

Cardiovascular diseases in China: Current status and future perspectives



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ABSTRACT

Despite revolutionary advancement in medicine over the past century, cardiovascular disease (CVD) remains the leading cause of death and disability in the world. Likewise, the morbidity and mortality of CVD in China are increasing persistently, although the government has taken an active part in the prevention and control of CVD. Here we present an overview regarding the current CVD status in China with respect to various disease phenotypes, as well as the anticipated future trend in accordance with the dynamics and distribution of pathogenesis in Chinese actual situations.

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1. Introduction

In the last 30 years, the rapid development of economy and medical science in China has led to a drastic improvement in public health; the average life span has been extended steadily and significantly year after year. In contrast, cardiovascular relevant morbidity and mortality in Chinese population rose quickly; in particular, the age of patients is becoming younger. It is estimated in the “Report on Cardiovascular Disease in China, 2011” that there are about 230 million patients with CVD, including 200 million patients with hypertension, 7 million patients with stroke, 2 million patients with myocardial infarction, and 4.2 million patients with heart failure. There are 3 million cases of death of CVD each year, accounting for 41% in total. However, delightedly, it is noticed that government sector is perfecting public health policy and law further, increasing research and capital investment [1] (Fig. 1) in this sector, and that the public health sense is being upgraded gradually.

2. Cardiovascular risk factors

The upwards tendency of the proportion of patients with CVD in China were closely associated with the increased number of cardiovascular risk factors (e.g., hypertension [2], smoking [3], dyslipidemia [4], diabetes [5,6], overweight [7], obesity [7] and metabolic syndrome [8,9], et al.) (Fig. 2) and population ageing. It is known that there are approximately 300 risk factors of CVD, mainly including dyslipidemia, smoking, hypertension and diabetes [10]. When multiple factors are at

co-existence, the effects are augmented and exacerbated; which result in accelerated CVD development and increased mortality. Therefore, programs delivering comprehensive management of risk factors for CVD are essential when we optimize the distribution of medical resources to overcome this national health challenge.

Based on the “Chinese Inhabitants Nutrition and Health Examination Survey in 2002” [11], the result showed that the prevalence rate of adult hypertension was 18.8%, higher in males than in females and more common in the north area than in south area; the awareness, treatment and control rates of patients with hypertension were 30.2%, 24.7% and 6.1% respectively, which was lower than that of developed countries. Another survey [12] showed that about 2.33 million CVD deaths were related to hypertension in 2005. In order to strengthen the guidelines for patients with hypertension and high-risk individuals involved in this disease, the Chinese government implemented the large management program for this patient population in 2009, with the total number enrolled reaching more than 35 million in 2010. To provide the evidence-based medicine to optimize the pharmacologic therapeutic regimen for hypertension, clinical studies focusing on this topic (Syst-China [13,14], FEVER [15] et al.) were conducted continuously in China. Recently, CCBs was recommended as a preferred drug for the management of hypertension in China to improve blood pressure control and to confront the aggravating epidemic of stroke and coronary heart disease [16]. As for the definite basic and standard hypotensive targets, based on former researches, “Guidelines for Prevention and Treatment of Hypertension in China” was promulgated in 2010. In parallel to routine application of antihypertensive medicine, percutaneous stent implantation for hypertension caused by renal arterial stenosis and catheter-based renal sympathetic denervation (RSD) (RSD were adapted to treat the first patient in China in Fuwai Hospital, Beijing in February, 2012), as well as Baroreflex activation therapy [17] might have gained widely clinical prospect

