that differed from the European medicine at its early beginning, it is reasonable to expect differences on both medical practices and respective evolution of medical theories. Nevertheless, recent randomized clinical trials, systematic reviews, and meta-analyses on the efficacy of Chinese medicine interventions in patients with SAH were conducted^[10] with promising albeit inconclusive results. In general, those studies help answering questions raised from the clinical point-of-view, such as “Is Chinese medicine intervention effective for reducing or controlling blood pressure levels?”. Investigating this point-of-view leaves opened the traditional point-of-view, which raised questions such as “Are there actual subtypes of hypertension as related to Chinese medicine?” or “Is the theory of pattern differentiation for diagnosis relevant for guidance on therapeutic intervention?”.

In other words, one may argue what are the scientific evidences for the statements found in the Chinese medicine literature, specially the most antique ones. On the one hand, diving into the traditional Chinese medical literature one can find a number of traditional assertions calling for scientific evidence, if any. On the other hand, researchers often assume that some of these traditional factors may not have a detectable effect on their study's outcome. As it was argued that integrative medicine might provide better clinical results than either one isolated^[11], a comprehensive overview of the asserted and neglected issues between evidence-based and Chinese medicines is necessary for both clinicians and researchers. Therefore, this paper discusses the asserted and neglected issues linking evidence-based and Chinese medicines as related to SAH, as well as their possible impact on the physical rehabilitation of those patients.

ASSERTED ISSUES

In this section, the natural history of SAH, pulse palpation, and herbal therapy are discussed. These topics are considered as asserted issues because of the scientific evidence collected either in favor or against their integration into the current medical practice. However, they should not be considered as final positions because there are lacunas that still need to be addressed in future studies. Table 1 presents summary information about the studies cited in this section.

Natural history of SAH

The epidemiological concept of natural history of diseases also applies to Chinese medicine, with proper correspondence due to their inherent conceptual differences. The Chinese medicine counterpart of an ongoing morbid process is called *zheng* or pattern. It is worth noticing that a pattern encompasses other information than just signs and symptoms in the Western sense: behavior, emotional states, self-awareness of social status, and physical constitution are among other manifestations considered for diagnosis or “pattern differentiation”^[9]. Regardless of these differences, Chinese medicine theory presents basic elements of the natural history of diseases such as the existence of protection and risk factors for patterns, a clinical horizon for the onset of manifestations, and health outcomes such as cure, permanent or temporarily disability, and death.

As a matter of fact, there is evidence supporting that most clinical manifestations observed in patients with SAH and that are used for pattern differentiation are actually associated with target-organs damage (TOD). For instance, the clinical manifestations of cerebrovascular disease are strongly associated (Pearson correlation coefficient = 0.718, $P < 0.001$) to those of “Obstruction of phlegm and dampness of Heart/Liver/Gallbladder”^[12]. Moreover, long-term SAH can lead to myocardial ischemia, conduction defects, arrhythmias, and ventricular hypertrophy^[13]. The brain is another target-organ usually damaged by the SAH; cognitive disturbances in the elderly are, at least in part, hypertension-related^[14-16]. High risk of stroke, cognitive decline, and dementia are also associated to SAH^[17-19]. Some mild retinal changes are largely non-specific except in young patients, hemorrhages, exudates and papilledema, are only present in severe hypertension and are associated with increased cardiovascular risk^[3]. All the above-cited TOD eventually manifests signs and symptoms, which should be early detected in the natural history of SAH. Therefore, it is possible to assert that there is a relationship between Chinese medicine patterns and the clinical presentation of SAH-including its related comorbidities.

Most importantly, it is also possible to infer that patients with SAH are candidates for cardiac rehabilitation, even from the traditional Chinese medicine point-of-view. Recent systematic reviews found that Chinese medicine mind-body exercises such as *qigong*^[20] and *taijiquan*^[21] can be of benefit for patients undergoing antihypertensive

Table 1 Summary description of studies on the asserted issues linking evidence-based and Chinese medicines

