

# Interventional Radiology in China: Current Status and Future Prospects

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## INTRODUCTION

Interventional radiology (IR) is a clinical specialty providing minimally invasive image-guided diagnosis and treatment of diseases in various organ systems.<sup>[1]</sup> Since Charles Dotter performed the first balloon angioplasty on patients with stenosis of the superficial femoral artery in 1964, IR has been applied in numerous aspects of modern medicine.<sup>[2]</sup> However, the development of IR also presents many problems such as the relationship with other disciplines and turf wars.<sup>[3,4]</sup> These problems puzzle many interventionists, and no solution has been proven to be applicable to every country.<sup>[5,6]</sup>

Since Dr. Gui Lin, a pioneer of Chinese IR, published the first article in Chinese about the application of selective angiography in patients with hepatocellular carcinoma in 1979, Chinese IR has made great progress over the past four decades.<sup>[7]</sup> However, a limited number of articles have been published on the current status of IR in China.<sup>[8,9]</sup> Therefore, the aims of this paper were to provide a description of the current status of Chinese IR and to predict its future development.

## DISCIPLINARY DEVELOPMENT

Since its creation, IR has been facing the problem of its relationship to other specialties. Many interventionists want to treat patients independently.<sup>[6]</sup> Establishing an independent IR department might be the most effective way. By investigating all 539 tertiary referral hospitals in China with the public records on their official websites, which were complemented by telephone interviews, we found that 43.7% of tertiary referral hospitals (229) have an IR department [Figure 1]. Su and Xu found that only 20.8%

of hospitals had independent IR departments in 72 tertiary referral hospitals in Northeast China in 2005.<sup>[10]</sup> In another survey in Jiangsu province in 2006, the results showed that although 64.8% of hospitals could provide inpatient care for IR patients, only 33.3% of hospitals had independent IR units including IR wards under the management of radiology departments (12.5%).<sup>[8]</sup> The reasons for a higher proportion of independent IR departments in our investigation could be: (1) tertiary referral hospitals could more easily obtain financial support to establish new departments and purchase large equipment. (2) Professional division is further detailed in tertiary referral hospitals. (3) Establishing an IR department has become a prerequisite for being considered as a tertiary referral hospital in China. According to our investigation, IR departments are separated as independent departments at the speed of three hospitals a year. As the reasons mentioned above still exist, we believe that the independent IR departments will continue to increase in Chinese tertiary referral hospitals in the near future.

The appropriate name for the IR discipline has been discussed for a long time, as the current name, IR, is difficult for the public to learn and barely shows its value in treatment.<sup>[5]</sup> According to our investigation, we found that interventional department is the most widely used name for IR departments in China. The proportions of the different

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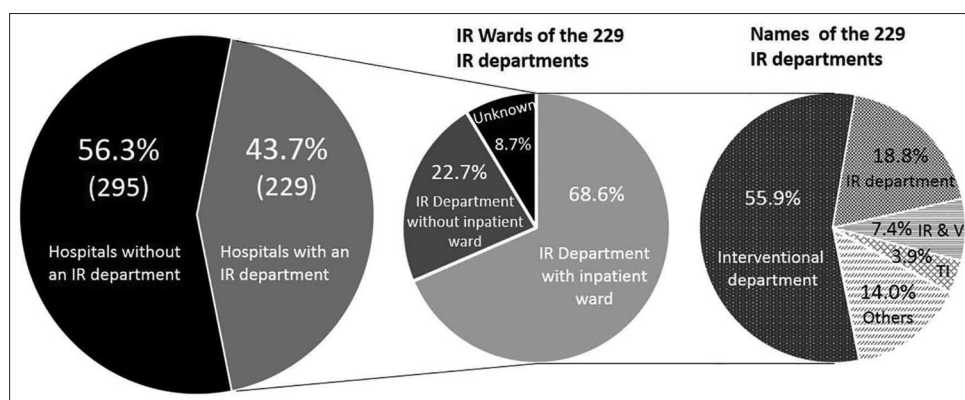
names are as follows: interventional department (55.9%), department of IR (18.8%), department of IR and vascular surgery (7.4%), department of tumor intervention (3.9%), and others (14%) [Figure 1]. This suggests that the dominant name, interventional department, might make it easier for doctors to propagate the specialty and attract patients' relative to the others.

