Interventional radiology. A survey of staff, imaging equipment and procedures

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Interventional radiology. A survey of staff, imaging equipment and procedures.

AIM: *To explore the current situation and problems of interventional radiology (IR) staff, imaging equipment and procedures in hospitals.*
METHODS: *An electronic questionnaire was sent to 186 officially registered secondary and tertiary hospitals through a dedicated network for medical administration in a city in China. Data collection efforts ceased two weeks after the questionnaire was sent out.*
RESULTS: *The response rate was 100%. IR procedures were provided in 22 hospitals (11.8%). 50.0% were 2A level hospitals. 95.5% began to perform IR procedures in the last three decades. The IR workload of 3A level hospitals was significantly heavier than that in 3B or 2 level hospitals (1139.20±699.32 vs. 95.60±45.48, 1139.20±699.32 vs. 85.17±61.15; P<0.001). There were more senior interventional radiologists than juniors (43 vs. 41), and insufficient radiographers (radiographer-equipment ratio 0.91 ± 0.54). Thirteen hospitals (59.1%) had set up independent IR departments, and several clinical departments provided IR service at the same time in ten hospitals.*
CONCLUSIONS: *The IR specialty of 3A hospitals had obvious advantages in staff, imaging equipment, and procedure volume over other hospitals. It should be noted that there were fewer junior interventional radiologists and the number of radiographers was inadequate. Further attract the talents to the IR field is important in future.*

KEY WORDS: Interventional radiology, Imaging equipment, Survey, Staff, Workload

Introduction

Interventional radiology (IR), which is an image-guided, minimally invasive diagnostic and therapeutic specialty, is currently being expanded in many fields of clinical medicine [1,2]. According to local factors in different countries and regions, IR is formally recognized as a subspecialty of diagnostic radiology or a distinct specialty. In 2010, a global statement developed by 42 national interventional radiology organizations set forth the basic elements of IR including the definition, clinical scope, training, certification, clinical practice, quality, research, and professionalism [3]. In 2019, the American College of Radiology (ACR) recommended revised ACR–SIR–SNIS–SPR Practice Parameter for the Clinical Practice of Interventional Radiology in the United States (https://www.acr.org/-/media/ACR/Files/ Practice-Parameters/IRClin-Prac-Mgmt.pdf). In practice, the field of IR remains challenging. Several issues, such as turf issue, IR awareness, gender gap, and radiation protection, have attracted widespread interest from interventional radiologists and IR societies [4-10]. However, on the other hand, few specialists focus on the general trend of baseline characteristics such as staff, equipment, and IR procedures. This information was believed to be the most important for decision making on where and how to address the effort [9].
A survey was conducted in a city of 9.4 million people to explore the current situation and problems of IR staff, imaging equipment, and procedures in hospitals except cardiovascular intervention.

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Materials and Methods

Study subjects

Hospitals in China are divided into three tiers: primary, secondary, and tertiary institutions, i.e. 1-level, 2-level, and 3-level hospitals. These three tiers are further divided into three subsidiary levels: A, B, and C, resulting in a three-tier system with nine levels [11]. All hospitals, including 3A-levels, the highest level institutions, were evaluated and accreditd by the Health Commission based on a series of strict assessment criteria. Higher tier and level indicate more disciplines and specialist departments, more health services, and higher health care quality and safty. Since the primary hospitals do not perform IR procedures, 186 secondary and tertiary hospitals that officially licensed before May 2018 were enrolled in the survey. Surveys were only excluded if the results of the questionnaire were blank or incomplete. According to the 2018 National Economic and Social Development Statistics Bulletin issued by the Municipal Bureau of Statistics, about 9.4 million people are serviced by these hospitals.