| Ref. | Study characteristics | Main results | Main limitation |
|---------------------------------------|--|--|---|
| Natural history of patterns | | | |
| Luiz <i>et al</i> ^[12] | Cross-sectional observational design Forty-three patients with hypertension grades I, II and III | Patterns were strongly or moderately associated with target-organ damage Manifestations were at most weakly associated with hemodynamic variables | Target-organ damages were not confirmed by laboratory or imagery methods Patients were under antihypertensive drug therapy |
| Chan <i>et al</i> ^[20] | Systematic review (8 studies) Seven randomized controlled trials and one non-randomized controlled clinical trial | Qigong improved physical symptoms in patients with coronary artery disease Qigong improved functional capacity of cardiac patients Qigong reduced blood pressure levels No adverse effects reported | Overall poor quality of most studies included in the review Study heterogeneity |
| Yeh <i>et al</i> ^[21] | Systematic review (26 studies) Nine randomized controlled trials, thirteen non-randomized controlled trials, and four observational studies | <i>Taijiquan</i> reduced blood pressure levels No adverse effects reported | Overall poor quality of most Chinese studies included in the review Study heterogeneity |
| Pulse palpation | | | |
| Luiz <i>et al</i> ^[12] | Cross-sectional observational design Forty-three patients with hypertension grades I, II and III | Frequency analysis of clinical manifestations and pulse images of patterns Most frequent pulse image: wiry pulse (52% of the cases) | Patients were under antihypertensive drug therapy |
| Ferreira <i>et al</i> ^[25] | Cross-sectional observational study Twenty-nine healthy subjects and twenty-three patients with hypertension grades I, II or III | Higher pulse wave velocity and lower arterial compliance of the brachial-radial artery segment in hypertension | Arterial tonometry was subjected to transducer set-up and manual positioning Patients were under antihypertensive drug therapy |
| Ferreira <i>et al</i> ^[26] | Cross-sectional observational study Sixty-three healthy subjects and fifty-two patients with hypertension grades I, II or III | Lower arterial compliance of the brachial-radial artery segment in hypertension Hypertrophic remodeling of medium-sized arteries in hypertension | Arterial tonometry was subjected to transducer set-up and manual positioning Patients were under antihypertensive drug therapy |
| Ferreira <i>et al</i> ^[27] | Cross-sectional observational study Sixty-three healthy subjects and fifty-two patients with hypertension grades I, II or III | Impaired flow-mediated vasodilation in hypertension | Arterial tonometry was subjected to transducer set-up and manual positioning Patients were under antihypertensive drug therapy |
| Ferreira <i>et al</i> ^[28] | Cross-sectional observational study Sixty-three healthy subjects and fifty-two patients with hypertension grades I, II or III | Increased peripheral vascular resistance immediately after ischemic occlusion Slower response to flow-mediated vasodilation | Arterial tonometry was subjected to transducer set-up and manual positioning Patients were under antihypertensive drug therapy |
| Lu ^[29] | Cross-sectional observational study Fifty-nine patients with hypertension grades I, II or III | Higher amplitudes for harmonics #0 (heart), #1 (liver), #3 (spleen), #4 (lung), and #6 (gallbladder) in hypertension | Poor description of the studied sample Patients were under antihypertensive drug therapy |
| Ferreira ^[30] | Computational simulation study Model of the radial artery during "simultaneous pressing" | Lack of correspondence between pressure pulse spectral harmonics and Chinese medicine theory of pulse palpation | No experimental data from patients with hypertension |
| Herbal therapy | | | |
| Xiong <i>et al</i> ^[32] | Narrative review | Herbal therapy may potentially reduce blood pressure variability, inhibit sympathetic activity, prevent target-organ damage, and improve insulin resistance | Potentially biased (selection and report bias) Some results outcome from animal studies not yet tested in humans |

treatment. The benefits of *qigong* practice may include the alleviation of physical symptoms related to cardiovascular disease (CVD) (*e.g.*, 63% of the group presented relieving of coronary artery disease symptoms) and the control of blood pressure (*e.g.*, 88% of the group presented lower blood pressure levels) after 1-year practice, and the increase in functional capacity (*e.g.*, 13.7% higher six-minute walk distance after a 16-wk *qigong* training program)^[20]. Likewise, the benefits of *taijiquan* practice may include a reduction in systolic and diastolic blood pressures (3-32 mmHg and 2-18 mmHg, respectively)^[21]. However, it is

not clear whether the effects on blood pressure are due to the traditional aspects of Chinese medicine practice or to the increased physical activity itself, or both. Nevertheless, further research is necessary to determine whether Chinese medicine therapy indicated from pattern differentiation is of benefit to patients with SAH, either at secondary or tertiary level of prevention.