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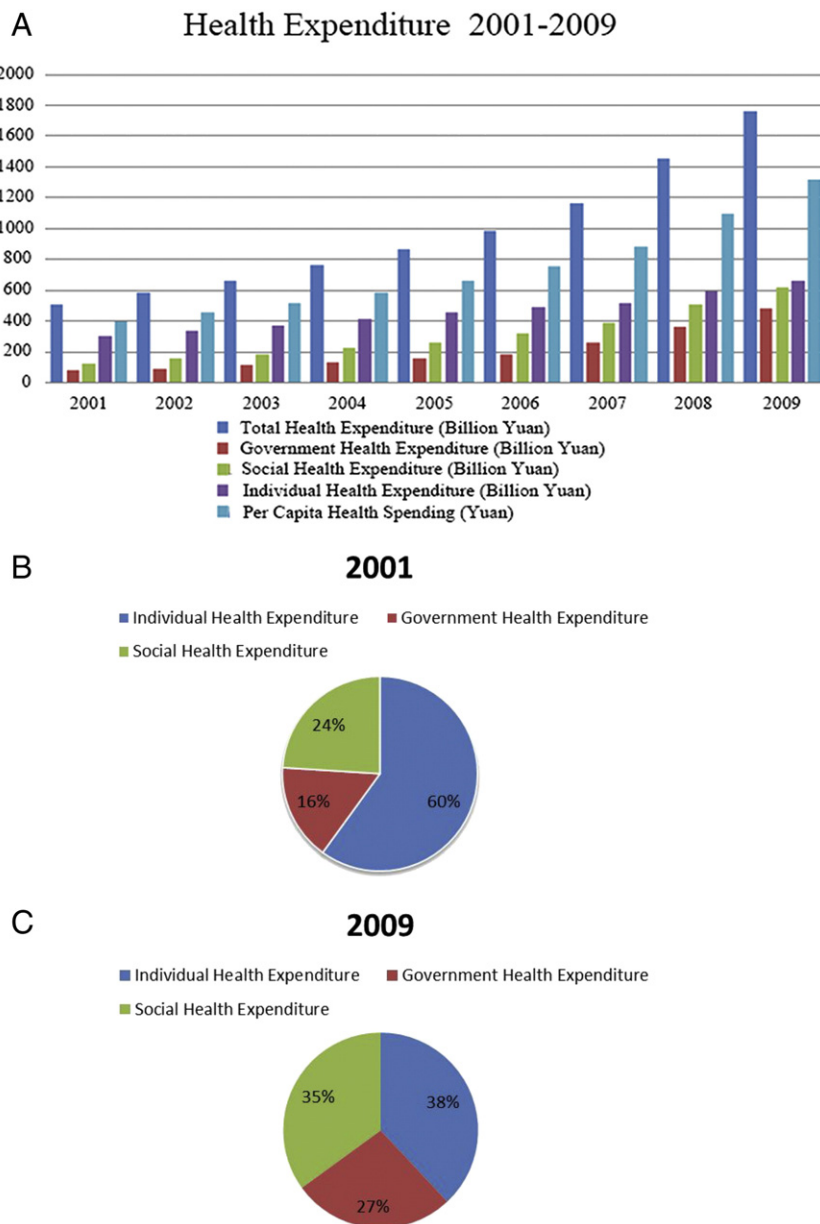


Fig. 1. A Data from China Statistical Yearbook 2011 indicates the health expenditure of China from 2001 to 2009. Total health expenditure, government health expenditure, social health expenditure, and individual health expenditure as well as per capital health spending were on the increase year by year from 2001 to 2009 and total health expenditure and per capital health spending in 2009 were more than 3 times that in 2001, whereas government health expenditure in 2009 rose to over six times than that in 2001. Fig. 1B & C shows that the proportions of health expenditure had changed significantly between 2001 and 2009. In 2001, 60% of total health expenditure was taken up by an individual sector; in 2009, more than 60% of its finance came from the government and social sectors.

in China, after further evaluation of the effectiveness and safety of their treatment for refractory hypertension.

Smoking is a second main risk factor of CVD and stroke in Chinese population [18], and the detrimental impact of smoking and passive smoking is considered as equally harmful to public health. The “Global Adult Tobacco Survey (GATS) – China section” in 2010 indicated that 52.9% of men, 2.4% of women, and 28.1% of the overall population (301 million adults aged over 15) currently smoke tobacco; 7 in 10 non-smoking adults were exposed to secondhand smoke in a typical week; only 46.4% of adults noticed anti-cigarette smoking information on the television or radio; and 23.2% of adults believe smoking causes stroke, heart attack, and lung cancer. Among the various smoking subpopulations in China, there is a noticeable increase in the younger age and the female groups. Accordingly, a series of measures have been adopted by the Chinese government to reducing its harmful impact; national

legislations on smoking ban in all public domains came into effect in 2011.