Questionnaire

A questionnaire was designed to acquire the baseline information of IR in secondary and tertiary hospitals. All questionnaires were completed with uniform guidance, e.g., definition of the key concepts, how to fill in the questionnaire, and the survey was not associated with any conflicts of interest. The questionnaire consisted of seven questions focusing on the practice situation of IR, equipment configuration, team members, and the professional status in the hospital (Appendix).

APPENDIX

Survey on baseline Information of Interventional Radiology (Except cardiovascular intervention.)

1. Whether or not to conduct interventional radiological procedures in your hospital?

If yes to question 1, please answer the following questions:

2. From which year did the interventional radiological procedures begin?
3. From January to June 2018, what is the number of interventional radiological procedures?
4. From January to June 2018, what are the top 5 interventional radiological procedures performed by IR team at your hospital?
5. What devices are available to guide interventional radiological procedures in your hospital?
6. Please provide information on the staff involved in the interventional radiological procedures.
7. Which departments perform interventional radiological procedures?

Outcome Measures

Professional ranks of doctors, nurses, and radiographers in China are classified into three levels: senior, medium, and junior. For example, professor and associate professor are defined as senior ranks. The attending doctor is medium rank. Other doctors, including residents, are junior ranks. The same goes for nurses and radiographers. These individuals are assessed and certified by an officially authorized specialized committee according to a complex standard including medical background, theoretical test, clinical skills, number of cases performed, medical scientific research, etc. Full-time and part-time doctors, nurses, and radiographers were all counted as team members. Staff-equipment ratios including doctor-equipment ratio, nurse-equipment ratio, and radiographer-equipment ratio were used as indicators to describe staffing. Insufficient staff, as defined in this study, was considered to be a doctor-equipment ratio of 2 or less, a nurse-equipment ratio of 2 or less, or a radiographer-equipment ratio of 1 or less.

Data Collection

The Survey Was Conducted in July 2018. Researchers were trained in all details related to the survey before the study. An electronic questionnaire was sent to 186 secondary and tertiary hospitals through a dedicated network for medical administration. If there was any doubt during the data collection, a telephone interview was subsequently performed by a researcher. Data collection efforts for all outstanding data forms ceased two weeks after the questionnaire was successfully sent out. All data were recorded and entered into Statistical Package for the Social Sciences (SPSS) software for analysis by one researcher and was then confirmed by another researcher.

Statistical Analysis

Measurement data were expressed as the mean and standard deviation (SD). Enumeration data were expressed as proportions. Differences were compared using one-way ANOVA or *t*-test for continuous variables and Pearson chi-square tests for categorical variables. A two-sided *P* value of 0.05 or less was considered statistically significant. SPSS (SPSS 15.0 for Windows, SPSS Inc., Chicago, IL, USA) was used to perform the statistical analysis.

Results

All 186 hospitals (100%) completed the questionnaire or confirmed that no IR procedure had been performed. The questionnaire was fully completed by almost all

responders. Any submissions that included partial answers were clarified in a follow-up telephone interview. No subject was excluded.

Practice situation of IR

Twenty-two responders (11.8%) confirmed that IR procedures were conducted in their hospitals. However, in effect, these hospitals provide almost 21,000 beds. It means more than 62% of the total beds in the city. Among them, 50.0% were 2A level hospitals. 95.5% reported that their IR team began to perform IR procedures in the last three decades. Whereas, only 4 3-level hospitals could provide IR services before 1997. Eighteen responses (81.8%) reported less than 500 IR procedures were conducted in the last six months. Among them, 10 responses (45.5%) revealed that only fewer IR procedures (18-87 cases) were completed in the last six months in their hospital. The amount of IR procedures in 3A level hospitals was significantly higher than that in 3B or 2 level hospitals (1139.20 ± 699.32 vs. 95.60 ± 45.48, 1139.20 ± 699.32 vs. 85.17 ± 61.15; $P < 0.001$) (Table I). While in the same period, the beds of 3A, 3B and 2 level hospitals were 1905.80 ± 981.28, 755.20±273.93, and 688.25±448.47, respectively.