Pulse palpation

Clinical examination in Chinese medicine is not different from that practiced in evidence-based medicine: inspec-

Table 2 Summary description of studies on the neglected issues linking evidence-based and Chinese medicines

| Ref. | Study characteristics | Main results | Main limitation |
|------------------------------------|---|---|--|
| Anatomical variations of vessels | | | |
| Chen <i>et al</i> ^[43] | Cross-sectional observational study One hundred healthy subjects, forty-six with pancreatitis, forty-two with duodenal bulb ulcer, twenty-two with appendicitis, and third-eight with acute appendicitis | Accuracy of 82% for classification of normal or abnormal pulses using an auto-regressive model for analysis of wrist pulse signals (blood flow signal) and a support vector machine | Ultrasound-based blood flow measurements was subjected to manual positioning and operator experience Only one position was investigated (above the styloid process) Pattern differentiation was performed (in either group) and the results were not related to Chinese medicine theory |
| Huang <i>et al</i> ^[44] | Cross-sectional observational study Thirty normal subjects and thirty patients with palpitation | Higher spectral harmonic energy ratio in patients | Only 10 s were evaluated at each position Palpitation was only characterized by the evidence-based medicine and no correspondence to patterns was established Pattern differentiation was performed in either group and the results were not related to Chinese medicine theory Lack of relationship between spectral harmonic energy ratio and Chinese medicine theory for pulse palpation |
| Hu <i>et al</i> ^[45] | Cross-sectional observational study Six normal subjects (all male) | No significant difference was observed on pulse waveform parameters obtained with single or array sensors Significant differences were observed among depths | Only one position was investigated (above the styloid process) Pattern differentiation was performed in either group and the results were not related to Chinese medicine theory |

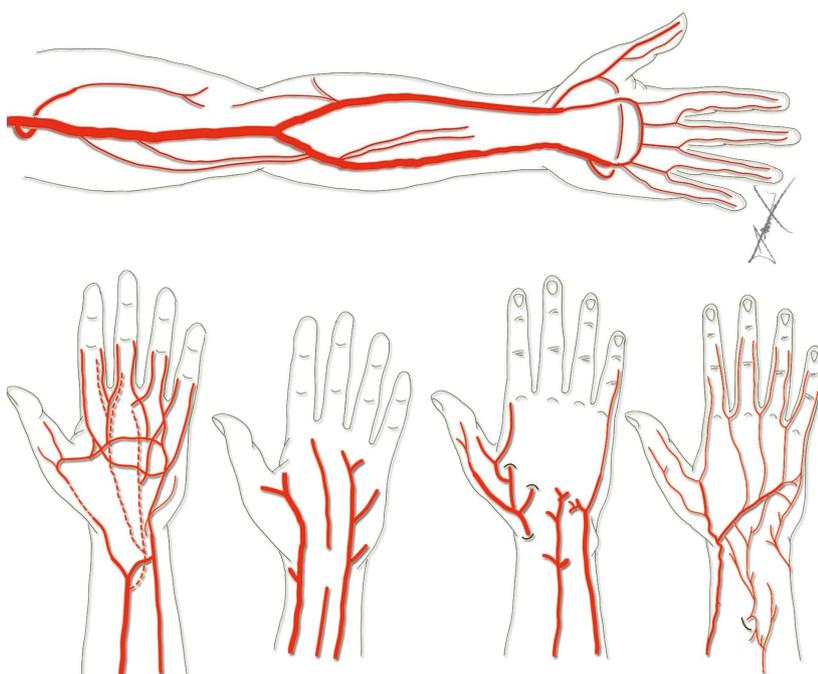


Figure 2 Anatomical drawings on variations of the course of the radial artery. Top: Most frequent arterial pattern of the radial artery. Bottom: Examples of anatomical variations of the radial artery at the wrist.

may strongly impact on the perception of the pulse as palpated at the radial artery and are reflected in the pulse waveform signal as collected using arterial tonometry. For instance, a study showed that some spectral harmonics of the pressure pulse waveform (C0, C1, C3, C4 and C6) are higher in patients with SAH as compared to health controls^[29]. However, a more recent study^[30] failed to found a relationship between the traditional method of ‘simultaneous pressing’ for wrist pulse palpation and the spectral harmonics assigned to the respective internal organs.

Herbal therapy

In the context of therapeutics for SAH, it was recently

proposed to merge the ancient knowledge with the current one, yielding “the earlier the better for treating who and what are not yet ill”^[31]. This proposal also reflects the epidemiologic interpretation of traditional Chinese medicine while it is in agreement with the natural history of patterns related to SAH.

The use of herbs, minerals, and animal parts to compose medicinal formulas is acknowledged as the oldest therapeutic method in Chinese medicine. Considerable advances were recently achieved in the field of antihypertensive drugs, with several drug classes available for optimization of blood pressure control^[3]. However, limited efficacy for reducing blood pressure levels and side ef-

fects are among the factors that lead researchers to study other therapeutic resources, including natural compounds used in traditional medicine recipes. A large number of information about cardioprotective food is currently available and the United States Food and Drugs Administration approved and recommended some of them, even though studies are not definitive about them.