According to the different types of connections with other disciplines and names of the IR departments mentioned above, we can group the clinical practice patterns of Chinese IR into three major forms [Table 1]: (1) Traditional mode: interventionists are under the management of the radiology department. Similar to the referral pattern in other countries,<sup>[11]</sup> many interventionists should also read films in addition to performing IR procedures. Meanwhile, their patients are limited, as referrals are not stable and controllable. (2) Subspecialty mode: interventionists are distributed to each clinical discipline based on their specialties such as neurology, oncology, and hepatology.<sup>[12]</sup> As the relationship between interventionists and clinical specialties is closer in this mode, it gives interventionists more opportunities to approach and treat patients, which enhances their proficiency. However, their procedures are limited to ones related to the clinical specialties to which they belong. In addition, interventionists are usually marginalized from the leadership of the department, as they are usually not able to perform the characteristic skills of the clinical specialties.<sup>[4]</sup> (3) Disciplinary mode: the IR specialty is completely separate from other disciplines. The

IR department has equal rights and obligations compared with the other specialties such as outpatient and inpatient care, the recruitment of IR personnel, and purchasing new devices and applying new techniques.<sup>[13]</sup> Compared with the other patterns, the disciplinary mode could improve the management efficiency of hospitals, inspire the motivation of IR personnel, and promote the development of the IR discipline.

## CLINICAL PRACTICE

The workloads of Chinese interventionists are reasonable. In a survey of 54 hospitals in Jiangsu Province in 2006, the authors found that hospitals have only 4.8 interventionists on average.<sup>[8]</sup> According to our investigation of Chinese tertiary referral hospitals, a total of 157 IR departments have independent inpatient wards (68.6% in IR departments and 29.1% in all tertiary referral hospitals) [Figure 1]. In these IR departments with independent wards, the average number of licensed beds and digital subtraction angiography machines are 37 and 2.4, respectively. The average number of IR doctors is 7.3. A doctor must manage an average of 5.1 beds. The data suggest that Chinese IR doctors are under reasonable stress. In a survey of 274 European IR departments, 17% of institutions have dedicated IR inpatient ward, and the average number of beds was eight.<sup>[14]</sup> In another survey of approximately 900 Chinese interventionists, the results showed that 41% of doctors have a master's or doctorate degree and 53% were under 40 years old.<sup>[15]</sup> This suggests that IR staff in China have



**Figure 1:** The number of Chinese tertiary referral hospitals with an interventional radiology department, the ratios of interventional radiology departments with or without inpatient wards, and the ratios of different names of these IR departments. IR: Interventional radiology; TI: Department of tumor intervention; IR and V: Department of interventional radiology and vascular surgery.

Items	Traditional mode	Sub-specialty mode	Disciplinary mode
Administrator	RD and hospital	CD and hospital	Hospital
Source of patients	Referral	Referral within CD	Outpatient and referral
Clinical practice	Film reading and procedures	Procedures related to CD	Procedures
Approval of new devices	RD and hospital	CD and hospital	Hospital
Scientific research	Corporate of other specialties	IR topics related to CD	All IR topics
Recruitment	Within RD	Within CD	Hospital

RD: Radiology department; IR: Interventional radiology; CD: The clinical department to which the interventionists belong.

reasonable age and education levels, which offers great potential in the future.

Neural and tumor interventions are the two most common procedures for interventionists in China. According to the investigation, cerebral angiography is the most commonly performed IR procedure in China, followed by transcatheter arterial chemoembolization (TACE), percutaneous transluminal angioplasty, cerebral aneurysm interventions, and percutaneous transhepatic cholangiography with or without drainage or stent placement. Similarly, another survey conducted among 61 hospitals in Shanghai showed that the average number of IR procedures for each hospital is 1152/year.<sup>[16]</sup> The ratios of different procedures are listed below: neural intervention (61.9%), tumor intervention (24.9%), peripheral vascular intervention (6.0%), nonvascular intervention (4.3%), and others (2.9%). The authors also found that 71.5% of neural interventions are cerebral angiography. The reason for the high ratio of neural intervention is that cerebral angiography has become the gold standard in detecting many neurological diseases.<sup>[17]</sup> Similarly, TACE has been recommended as the first-line treatment in patients with Stage B hepatocellular carcinoma by the Barcelona Clinic Liver Cancer staging classification.<sup>[18,19]</sup> This comprised 80% of all tumor interventions. Therefore, improving the first-line IR procedures is crucial to the survival and sustainable development of the IR discipline.