The “National Investigation of Adult Lipid Abnormality” in 2002 showed that prevalence rate of dyslipidemia was 18.6%, with 2.9% hypercholesterolemia and 11.9% hypertriglyceridemia [19]. The “China Cholesterol Education Program” [20] (CCEP) in 2008 indicated that the success rate of LDL-C management in high-risk patients and very high-risk patients were 36.2% and 42.2% respectively. These results are promising; they are credited to the rigorous lipid-reduction therapeutic programs in both prevention and management of the disease situation, which are widely taking place in China. Based on previous large-scale epidemiological surveys and clinical investigations, the different criteria of serum cholesterol levels and the target value with regulating lipid drugs in Chinese population have been defined. Cardiovascular residual risk [21–23] began to attract considerable attention of scholars and

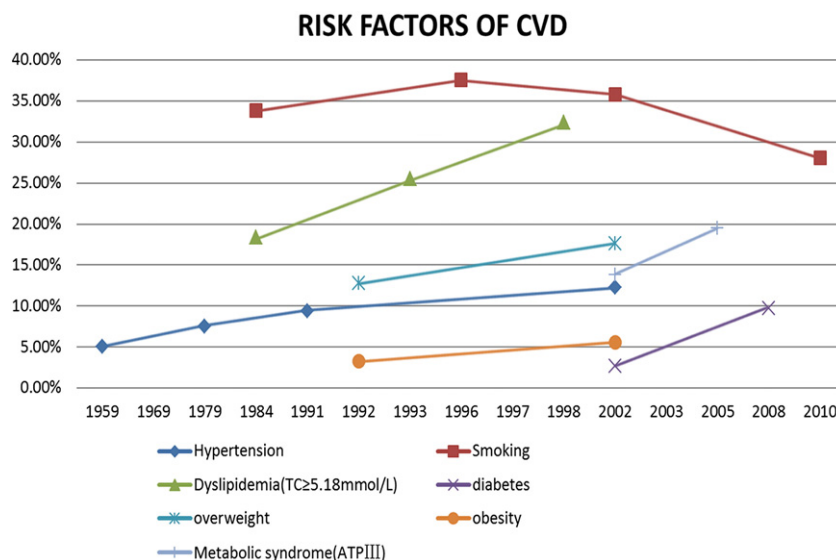


Fig. 2. Presented the prevalence of CVD risk factors: hypertension, smoking, dyslipidemia, diabetes, overweight, obesity and metabolic syndrome, in Chinese population. Besides the prevalence of smoking which had declined since 1996, all that remains showed a rising trend: that of dyslipidemia, diabetes, and metabolic syndrome with strong upward trend; that of hypertension, overweight, and obesity being moderately increasing.

physicians in China. It is increasingly recognized that the effects of rational combined therapy for lipid control had been more effective than that in the treatment with any singular reagent; for example, Ezetimibe in combination with statins, have offered tremendous success to improve total cholesterol, LDL-C, non-HDL cholesterol, and apolipoprotein B in several reports [6,24].

From 2007 to 2008, the Chinese Medical Association Diabetes Branch (CDS) conducted a national survey [25] of diabetes in several large cities in China and demonstrated that the average prevalence rate of diabetic patients was 9.7%, with higher occurrences in males than in females; the rate in the urban and in the rural populations were 11.4% and 8.2%, respectively. Due to the recent population aging and overweight issues in China, more than 95% diabetic patients were patients with type II diabetes mellitus. A follow-up study [26] that has been ongoing for 20 years, with evidence-based investigations, illustrated that life style intervention (rational diet, proper exercises and weight control et al.) in Chinese population had a demonstrable effect to prevent diabetes (43% versus 66%). However, it was noted that a significant subpopulation of Chinese CVD patients are hyperglycemic, per a report by “China Heart Survey” in 2006 [27]. In view of this scenario, many of them are recommended to undergo individualized glucose-lowering therapy [28–31]. With the recent advancement in insulin therapy, patients with diabetes mellitus will benefit from the newly marked oral or inhaled administration of encapsulated insulin nano-particles with biofilm in the near future, which could get rid of present quandary.