More specifically related to Chinese medicine, a recent systematic review summarized evidences in favor of Chinese herbal therapy for patients with patterns related to SAH^[32]. There are formulas that have been used widely in clinical practice for treatment of hypertension such as the *Banxia Baishu Tianma Tang* (Decoction of Pinellia ternate, Atractylodes and Gastrodia elata), *Da Chaihu Tang* (Major Bupleurum Decoction), *Liu Wei Dihuang Wan* (Pill of Rehmannia), and *Banxia Baishu Tianma Tang* (Decoction of Pinellia ternate, Atractylodes macrocephala, and Gastrodia elata). The general effects observed in previous studies include the reduction of blood pressure variability, inhibition of the activity of sympathetic nerve, blocking of the renin-angiotensin system, improvement of endothelial function and insulin resistance, and prevention of TOD^[32]. Altogether, it is possible to assert that ancient Chinese medicine practitioners were aware of the potential benefits of herbs on the cardiovascular system. Despite these whole-body effects, there are still some challenges for a large-scale usage of herbal therapy for Chinese medicine patterns related to SAH including the quality control of compounds, interaction among formula's compounds, and dose-response effects.

NEGLECTED ISSUES

In this section, the anatomical variations of vessels and comparative physiology are discussed. These issues are considered neglected because previous researches on integrative medicine ignored these aspects as related to the studies' main outcomes. Thus, these issues must be considered in future studies as factors for analysis and not as issues that could be assumed negligible. Table 2 presents summary information about the studies cited in this section.

Anatomical variation of vessels

The radial artery is classically described at the wrist as passing deep to the tendons of the anatomical snuff-box (Figure 2, top). However, variations in the arterial pattern-*i.e.*, number and/or course of the arteries-of the upper limb have been observed frequently either in routine dissections or in clinical practice^[33] and are of both clinical and surgical significances^[34-39]. Variations in the origin and proximal course of this artery are the most common anomalies found in the forearm (Figure 2). For instance, a study with 150 routine dissections of the brachio-antebrachial arterial axis from adults cadavers and 10 from full-term fetuses found that 7 cases showed high origin of the radial artery, and were divided into 2 groups where one had the presence of a median artery (3

cases) and the other had the absence of the artery (4 cases)^[40]. Moreover, radial artery tortuosity, hypoplasia, and stenosis were observed in patients undergoing transradial coronary intervention^[41].

Chinese medicine literature states that the wrist pulse is generally felt above the styloid process of the radius and nearby proximal-distal regions in the arterial course, and that it is possible not to feel the pulse at these locations; in this case, one can feel the pulse at the external aspect of the wrist-and most importantly, it is not a sign of disease^[42]. Thus, ancient Chinese medicine scholars were aware of the existence of anatomical variations of arteries and on the distinction between pulse images resulting from normal variations and morbid patterns.

Studies have been focusing on the modernization of Chinese medicine by incorporating devices (*i.e.*, pressure sensors) and automated methods (*i.e.*, software tools) to acquire pressure data from the radial artery^[43-45]. However, it is intriguing that in spite of the above-cited traditional and current knowledges, none of these studies considered the anatomical variation as a confounding factor for either qualitative or quantitative pulse image analysis. Patients with hypertension are at an increased risk of presenting radial artery tortuosity^[46]. Because the geometrical characteristics of the radial artery determine the transmission of the pressure pulse waveform along the vessel^[26], it is expected that patients with SAH present pulse image characteristics due to arterial tortuosity, vascular remodeling, or both. Therefore, the anatomical variation of the radial artery cannot be neglected in future studies on pulse image analysis since it may help explain the qualitative or quantitative observed pulse image.

Comparative physiology

Recognized as the Father of western Medicine, Hippocrates (460-375 BC) and Huangdi (2695-2589 BC), reference inside the oldest known treatise of medicine in existence (the *Huangdi Neijing*) had in common in their discussions the use of acupuncture for treatment of various diseases, including coronary artery disease^[47]. Hippocrates advocated the theory of four humors-earth, air, fire and water-when trying to explain the pathogenesis of a disease, analogous to the five-phase theory of Huangdi-wood, fire, earth, metal and water. This example of comparative reasoning can be extended to all major fields of medical knowledge in Chinese and evidence-based medicines: anatomy, physiology, semiology, pathophysiology, and therapy. It is acknowledged that there are important conceptual differences between these medical practices as related to the body structures^[48], but strong similarities are empirically present at the functional level. As related to the circulatory system, Chinese medical theory also recognize its role on several functions such as the whole-body integration for distribution of substances, regulation of body temperature, and the relationship between circulation and life support^[48].