Transcatheter arterial chemoembolization (TACE), percutaneous transhepatic cholangial drainage (PTCD), gastrointestinal interventions (stent and/or balloon), transcatheter arterial embolization (TAE), and transcatheter arterial infusion (TAI) were the most familiar procedures for IR specialists in this city. The image-guided biopsies performed by IR specialists were relatively fewer (only 18.18%). The results of questions 1-4 are presented in (Fig. 1).

Equipment Configuration

Regarding the imaging equipment for guidance, there were 15 hospitals (68.2%) that provided a single type of equipment for IR procedures. Here, 13 responders (59.1%) reported that only one digital subtraction angiography (DSA) machine could be used for IR procedures in their hospitals. Seven hospitals (31.8%) provided two or three types of equipment for IR procedures. Eleven hospitals (50.0%) had established independent IR departments to manage these equipments.

Table I - *The amount of IR procedure in hospitals of different levels in the first half of 2018.*

Hospital level	N	The amount of IR procedure		F	P value	Multiple comparison*	
		Mean	SD			3B	2A & 2B
3A	5	1139.20	699.32	20.136	0.000	0.000	0.000
3B	5	95.60	45.48				0.953
2A & 2B	12	85.17	61.15				
Total	22	327.09	546.57				

Due to the small number of 2B level (only 1), 2B and 2A were merged; There's no 3C and 2C hospital in this city.
* P value (LSD method)

Table II - *Configuration of the imaging equipment and their relationship with the IR Procedures In Hospitals.*

Characteristic	N Equipment	N Hospital	N Ir Procedure		Significance	
			Mean	SD	t	P value
Type of equipment						
Single type			171.13	262.04	t =-1.522	0.175
DSA	1	13				
	2	1				
US	5	1				
Multi-type			661.29	833.22		
DSA+CT	2	1				
	3	1				
	4	1				
	6	1				
	10	1				
DSA+US	4	1				
DSA+CT+US	4	1				
Management department						
IR department	1-10	11	392.73	664.32	t =0.554	0.586
Other department	1-6	11	261.45	420.19		