A national survey [7] in 2002 was conducted and the data was analyzed that the prevalence rates of overweight and obesity were at an unprecedented stage; they were 22.8% and 7.1%, respectively. To address this urgent national issue, “Dietary Guidelines for Chinese” was published in 2007 and subsequently, an updated version was released 2011 [32,33]. These guidelines recommend that daily nutrition intake should compose 55–65% of calories as carbohydrate, 20–30% as fat and 11–15% as protein. The concept of metabolic syndrome (MS) was first put forward by CDS in 2004. According to an investigation [34], prevalence of MS in the population group aging from 35 to 74 years old was 16.5%, which is also more prominent in females than males (23.3% versus 10.0%); the occurrence is much higher in the urban residents than in the rural populations (23.5% versus 11.7%). A dietary intervention study [35] demonstrated that accompanying the rising number of metabolic risk factors, salt sensitive high blood pressure in non-

diabetic people in China was increased. Life-style has again, shown to be important for CVD management. The analysis of related risk factors in Chinese population with MS [36] indicated that the prevalence rate of MS could be attenuated by moderate physical activity. It is gradually recognized that MS is a series of diseases with high correlation to patient life-style. The intervention on life style is of equal importance to blood glucose control, blood lipid adjustment and antihypertensive therapy.

3. Coronary heart disease

Information presented in the “China Health Statistics Annuals in 2009” indicated that coronary heart disease mortality rate of urban residents in 2008 was about 91.41 out of 100,000 examined, with 51.89 out of 100,000 surveyed in the rural residents. Due to the increased incidence of coronary heart disease in recent years, therapies on coronary heart disease developed continuously. Anti-anginal drug and anti-metabolites (e.g., trimetazidine) had been suggested for combined applications on myocardial ischemia, in addition to drugs improving hemodynamics. Statin Drugs (Atorvastatin) was also approved to treat CVD directly in 2010. Urokinase is being gradually replaced by recombinant tissue plasminogen activator (rt-PA) as the preferred treatment for thrombolysis in China, especially in the geographical locations lacking emergency support for percutaneous coronary intervention (PCI).

Overall, revascularization of coronary artery by intervention is routinely the primary choice for patients with ST segment-elevation myocardial infarction (STEMI) as well as the main approach of invasive therapy for patients with acute coronary syndrome (ACS) in China. The past three decades also marked enormous progress and rapid growth at the forefront of invasive therapy. Since the first percutaneous transluminal coronary angioplasty (PTCA) was performed in Suzhou, China in 1984, the total number of PCI in China reached 180,000 procedures in 2007 [37], and then it nearly doubled again in less than four years, when the number of procedures was recorded as 330,000 in 2011. The ever-increasing demand for invasive therapy has facilitated the innovation and creation of cardiovascular device industry in China. Running parallel with Medtronic, Boston Scientific, Guidant Abbott, and B. Braun in the Chinese medical device market, are more than six domestic products that have been applied successfully in clinics throughout China; including stents from Lepu Medical Technology, MicroPort

Scientific Corporation, and JW Medical System. According to published statistics in 2006, more than 95% patients were treated with drug-eluting stents (DES) [38]; among those, more than 70% were domestic DES thus far, including durable polymer DES, bio-absorbable polymer DES and polymer free DES. In addition, our preclinical study of fully bio-absorbable PLLA coronary stent- Xinsorb™ has shown promising results [39]; and large-scale clinical studies are soon to be launched. In the past decades, technological innovations of PCI relevant methods have elevated cardiovascular therapy to a new horizon in China. To enhance the success rate of recanalization of chronic total occlusion (CTO), Chronic Total Occlusion Club, China (CTOCC) was established in Shanghai in August, 2005. In October, 2005, kissing wire technique was firstly demonstrated in live case transmission of TCT, Washington DC. Recently, retrograde approaches for CTO PCI have become popular in many centers. However, according to results from a multicenter trial and prospective study analyses in China [40], a total of 2901 patients with acute coronary artery syndrome (ACS) were surveyed and the majority of them (45%) were SETMI, whereas 12% of them were non-STEMI. Compared to other developed countries in the western world, Sino-GRACE study [41] showed that the rate of primary PCI within 90 min and thrombolytic therapy within 30 min for the treatment of acute myocardial infarction is considerably lower in China. Door-to-balloon time of primary PCI in China is longer than that in developed countries. One contributing reason might be related to the distribution of economic status and medical resources in China. Great efforts have been made to improve health care nationwide; training/education programs for diagnosis and treatment of CVD by intervention have been launched and implemented by the Chinese Ministry of Health in 2009. Among the many challenges, improving reperfusion therapy for patients with AMI via PCI or thrombolytic therapy within “the therapeutic window” has been the center of focus. Significant progress has been made in several areas with rewarding outcomes; for example, clinical application of anticoagulation and antithrombotic therapy in primary PCI for patients with ACS, combined application of distal protection device, thrombus aspirated catheter, intra-aortic balloon counterpulsation or extracorporeal membrane oxygenation when necessary, had made post-PCI mortality decrease significantly, and the relevant prognosis in post-PCI cardiogenic shock improved remarkably in recent years.