Researchers are investigating Chinese medicine searching for anatomical and/or physiological explana-

tions for the phenomena related to the safety-efficacy of interventions in the patients with SAH and other CVD^[10]. However, it is apparent that no comparative analysis have been systematically performed between Chinese and evidence-based medical theories. More specifically, it is not a matter of translation of terms from Chinese to English, but to properly transpose the interpretation of Chinese medicine knowledge to its counterpart in evidence-based medicine. For instance, such comparative reasoning may help explain: (1) the strong association observed between descriptions of TOD and patterns in patients with SAH; and (2) the similarities and dissimilarities between abnormal pulses, quantitative pulse waveform analysis, and qualitative pulse images. Therefore, it is recommended to not neglect the study of a comparative physiology between these two medical practices since it may improve our understanding on the natural history of SAH and the potential benefits of an integrated approach to patients undergoing cardiac rehabilitation programs.

DISCUSSION

Complementary and alternative medicine (CAM) are increasingly available and used for health care. A study^[49] that analyzed data on CAM use among patients with CVD found that 36% of patients with CVD had used CAM in the previous 12 mo and 10% respondents used CAM specifically for their cardiovascular conditions—among which 5% for hypertension, 2% for coronary disease, and 3% for vascular insufficiency. The same study showed that cardiac patients use mind-body therapies including deep-breathing exercises, group support, hypnosis, meditation, relaxation, *taijiquan*, *yoga*, and *shiatsu*, among others^[49]. Acupuncture, herbal Chinese medicine, moxibustion, cupping, Chinese massage, *qigong* and *taijiquan*, and dietary therapy^[50], when associated to antihypertensive medication significantly reduced systolic blood pressure (-8 mmHg) and diastolic blood pressure (-4 mmHg) with no heterogeneity detected, although given the poor methodological quality and small sample sizes of most acupuncture trials, the notion that acupuncture may lower high blood pressure remains inconclusive^[51].

In summary, the asserted issues highlighted in this paper stimulate the increasing use of Chinese medicine for health care and the continuity of research on integrative medicine in the cardiovascular field. Conversely, the neglected issues poses additional challenges that must not be overlooked in future research on this topic so that the integration of both traditional and current knowledge may be of benefit to the population with CVD.

ACKNOWLEDGMENTS

We would like to thank Leonardo Armond for providing the hand-made anatomical drawings.

REFERENCES

1 Kearney PM, Whelton M, Reynolds K, Whelton PK, He J.

Worldwide prevalence of hypertension: a systematic review. *J Hypertens* 2004; **22**: 11-19 [PMID: 15106785]

2 Picon RV, Fuchs FD, Moreira LB, Riegel G, Fuchs SC. Trends in prevalence of hypertension in Brazil: a systematic review with meta-analysis. *PLoS One* 2012; **7**: e48255 [PMID: 23118964 DOI: 10.1371/journal.pone.0048255]

3 Mancía G, Fagard R, Narkiewicz K, Redon J, Zanchetti A, Böhm M, Christiaens T, Cifkova R, De Backer G, Dominiczak A, Galderisi M, Grobbee DE, Jaarsma T, Kirchhof P, Kjeldsen SE, Laurent S, Manolis AJ, Nilsson PM, Ruilope LM, Schmieder RE, Sirnes PA, Sleight P, Viigimaa M, Waeber B, Zannad F, Redon J, Dominiczak A, Narkiewicz K, Nilsson PM, Burnier M, Viigimaa M, Ambrosioni E, Caulfield M, Coca A, Olsen MH, Schmieder RE, Tsioufis C, van de Borne P, Zamorano JL, Achenbach S, Baumgartner H, Bax JJ, Bueno H, Dean V, Deaton C, Erol C, Fagard R, Ferrari R, Hasdai D, Hoes AW, Kirchhof P, Knuuti J, Kolh P, Lancellotti P, Linhart A, Nihoyannopoulos P, Piepoli MF, Ponikowski P, Sirnes PA, Tamargo JL, Tendera M, Torbicki A, Wijns W, Windecker S, Clement DL, Coca A, Gillebert TC, Tendera M, Rosei EA, Ambrosioni E, Anker SD, Bauersachs J, Hitij JB, Caulfield M, De Buyzere M, De Geest S, Derumeaux GA, Erdine S, Farsang C, Funck-Brentano C, Gerc V, Germano G, Gielen S, Haller H, Hoes AW, Jordan J, Kahan T, Komajda M, Lovic D, Mahrholdt H, Olsen MH, Ostergren J, Parati G, Perk J, Polonia J, Popescu BA, Reiner Z, Rydén L, Sirenko Y, Stanton A, Struijker-Boudier H, Tsioufis C, van de Borne P, Vlachopoulos C, Volpe M, Wood DA. The Task Force for the Management of Arterial Hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). *J Hypert* 2007; **25**: 1105-1187 [PMID:17563527 DOI:10.1097/HJH.0b013e3281fc975a]