## SCIENTIFIC RESEARCH

The ability to conduct scientific research in China has improved in recent years. The data on PubMed (<http://www.ncbi.nlm.nih.gov/pubmed/>, last accessed on January 6, 2017) show that in the past 16 years, an increasing number of IR articles have been published by Chinese interventionists [Figure 2a]. Although the number of IR articles published by Chinese interventionists is stable and limited before 2006, it has increased from 4 to 987/year in the past 10 years. Recently, several position papers have been published by Chinese interventionists, which suggest that the ability of Chinese medical researchers to perform studies has also improved.<sup>[20]</sup>

We searched the National Natural Science Foundation of China (NSFC, <http://www.nsf.gov.cn/>, last accessed on January 6, 2017), which was set up by the Chinese Central Government, and is the most common research foundation for medical scientists. The financial support for IR from NSFC has increased enormously in the past decade [Figure 2b]. However, its proportion of all contributions to medicine from the NSFC has not remarkably changed (0.3–0.6%), and only a handful of interventionists successfully get funded [Figure 2c]. In addition, as the relationship between the IR discipline and other specialties is unclear, the IR specialty has no independent categories for the application of many provincial and municipal funds. Except for funds from the governments at all levels, financial support from related industries is also limited and unbalanced.<sup>[8]</sup> As a result, most

Chinese interventionists rely on limited funds from the government to conduct scientific research and innovations. To improve these research conditions, clarifying the exact relationship of the IR discipline with other specialties by the government might be the most effective method, as the unclear position of the IR discipline might be the main problem.

## EDUCATION AND TRAINING

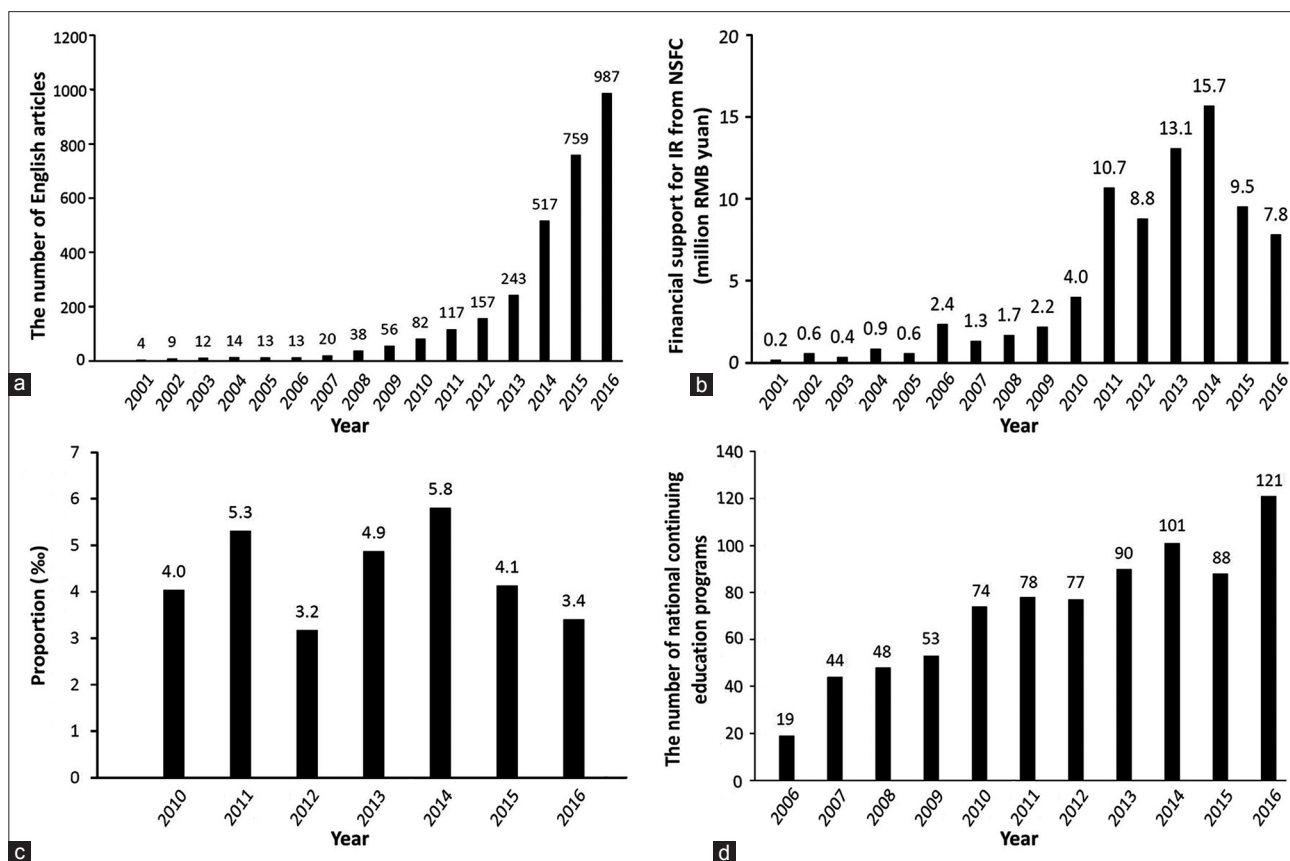
Many issues still exist in the education and training system of IR in China. (1) In medical colleges, IR is usually introduced by a few lessons in the course of diagnostic radiology. Several medical schools have provided independent IR courses; however, it is mostly elective. (2) Nationwide IR residency training programs are still not available in China. The training programs are usually set up according to the situation in different regions. Most of the training programs are modified from the residency training program of diagnostic radiology, in which the rotation of clinical specialties is always less than one year. This is a limitation for interventionists to improve their patient management skills. (3) A national qualification examination for IR has not yet been established. No official standard has been used to evaluate the ability of IR personnel.