China has also led a pioneer effort on stem cell therapy for STEMI; preliminary studies using bone marrow stem cell transplantation demonstrated study feasibility as well as moderate improvement in cardiac function during early treatment. Future investigations are required to delineate the destinations and mechanistic actions of these stem cells.

4. Heart failure

Longitudinal analyses of several CVD patient populations were reported in 1980, 1990, and 2000; these studies showed that the hospitalization rate of patients with heart failure was 16.3%–17.9% for CVD patients, with more than 60% of patients being over 60 years old, and the improvement rates of symptom were 15.5%, 19.6% and 22.2%, respectively [42]. Comparison analyses of all major causes of heart failure in China revealed an interesting trend; CVD (45.6%) ranked number one in 2000, followed by rheumatic valvular disease (21.0%) [42]. This order was reversed in 1980; when rheumatic valvular disease was the number one cause of death three decades ago.

Brain Natriuretic Peptide (BNP), also known as the B-type natriuretic peptide, has been adapted successfully in Chinese cardiovascular medicine; it has been gradually becoming an important clinical standard marker for the diagnosis of heart failure in patients, even in the absence of symptom or clinical evidence of CVD. The recombinant form of human B-type natriuretic peptide (Xin huo su) in China was approved to treat heart failure in 2005, which has displayed consistent and beneficial effects, including vasodilatory, natriuretic, diuretic, and neurohormonal effects. The rh-BNP phase IV clinical trial in China, consisting of 9 centers nationwide from 2008 to 2009, has achieved a

rewarding outcome. Their reports demonstrate that clinical manifestation of heart failure was significantly improved in the majority of 1493 patients enrolled in the trial and per trial studies presented at the 20th Great Wall International Congress of Cardiology. In 2003, Delle Karth G et al. [43] reported that Levosimendan (LS) infusion is feasible and able to improve hemodynamics in severely compromised, critically ill patients with cardiogenic shock requiring catecholamine therapy. In 2010, a domestic inotropic and vasodilator agent (YueWen) was approved for clinical applications. YueWen is a calcium sensitizer; which functions to increase the sensitivity of the heart to calcium, thereby augmenting cardiac contractility without impacting the intracellular calcium levels. The control rates of β -receptor blockers in the treatment of heart failure was low in China in the past few years, so attaining necessary target dosage has become an exigent and necessary mission in the next few years.

The first cardiac resynchronization therapy (CRT) device was applied in China in 1999. To date, more than 4000 heart failure patients were treated with CRT or CRT + ICD. It is believed that a considerable population of Chinese patients with refractory heart failure will benefit from it. One issue requires special attention is under the scenario where patients are diagnosed with atrial fibrillation co-existing with ventricular asynchrony; this group could benefit from CRT therapy, per preliminary studies, however, their safety and effectiveness still require further evaluations by large-scale clinical trial. Over the past decade, the Chinese cardiologists have exhibited tremendous courage in creativities and innovations. In October, 2010, Zhongshan Hospital at Shanghai, accomplished the very first case of percutaneous aortic valve implantation (TVAI) in China [44]; the success of this exceptionally challenging procedure pioneered the Chinese TVAI program and advanced the Chinese cardiac non-invasive therapy to a new level. In May, 2012, a severe mitral regurgitation patient was successfully treated with MitraClip via femoral vein catheterization in the same hospital in Shanghai, representing another major milestone in non-invasive therapy in China. Giving the prevalence of rheumatic heart diseases is much higher in China than that in the western countries; the success of these procedures is of great significance. A large number of valve disease patients are anticipated to benefit from this new procedure; in particular, this non-invasive procedure will help the large aging patient population in China. The percutaneous transseptal ventricular assist system was originally designed as a short-term circulatory support system for patients with end-stage heart failure. The assisted devices, for example, Tandem and Impella, had been successfully applied to clinic therapy elsewhere for over a decade now; however, they have not made their way to the therapeutic market in China. Despite its complication and LVAD is not recommended to be the first choice of mechanical therapy for patients with cardiogenic shock [45], it is anticipated that percutaneous circulatory support technology would be an important future direction for Chinese cardiovascular therapy, pending regulatory and policy issues to be resolved.