4 Arribas SM, Hinek A, González MC. Elastic fibres and vascular structure in hypertension. *Pharmacol Ther* 2006; **111**: 771-791 [PMID: 16488477 DOI: 10.1016/j.pharmthera.2005.12.003]

5 Hernández N, Torres SH, Finol HJ, Vera O. Capillary changes in skeletal muscle of patients with essential hypertension. *Anat Rec* 1999; **256**: 425-432 [PMID: 10589028]

6 Messerli FH, Williams B, Ritz E. Essential hypertension. *Lancet* 2007; **370**: 591-603 [PMID: 17707755 DOI: 10.1016/S0140-6736(07)61299-9]

7 Hajjar I, Lackland DT, Cupples LA, Lipsitz LA. Association between concurrent and remote blood pressure and disability in older adults. *Hypertension* 2007; **50**: 1026-1032 [PMID: 18025294 DOI: 10.1161/HYPERTENSIONAHA.107.097667]

8 Gusmão JL, Mion D, Pierin AM. Health-related quality of life and blood pressure control in hypertensive patients with and without complications. *Clinics (Sao Paulo)* 2009; **64**: 619-628 [PMID: 19606236 DOI: 10.1590/S1807-59322009000700003]

9 Guang JY. The mode of thinking in Chinese clinical medicine: characteristics, steps and forms. *Clin Acupunct Orient Med* 2001; **2**: 23-28 [DOI: 10.1054/caom.2001.0075]

10 Wang J, Xiong X. Evidence-based chinese medicine for hypertension. *Evid Based Complement Alternat Med* 2013; **2013**: 978398 [PMID: 23861720 DOI: 10.1155/2013/978398]

11 Ferreira AS, Lopes AJ. Chinese medicine pattern differentiation and its implications for clinical practice. *Chin J Integr Med* 2011; **17**: 818-823 [PMID: 22057410 DOI: 10.1007/s11655-011-0892-y]

12 Luiz AB, Cordovil I, Filho JB, Ferreira AS. Zangfu zheng (patterns) are associated with clinical manifestations of zang shang (target-organ damage) in arterial hypertension. *Chin Med* 2011; **6**: 23 [PMID: 21682890 DOI: 10.1186/1749-8546-6-23]

13 Reichel N, Devereux RB. Left ventricular hypertrophy: relationship of anatomic, echocardiographic and electrocardiographic findings. *Circulation* 1981; **63**: 1391-1398 [PMID: 6452972 DOI: 10.1161/01.CIR.63.6.1391]

14 Launer LJ, Masaki K, Petrovitch H, Foley D, Havlik RJ. The association between midlife blood pressure levels and late-life cognitive function. The Honolulu-Asia Aging Study.