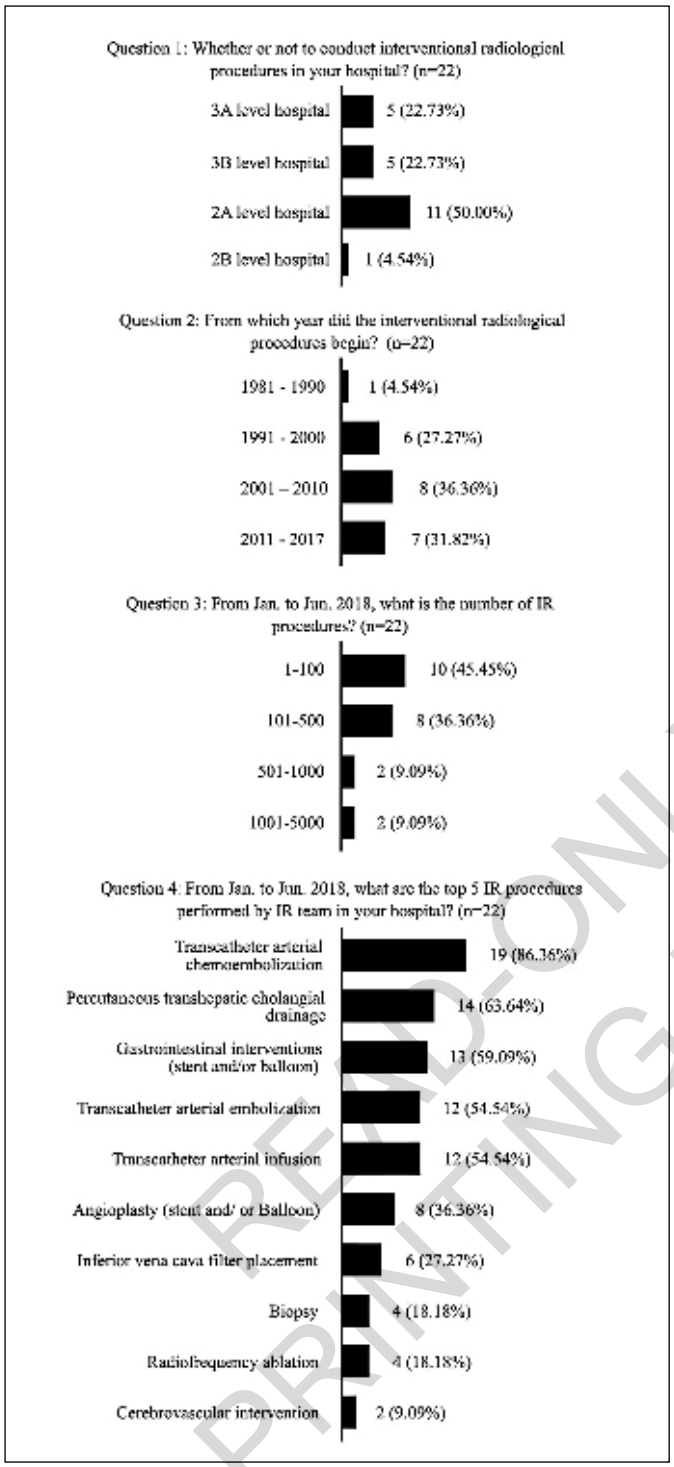

Fig. 1: Practice situation of IR in the hospitals.

The other hospitals arranged one or more other departments for their management. There was no evidence that the number of IR procedures was correlated with the types or the management departments of these equipment ($P > 0.05$). The configuration of the imaging equipment and their relationship with the IR procedures are summarized in (Table II).

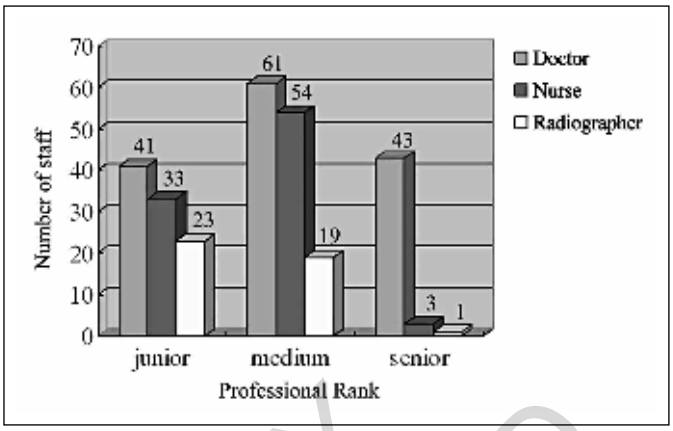

Fig. 2: Distribution of different ranks in doctor, nurse and technician in the IR specialty.

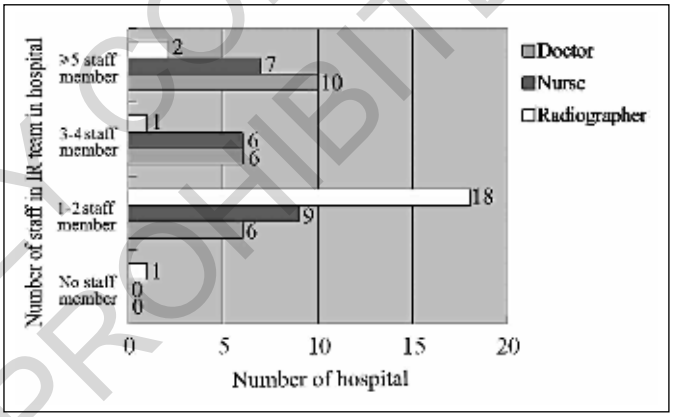

Fig. 3: Distribution of doctors, nurses and technicians of IR team in the hospitals.