5. Arrhythmia

Artificial pacemakers had been administered as therapies to patients with an abnormal heart beat pattern for at least half century. The first cardiac pacemaker was implanted into a patient in China in 1962. In 2006, the total pacemaker cases reported were more than 20,000 [46]. In August, 2012, transseptal endocardial left ventricular pacing was first performed in Zhongshan Hospital, Shanghai.

Two decades ago, radiofrequency catheter ablation (RFCA) became an approved procedure to correct disturbances in heart rhythm in China; the first RFCA case was reported in 1991. According to statistic data published in 2000, 56.3% of patients underwent RFCA had atrioventricular nodal reentrant tachycardia (AVNRT), and 31.7% of them were diagnosed of atrioventricular reentrant tachycardia (AVRT). In 2006, RFCA cases reached 20,000 [46]. This case number has steadily increased in recent years. Among them, patients who underwent atrial fibrillation

ablation procedures increased rapidly from 11 in 1998 to 2620 in 2007; these procedures had a success rate of 77.1%, a recurrence rate of 22.9% and a complication rate of 22.9% [47]. In 2004, a population study on atrial fibrillation (AF) [48] surveyed 29,079 residents in 14 provinces and cities in China; the results indicated that the total prevalence rate of patients aging from 30 to 85 was 0.77%; which was higher in males than in females. Furthermore, a recent multicenter registry study [49] in 2008 showed that the average age of patients with AF was (57.4 ± 1.4) years, and the proportions of paroxysmal, persistent and permanent AF were 71.5%, 22.8% and 5.7%, respectively; 47.2% of which had organic heart diseases. The primary therapeutic procedures were circumferential pulmonary vein isolation and circumferential PV isolation plus necessary atrial auxiliary line; the energy applied for catheter ablation was radiofrequency, which had an 82.1% success rate and a 17.9% recurrence rate; the overall rate of complications was 1.7%. The significant progress towards the understanding on the underlying pathogenesis of AF [50–52] combined with the continuous advancement of radiofrequency ablation techniques (e.g., the circular cryoablation catheter and the magnetic navigation system), have drastically improved the success rate for this procedure.

Parallel to technological improvement of radiofrequency ablation (RFA), new drug discovery during the last few years has also optimized the treatment strategy for AF. Despite this, the successful translation of these therapies to clinical applications remains limited. An epidemiological analysis in 2004 [53] revealed that 60% of patients with AF did not receive any anticoagulation therapy. As a preferred drug, Warfarin was only applied to 7.1% patients with non-valvular AF according to data from Fuwai Hospital in 2007. The causes contributing to this barrier are not entirely clear but may be attributed by the adversary effects of Warfarin (e.g., bleeding). Recently, Aspirin combined with Clopidogrel were recommended as substitutes for Warfarin to treat patients who can't or will not accept the latter in China. However, a large clinic trial [54] indicated that the effect of anticoagulation therapy with Aspirin combined with Clopidogrel was inferior to that with Warfarin. These findings necessitate the introduction of novel anticoagulant drugs and exigent its development in China. There have been reports on strong candidates for new AF therapies outside of China. Dabigatran (Boehringer Ingelheim), also known as the direct thrombin inhibitors, was granted marketing authorization by European Medicines Agency in 2008. RELY [55] showed that it could offer an alternative to warfarin as the preferred orally administered anticoagulant to prevent strokes in patients with atrial fibrillation. Dabigatran is viewed to have a broad clinical prospect for the management of AF in China; in some cases, this drug is likely to reach an impact similar to Aspirin; which has been recommended as the most effective anti-platelet therapy with best effect/risk ratio in all clinics [56]. In view of the respective advantages offered by the pharmacologic treatment or mechanical therapies (e.g., ablation), a large-scale comparative clinical trial differentiating the susceptibility and sensitivity of the patient populations on these two approaches is required to further optimize therapy and to enhance its success rate for AF patients in China.