- JAMA 1995; **274**: 1846-1851 [PMID: 7500533 DOI: 10.1001/jama.1995.03530230032026]
- 15 **Skoog I**, Lernfelt B, Landahl S, Palmertz B, Andreasson LA, Nilsson L, Persson G, Odén A, Svanborg A. 15-year longitudinal study of blood pressure and dementia. *Lancet* 1996; **347**: 1141-1145 [PMID: 8609748 DOI: 10.1016/S0140-6736(96)90608-X]
 - 16 **Kilander L**, Nyman H, Boberg M, Hansson L, Lithell H. Hypertension is related to cognitive impairment: a 20-year follow-up of 999 men. *Hypertension* 1998; **31**: 780-786 [PMID: 9495261 DOI: 10.1161/01.HYP.31.3.780]
 - 17 **Longstreth WT**, Manolio TA, Arnold A, Burke GL, Bryan N, Jungreis CA, Enright PL, O'Leary D, Fried L. Clinical correlates of white matter findings on cranial magnetic resonance imaging of 3301 elderly people. The Cardiovascular Health Study. *Stroke* 1996; **27**: 1274-1282 [PMID: 8711786 DOI: 10.1161/01.STR.27.8.1274]
 - 18 **Vermeer SE**, Hollander M, van Dijk EJ, Hofman A, Koudstaal PJ, Breteler MM. Silent brain infarcts and white matter lesions increase stroke risk in the general population: the Rotterdam Scan Study. *Stroke* 2003; **34**: 1126-1129 [PMID: 12690219 DOI: 10.1161/01.STR.0000068408.82115.D2]
 - 19 **Prins ND**, van Dijk EJ, den Heijer T, Vermeer SE, Koudstaal PJ, Oudkerk M, Hofman A, Breteler MM. Cerebral white matter lesions and the risk of dementia. *Arch Neurol* 2004; **61**: 1531-1534 [PMID: 15477506 DOI: 10.1001/archneur.61.10.1531]
 - 20 **Chan CL**, Wang CW, Ho RT, Ho AH, Ziea ET, Taam Wong VC, Ng SM. A systematic review of the effectiveness of qigong exercise in cardiac rehabilitation. *Am J Chin Med* 2012; **40**: 255-267 [PMID: 22419421 DOI: 10.1142/S0192415X12500206]
 - 21 **Yeh GY**, Wang C, Wayne PM, Phillips RS. The effect of tai chi exercise on blood pressure: a systematic review. *Prev Cardiol* 2008; **11**: 82-89 [PMID: 18401235 DOI: 10.1111/j.1751-7141.2008.07565.x]
 - 22 **de Sá Ferreira A**, Lopes AJ. Pulse waveform analysis as a bridge between pulse examination in Chinese medicine and cardiology. *Chin J Integr Med* 2013; **19**: 307-314 [PMID: 23546634 DOI: 10.1007/s11655-013-1412-z]
 - 23 **Vlachopoulos C**, O'rourke M. Genesis of the normal and abnormal arterial pulse. *Curr Probl Cardiol* 2000; **25**: 303-367 [PMID: 10822214 DOI: 10.1067/mcd.2000.104057]
 - 24 **Shannon P**, Markiel A, Ozier O, Baliga NS, Wang JT, Ramage D, Amin N, Schwikowski B, Ideker T. Cytoscape: a software environment for integrated models of biomolecular interaction networks. *Genome Res* 2003; **13**: 2498-2504 [PMID: 14597658 DOI: 10.1101/gr.1239303]
 - 25 **Ferreira AS**, Santos MA, Barbosa Filho J, Cordovil I, Souza MN. Determination of radial artery compliance can increase the diagnostic power of pulse wave velocity measurement. *Physiol Meas* 2004; **25**: 37-50 [PMID: 15005303 DOI: 10.1088/0967-3334/25/1/004]
 - 26 **Ferreira AS**, Barbosa Filho J, Cordovil I, Souza MN. Three-section transmission-line arterial model for noninvasive assessment of vascular remodeling in primary hypertension. *Biomed Signal Process Control* 2009; **4**: 2-6 [DOI: 10.1016/j.bspc.2008.07.001]
 - 27 **Ferreira AS**, Barbosa Filho J, Souza MN. Model for post-occlusive reactive hyperemia as measured noninvasively with pressure pulse waveform. *Biomed Signal Process Control* 2011; **6**: 410-413 [DOI: 10.1016/j.bspc.2010.11.003]
 - 28 **Ferreira AS**, Barbosa Filho J, Cordovil I, Souza MN. Noninvasive pressure pulse waveform analysis of flow-mediated vasodilation evoked by post-occlusive reactive hyperemia maneuver. *Biomed Signal Process Control* 2012; **7**: 616-621 [DOI: 10.1016/j.bspc.2012.03.001]
 - 29 **Lu WA**. Pulse spectrum analysis in primary hypertension patients. *Taipei City Med* 2006; **3**: 859-868
 - 30 **Ferreira AS**. Resonance phenomenon during wrist pulse-taking: A stochastic simulation, model-based study of the 'pressing with one finger' technique. *Biomed Signal Process Control* 2012; **8**: 229-236 [DOI: 10.1016/j.bspc.2012.10.004]
 - 31 **Ferreira Ade S**. Integrative medicine for hypertension: the earlier the better for treating who and what are not yet ill. *Hypertens Res* 2013; **36**: 583-585 [PMID: 23575381 DOI: 10.1038/hr.2013.15]