Team members of IR

The number of IR staff widely varies according to the configuration of imaging equipment and the IR procedure volume. It was clarified that there were more senior interventional radiologists than junior interventional radiologists (43 vs. 41), and there were fewer IR nurses and radiographers in the senior rank (3 and 1, respectively) (Fig. 2). The doctor-equipment ratio, nurse-equipment ratio, and radiographer-equipment ratio were 3.58 ± 2.98, 2.14 ± 1.75, and 0.91 ± 0.54, respectively. This means an average of 3.58 doctors, 2.14 nurses and 0.9 radiographers per equipment (DSA or CT, or US.). There were an insufficient number of radiographers. One responder reported that there was no full-time IR radiographer in his hospital (Fig. 3).

Professional Status of Ir Team in Hospitals

In this city, the department determine the specialty of the physicians performing the IR procedure. Twelve

TABLE III - *The departments performing the IR procedures in the hospitals.*

Department	The only department		One of multiple departments		Total
	N	%	N	%	
IR department	6	50.0	7	24.1	13
Radiology department	1	8.3	3	10.3	4
US department			2	6.9	2
Interventional vascular surgery department	2	16.7			2
Vascular surgery department			5	17.2	5
Neurosurgery department			3	10.3	3
Neurology department			1	3.5	1
Oncology department	1	8.3	5	17.2	6
General surgery	1	8.3	2	6.9	3
Hepatobiliary surgery department			1	3.5	1
Internal medicine department	1	8.3			1
Total	12		29		41

responders reported that there was only one department performing IR procedures in their hospitals. Among them, six hospitals had set up IR departments as an independent special subject to provide IR services. Even though seven of the 10 other hospitals had established IR departments, IR was not recognized as an independent clinical specialty and had been expanding in several clinical specialties as a series of special procedures. The departments performing the IR procedures in the hospitals are summarized in (Table III).

Discussion

This study selected a larger-sized city as a sample to explore the current situation of IR. In this city, secondary and tertiary hospitals included some special hospitals. The results showed that 22 (11.8%) hospitals provided IR services in this city. Among them, the proportion of medium-sized hospitals (12/22), i.e., the proportion of hospitals at 2A and 2B levels, indicated that IR procedures had extended to the medical institutions in municipal districts and counties. However, this expanding process was found only in the last two decades. It is consistent with the history of IR, which is a young specialty in China.

Most hospitals (18/22) had an IR workload of less than 500 procedures in the first half of 2018, and 10 out of 22 performed less than 100 procedures. Another statistical result demonstrated that most IR procedures were performed in 3A level hospitals, and their workloads were more than ten times that of 3B, or 2A and 2B hospitals, while the ratio of hospital beds in the same period was far from than amount. This means that many people would rather transfer the patient to a larger, better resourced hospital than the smaller hospital to provide IR procedures. The clinical needs for IR services are seriously unbalanced in hospitals at different levels, and this result is consistent with the outcomes of the survey conducted by Friedberg et al. in the United States [12]. Tertiary hospitals are appropriately referred more complex patients from smaller hospitals and such an imbalance may be entirely appropriate and meet the needs of the community.

Recently, a joint survey from the European Society of Radiology (ESR) and the Cardiovascular and Interventional Radiological Society of Europe (CIRSE) reported that a large variety of IR procedures – such as image-guided biopsy, image-guided aspiration, the drainage of collections and abscesses, peripheral arterial disease intervention, emergency embolisation for haemorrhage, and chemo-/radioembolisation – were performed in most European hospitals (73.2-91.8%) [9]. In the present study, several procedures, including TACE, PTCD, gastrointestinal interventions (stent and/or balloon), TAE, and TAI, were proved to be the most frequent IR procedures in these hospitals in China. It is believed that the differences between Europe and China are obvious. Above differences might be due to the different criteria for the implementation of the surveys in different region. Interventional oncology was the most major field of IR in this study.