For patients with AF as well as combined high-risk thrombus factor with a contraindication for oral anticoagulation treatment, percutaneous left atrial appendage transcatheter occlusion (PLAATO) has been recently applied as an alternative and feasible approach in preventing embolism. Meanwhile, for patients with paroxysmal or lone AF exhibiting low susceptibility to both pharmacological and procedure based therapies, minimally invasive surgery has been successfully performed in recent years; the thoracoscopic based procedures may gradually replace the conventional maze procedure for chronic AF in China. In addition to all listed above is the rise of stem cells (SCs) based therapy for AF; common to its challenges in other fields, the clinical studies applying stem cells to treat arrhythmia still face difficulties pertaining to the optimization of transplantation methods, the modification of SCs, and the directed differentiation of SCs.

6. Congenital heart disease

Congenital heart disease (CHD) is the most common pediatric heart disease, and the detection rate of infants with CHD is about 0.7% in China. It is estimated that there are almost 150,000–170,000 Chinese newborn infants with CHD every year [57]. Surgical ligation of patent ductus arteriosus was firstly reported to carry out in China in 1942, with atrial septal defect repair under cardiopulmonary bypass in 1956. The total number of cardiac surgical procedures was over 80,000 in 2004, among which, 60%–65% was related to CHD [57]. Balloon atrial septostomy was carried out in the 1970s, which marks the earliest interventional therapy for CHD in China. In the middle of the 1980s, the technology has matured; interventional therapy for CHD had been applied broadly in clinical treatment; since that time, the techniques have been rapidly popularized itself throughout China. It remains as the primary choice in some cases till today; it has been proven to be especially beneficial following clinical application of domestic occluder device. Y.W. Qin and colleagues (Changhai Hospital, Shanghai) conducted a review [57] on CHD in China in 2005; they report that more than 4500 individuals underwent CHD relevant interventional therapy in 2004. The statistic analysis indicated that 9311 ventricular septal defect (VSD) cases were treated with transcatheter closure of VSD within 21 hospitals in 2007, with 96.45% success rate and 2.61% complication rate as well as 0.05% mortality. For patients with complex congenital malformations, the availability of hybrid cardiovascular suite undoubtedly brings renewed hope; as this approach integrates the interventional techniques into thoracic operations; it is likely to play a vital role for cardiovascular surgery [58]. From 2009 to 2010, the Chinese Ministry of Health reported that a total of 34,693 CHD cases, including atrial septum defect, ventricular septum defect and patent ductus arteriosus, were treated percutaneously; The overall successful rate was 97.24%–97.67%, with 0.90%–0.92% complications rate, and 0.03%–0.05% mortality rate [59]. Giving the identified risk as well as other uncertainties surrounding the implantation of metal framework in the body, advancement of biodegradable occluder has become a key future development trend in China. With the rapid growth of omics technologies in personalized medicine, gene chips and protein chips will be available to identify markers indicative of high risk for CHD in China, affording new opportunities to aid the stratification of therapeutic regimens for CHD.

7. Stroke

Historically, China has had high susceptibility for stroke. Compared to western countries, the stroke incidence in Chinese population is universally higher and the etiology of acute stroke investigated in China is distinct, mainly triggered by intracranial atherosclerotic stenosis. At present, stroke is ranked as the second leading cause of death in China. According to the statistics of a national survey, the annual incidence rate and annual mortality rate of cerebrovascular diseases in the large cities were 219/100,000 and 116/100,000, respectively, which corresponds to 185/100,000 and 142/100,000 in the countryside; regional and gender differences are also noted; stroke is more common in the northern part of China compared to the southern areas, it is higher in males than in females. Mortality trend of cerebral infarction is increasing gradually, whereas that of cerebral hemorrhage is decreasing. Many studies optimizing pharmacological therapy in China were performed twenty years ago. Post-stroke antihypertensive treatment study (PATS), which represents the first large-scale antihypertensive therapy for stroke research was accomplished independently in China from 1991 to 1994, demonstrating that the recurrent stroke rate has been reduced by 31% amid the beneficial treatment of diuretics. Perindopril protection against recurrent stroke study (PROGRESS) which was an internationally organized, large-scale and multi-center based clinical trials included 1520 Chinese patients from 1995 to 2001. The outcome indicated that Perindopril is beneficial for secondary