Many resources for continuing education for interventionists are widely available in China. In the past 10 years, the number of national continuing medical education programs has increased from 19 to 121 (<http://cmegsb.cma.org.cn/>, last accessed on January 6, 2017), with an annual growth of 20% [Figure 2d]. In addition, the scientific meeting of Chinese Society of IR has been successfully held for 13 sessions. In the 13<sup>th</sup> meeting in Suzhou, almost 5000 individuals participated, which suggests that Chinese IR has made great progress in education and training.

Professional journals can be a platform to promote and propagate a discipline. Several IR journals have been published in Chinese including the Journal of IR, Chinese Journal of Interventional Imaging and Therapy, Diagnostic Imaging and IR, Modern Digestion and Intervention, and Electronic Edition of Chinese Journal of IR. As Chinese interventionists have published an increasing number of English articles, the Chinese IR discipline is eager to have an English journal to speak for the growing community of interventionists. However, no English IR journal has been established in China.

## DISCUSSION AND FUTURE PROSPECTS

The development of Chinese IR has its own unique characteristics. Approximately 15 years ago, Prof. Gao-Jun Teng stated that if diagnostic radiology still held onto IR too long, most of the IR procedures would be conducted by clinicians.<sup>[3]</sup> For this reason, several generations of Chinese IRs have made concerted efforts to change the relationship between IR and relevant disciplines, which included establishing many independent IR departments,



**Figure 2:** Current status of interventional radiology in China (a) The number of English articles completed by Chinese interventionalists according to data on PubMed. (b) The financial support for interventional radiology from the National Natural Science Foundation of China. (c) The proportion of the financial support for interventional radiology of all support for medicine from the National Natural Science Foundation of China. (d) The number of national continuing medical education programs of interventional radiology in the past decade. NSFC: National Science Foundation of China.

providing various procedures to serve other specialties, and strengthening the discipline by improving the capacity for scientific research. These efforts have created more opportunities for Chinese interventionalists to approach and treat patients and make IR more disciplinary in China.

Despite these progresses, Chinese interventionalists are facing similar challenges as the other countries: (1) the relationship between IR and related disciplines is still unclear. No pattern has played a dominant role over the others. (2) First-line IR treatments are still limited.<sup>[11,14,21]</sup> (3) Foundations and articles with high-grade evidence are still limited.<sup>[22]</sup> (4) No nationwide training program and evaluation system have been applied.<sup>[23]</sup> To address these problems, we should reflect on the technical basis and the essence of the discipline of IR.

Interventional medicine has a distinctive technical culture. IR is essentially a minimally invasive “surgery” aimed at detecting or treating diseases under indirect vision from X-ray, ultrasound, computed tomography scan, or magnetic resonance imaging. It is obviously distinct from surgery, internal medicine, and diagnostic radiology. From an economic point of view, the productivity could be greatly improved by the social collaboration and division of labor.<sup>[24]</sup> Therefore, determining the relationship between IR and related disciplines could contribute to the liberation of

the pent-up motivation of interventionalists and benefit the development of the discipline.<sup>[25,26]</sup> Interventionists should be deeply involved in the entire process of inpatient and outpatient care and exert their influence on management and policies.<sup>[11]</sup> Compared with other patterns, the disciplinary mode can provide a unique and appealing identity to interventionalists and more comprehensive service to patients. Above all, it shows more potential for the future development of IR. Therefore, we believe that more hospitals would adopt disciplinary modes in the future.

In conclusion, Chinese IR has made great progress in discipline construction, clinical practice, scientific research, and education. The idea that IR should be deeply involved in the entire process of patient care has been widely accepted. We suggest that the IR discipline and its requisite training should be based on hospital wards, supported by scientific research, and eventually provide an open and sharing platform for patients and doctors in the future.

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### Conflicts of interest

There are no conflicts of interest.



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