The imaging equipment, as the necessary equipment for guidance, is one of the most important supports in IR activities. The results of the present study revealed that there was no relation between the type of equipment and procedure volume; though, the combination of multiple types of imaging equipment, to the authors' knowledge, was beneficial to complex procedures. In addition, the result clarified that the management department was not associated with the IR workload.

A previous study reported a survey of medical undergraduates and found that 68.5% were interested in IR, but only 13.2% of males were willing to pursue a career in IR. In this study, the data suggested that there were fewer junior interventional radiologists than seniors. This proportion is unusual. This result may indicate the same trend as the prior study. In fact, this issue had been exposed earlier in medium and small hospitals because of their inadequate access to IR procedures and IR physi-

cians [12]. On the other hand, based on the average radiographer-equipment ratio of 0.91, the shortage of radiographers was another issue for all hospitals.
Levin et al [13] reviewed the Medicare databases and found that the procedure volume in peripheral arterial interventions grew at faster rates among vascular surgeons and other physicians than it did among radiologists. However, interventional radiologists still had the largest share. In this study, it was found that interventional radiologists and IR departments still maintained a strong position, even though the oncologic intervention services were provided more frequently. Furthermore, vascular surgeons, oncologists, and other physicians had obtained a larger share than before [13]. This will be an inescapable issue in the future.
There are several limitations to this study. The first limitation is that the sample was limited to one city. Therefore, there may be an inherent selection bias. Another limitation of this study is the potential bias associated with the use of a self-administered questionnaire. More issues and details need to be added and implemented in future research.

Conclusion

Interventional oncology was the major field of IR. The IR specialty of 3A hospitals had obvious advantages in staff, imaging equipment, and procedure volume over other hospitals. It is still unclear if the smaller hospitals are underserved for IR procedures or have lower needs. It should be noted that there were fewer junior interventional radiologists and the number of radiographers was inadequate. Further attract the talents to the IR field is important in future.

Riassunto

Lo scopo di questo studio è l'analisi della attuale situazione negli ospedali secondari e terziari di una città della Cina a proposito dei problemi relativi al personale di radiologia interventistica (IR), delle apparecchiature e delle procedure di imaging.
Per questo è stato inviato un questionario elettronico a 186 ospedali secondari e terziari ufficialmente registrati attraverso una rete dedicata per l'amministrazione medica in una città della Cina. Gli sforzi per la raccolta dei dati sono stati interrotti due settimane dopo l'invio del questionario.
Risultati: Il tasso di risposta è stato del 100%. Le procedure IR sono state fornite in 22 ospedali (11,8%). Il 50,0% erano ospedali di livello 2A. Il 95,5% ha iniziato a eseguire procedure IR negli ultimi tre decenni. Il carico di lavoro IR degli ospedali di livello 3A era significativamente più pesante di quello degli ospedali di livello 3B o 2 (1139,20 ± 699,32 contro 95,60 ± 45,48, 1139,20 ± 699,32 contro 85,17 ± 61,15; P <0,001). C'erano più radiologi interventisti senior rispetto ai giovani (43 contro 41) e radiografi insufficienti (rapporto radiografo-attrezzatura 0,91 ± 0,54). Tredici ospedali (59,1%) avevano istituito dipartimenti IR indipendenti e diversi dipartimenti clinici fornivano servizi IR contemporaneamente in dieci ospedali.
Conclusioni: La specialità IR degli ospedali 3A presentava evidenti vantaggi in termini di personale, apparecchiature di imaging e volume delle procedure rispetto ad altri ospedali. Va notato che c'erano meno radiologi interventisti junior e il numero di radiografi era inadeguato. Attirare ulteriormente i talenti nel campo IR è importante in futuro.

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