prevention of post-stroke. Another multi-center, prospective registry study [60] showed that all-cause death rate and recurrent cerebrovascular events in adult patients were decreased by antiplatelet therapy. In recent two decades, percutaneous neural interventional treatment has been gradually becoming an important means for non-drug therapy of cerebrovascular disease in Chinese population. Although the interventional neuroradiology (thrombectomy or thrombolysis of hyperacute cerebral infarction, stenting of extra- and intra-cranial artery stenosis, interventional embolization of cerebral aneurysm or arteriovenous fistula, etc.) in China began at a much later time than that in the developed countries, China has undergone a rapid growth phase in many aspects regarding stroke therapy in the last decade.

8. Lower extremity arterial disease

From 2003 to 2008, five investigations in different areas of China were conducted and the data were analyzed that: among the 29,406 adults studied who are aged over 18, the prevalence of lower extremity arterial disease (LEAD) in natural population was 6.2%; among the population with diabetes and metabolic syndrome, the incidence was up to 38.7% and 45.1%, respectively. Gender difference was also detectable; with higher occurrence in females than in males. Correlative analysis based on the epidemiological study in Beijing area [61,62] showed that there was a significantly positive correlation between the occurrence and the severity of LEAD with risk factors, including age, smoking, diabetes, high systolic blood pressure and high low-density lipoprotein cholesterol. In particular, approximately 25% patients with ischemic heart disease suffer from their coexisting LEAD [61,63]. In 2008, the survey [62] of peripheral vascular disease (PAD) in Chinese natural population showed that the overall prevalence of PAD was 3.08%, whereas it was 2.52% in males and 3.66% in females; the prevalence of PAD was significantly increased with age in population ($P < 0.01$). The clinical application of interventional techniques in China has revolutionized therapeutic concepts and approaches on previously challenging cases, where routinely-administered drugs for LEAD patients had become ineffective, thereby overcoming quandary in many aspects of those patients with severe symptoms and avoiding revascularization by surgical method in recent years.

9. Expertise and workforce in Chinese cardiovascular medicine

Recently, the Chinese government has placed large resources into the education and training of the work force in various sectors of public health. These investments have shaped an expert team to combat the cardiovascular disease challenges facing the nation. A survey [64] including 25,240 doctors specializing in cardiovascular medicine throughout China indicated their average age as 38 years old, among them are 58.5% males; their average practicing time post obtaining license was 12 years, approximately 40.4% of them host a senior academic title and 33.3% of them have an advanced degree, either a master or a doctorate degree following their graduation from medical school. Among this population, the number of physicians participating in interventional operations was up to 25.9%, however, only 10.2% of them have the qualifications attestation (The examination of cardiovascular specialists and the test of interventional diagnosis and treatment are required for qualifications). With respect to new workforce training, the data based on China Statistic Almanac (2011) indicated that 6524 candidates for advanced doctor degree were recruited by medical colleges, whereas 33,543 for advanced master degree in 2010. Among them, one of the largest groups, physicians are attending an advanced degree in population medicine with a special concentration in cardiovascular diseases. In Beijing and Shanghai, as a cardiovascular specialist, it usually requires 11 years in school training for their degrees (5 years for their bachelor degree in medicine; 3 years for their advanced master degree in medicine; and 3 years for their advanced doctoral degree in cardiovascular medicine); and an additional 3 years clinical training in general

medicine. Furthermore, in the top ranking cardiovascular centers, doctoral candidates will undergo intense hands-on training with various procedures for up to 300 operations each year.

10. Conclusion

Over the past twenty years, Chinese cardiovascular medicine has undergone a major paradigm shift; transforming its focus from symptom-based therapy to life-style guided improvement. Prevention in cardiovascular medicine has taken central stage; it has emerged to coordinate efforts addressing all elements in the cascade of pathogenesis: from identification of behavior and biological triggers, to characterization of markers indicative of occurrence of disease, disease persistence, as well as its progression and recurrence. Ostensibly, to combat cardiovascular diseases in China requires the continued support of our government agencies; the innovation and advancement in medicine; furthermore, it requires an active engagement of the general public with their commitment and determination for a healthy and strong nation.

Conflict of interest statement

The authors declare no conflict of interests.

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