 - 32 **Xiong X**, Yang X, Liu Y, Zhang Y, Wang P, Wang J. Chinese herbal formulas for treating hypertension in traditional Chinese medicine: perspective of modern science. *Hypertens Res* 2013; **36**: 570-579 [PMID: 23552514 DOI: 10.1038/hr.2013.18]
 - 33 **Lippert H**, Pabst R. Arterial Variations in Man. New York: Springer, 1985: 71-77
 - 34 **Cohen SM**. Accidental intra-arterial injection of drugs. *Lancet* 1948; **252**: 409-416 [DOI: 10.1016/S0140-6736(48)90986-6]
 - 35 **Hazlett JW**. The superficial ulnar artery with reference to accidental intra-arterial injection. *Can Med Assoc J* 1949; **61**: 289-293 [PMID: 18148099]
 - 36 **Mccormack LJ**, Cauldwell EW, Anson BJ. Brachial and antebrachial arterial patterns; a study of 750 extremities. *Surg Gynecol Obstet* 1953; **96**: 43-54 [PMID: 13015348]
 - 37 **Seldinger SI**. Arteries of the extremities. In: Handbuch Medizinischer Radiologie. Deithelm L, Olsson O, Strnad F, Vieten H, Zuppinger A, editors. Berlin: Springer, 1964: 400-472
 - 38 **Jurjus A**, Sfeir R, Bezirdjian R. Unusual variation of the arterial pattern of the human upper limb. *Anat Rec* 1986; **215**: 82-83 [PMID: 3706795]
 - 39 **Tountas CHP**, Bergman RA. Anatomic Variations of the Upper Extremity. New York: Churcill Livingstone, 1993: 196-210
 - 40 **Rodríguez-Baeza A**, Nebot J, Ferreira B, Reina F, Pérez J, Sañudo JR, Roig M. An anatomical study and ontogenetic explanation of 23 cases with variations in the main pattern of the human brachio-antebrachial arteries. *J Anat* 1995; **187** (Pt 2): 473-479 [PMID: 7592009]
 - 41 **Yokoyama N**, Takeshita S, Ochiai M, Koyama Y, Hoshino S, Isshiki T, Sato T. Anatomic variations of the radial artery in patients undergoing transradial coronary intervention. *Catheter Cardiovasc Interv* 2000; **49**: 357-362 [PMID: 10751755]
 - 42 **Li SZ**. In: Flaws B, translator. The Lakeside Master's Study of the pulse: a translation of the Bin Hu Mai Xue Bai Shuo Jie. Boulder: Blue Poppy Press Enterprise, Inc., 1999
 - 43 **Chen Y**, Zhang L, Zhang D, Zhang D. Computerized wrist pulse signal diagnosis using modified auto-regressive models. *J Med Syst* 2009; **35**: 321-328 [DOI: 10.1007/s10916-009-9368-4]
 - 44 **Huang CM**, Wei CC, Liao YT, Chang HC, Kao ST, Li TC. Developing the effective method of spectral harmonic energy ratio to analyze the arterial pulse spectrum. *Evid Based Complement Alternat Med* 2011; **2011**: 342462 [PMID: 21845200 DOI: 10.1093/ecam/nej054]
 - 45 **Hu CS**, Chung YF, Yeh CC, Luo CH. Temporal and spatial properties of arterial pulsation measurement using pressure sensor array. *Evid Based Complement Alternat Med* 2012; **2012**: 745127 [PMID: 21754947]
 - 46 **Li L**, Zeng ZY, Zhong JM, Wu XH, Zeng SY, Tang EW, Chen W, Sun YH. Features and variations of a radial artery approach in southern Chinese populations and their clinical significance in percutaneous coronary intervention. *Chin Med J (Engl)* 2013; **126**: 1046-1052 [PMID: 23506576 DOI: 10.3760/cma.j.issn.0366-6999.20122966]
 - 47 **Cheng TO**. Hippocrates and cardiology. *Am Heart J* 2001; **141**: 173-183 [PMID: 11174329 DOI: 10.1067/mhj.2001.112490]
 - 48 **O'Connor J**, Bensky D. Acupuncture a comprehensive text. Seattle: Eastland Press, 1987
 - 49 **Yeh GY**, Davis RB, Phillips RS. Use of complementary therapies in patients with cardiovascular disease. *Am J Cardiol* 2006; **98**: 673-680 [PMID: 16923460 DOI: 10.1016/j.amjcard.2006.03.051]
 - 50 National Center for Complementary and Alternative Medi-

cine, December 2012. Available from: URL: <http://nccam.nih.gov>

51 Lee H, Kim SY, Park J, Kim YJ, Lee H, Park HJ. Acupuncture

for lowering blood pressure: systematic review and meta-analysis. *Am J Hypertens* 2009; **22**: 122-128 [PMID: 19008863 DOI: 10.1038/ajh.2008.311]

P- Reviewers: Izawa KP, Jankowski P **S- Editor:** Ji FF
L- Editor: A **E- Editor:** Wu HL





Published by **Baishideng Publishing Group Inc**

8226 Regency Drive, Pleasanton, CA 94588, USA

Telephone: +1-925-223-8242

Fax: +1-925-223-8243

E-mail: bpgoffice@wjgnet.com

Help Desk: <http://www.wjgnet.com/esps/helpdesk.aspx>

<http://www.wjgnet.com>

