



State-of-the-art of nuclear medicine and molecular imaging in China: after the first 66 years (1956–2022)

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This is a historical event. The five of us (Xiaoli Lan, Li Huo, Shuren Li, Jing Wang, and Weibo Cai) are thrilled and extremely proud to announce the publication of a *European Journal of Nuclear Medicine and Molecular Imaging (EJNMMI)* special issue entitled “State-of-the-Art of Nuclear Medicine and Molecular Imaging in China: After the First 66 Years (1956–2022)”, thanks to the tremendous support from the Editor-in-Chief of EJNMMI, Prof. Arturo Chiti from Humanitas University in Milan, Italy. With a total of more than 40 articles, including review articles, research articles, and this editorial, we sincerely hope this special issue will be a good snapshot in time of the State-of-the-Art of Nuclear Medicine and Molecular Imaging in China, which has witnessed exceptional growth and development over the last several decades. We are truly grateful to all the authors, reviewers, editors, patients, and EJNMMI editorial staff for their invaluable contribution of time and expertise, and we are convinced that this special issue will be very well-received by readers in Europe and China, as well as around the world.

One might say that in some way, this special issue originated on 1/6/2021, when Weibo Cai was invited by Prof. Chiti to become an Associate Editor of EJNMMI, in

recognition of the increasing number of manuscript submissions to EJNMMI each year, especially from countries outside of Europe which clearly indicated the ever-increasing global impact and influence of EJNMMI in the field of nuclear medicine and molecular imaging. Needless to say that Cai gladly accepted the invitation and agreed to devote significant amount of time to help further increase the global impact of EJNMMI. On 1/16/2021, Prof. Chiti emailed all Associate Editors of EJNMMI to welcome any suggestions for further initiatives or “special issues”, aiming at capturing the state-of-the-art and/or emerging topics of the field. With such a special issue in mind for several years already, Cai immediately replied with a brief proposal of a EJNMMI special issue entitled “State-of-the-Art of Nuclear Medicine and Molecular Imaging in China”. Prof. Chiti was very delighted to receive the proposal with such a quick turnaround time, and enthusiastically encouraged Cai to “proceed with the proposal” on 1/17/2021.

Cai immediately discussed this proposal with several professors about guest editing the special issue together: Department Chairs of the top 2 Nuclear Medicine departments in China (Li Huo from Peking Union Medical College Hospital and Xiaoli Lan from Union Hospital in Wuhan,

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affiliated with Huazhong University of Science and Technology), Jing Wang (President-Elect of the Chinese Society of Nuclear Medicine, Chair of Department of Nuclear Medicine, Xijing Hospital), and Shuren Li from Medical University of Vienna. Together, the 5 guest editors are located in China, Europe, and USA with a very good gender balance (60% female). After a few rounds of discussion over the logistic details, on 1/21/2021, about 50 invitation emails to potential senior authors were sent out to invite them to consider contributing manuscript(s) to this special issue. Considering the time difference among Europe/USA/China, this special issue was kick started with lightning speed: everything was done in a matter of just a few days during the surging waves of the COVID-19 pandemic [1, 2].

In terms of the specific topic of this EJNMMI special issue, the five guest editors all agreed that we likely would not have enough high-quality manuscripts on any specific and focused topic such as artificial intelligence, new tracers, fibroblast activation protein inhibitor (FAPI), immunotherapy, total-body PET, or targeted radionuclide therapy. Hence, we all felt it was more suitable to include all areas of nuclear medicine, including but not limited to new tracer development/validation/optimization, first-in-human studies, clinical trials, therapy, theranostics, etc., as well as non-nuclear medicine molecular imaging studies (e.g., nanotechnology, image-guided drug delivery, other imaging modalities). With a broad scope, we were confident that we would be able to get excellent quality manuscripts in sufficient quantity that will not only meet the high standard of EJNMMI, but also be able to increase the exposure of EJNMMI in closely related biomedical fields.

With regard to who we should invite to contribute to this special topic issue, the process was highly selective. We tried to cover a large number of major research groups in China in the field, and only invited those who have published in top-quality journals (such as EJNMMI, Journal of Nuclear Medicine, or above), those (who may not be in the nuclear medicine field per se) with the potential to publish in these journals, as well as young rising stars to foster/promote the next generation of translational researchers. Even though this special issue is by invitation only, if there are accepted manuscripts in EJNMMI that fit the scope of the special issue, Dr. Chiti agreed that we could also cherry-pick and include these articles in our special issue.

The initial deadline of manuscript submission was set as 9/30/2021, with earlier submission highly encouraged in the invitation emails. Each manuscript underwent the standard quality control, and subsequent peer-review process immediately if it passed quality control. Accepted manuscripts were published online within a few days after manuscript acceptance, and generally would only be assigned specific issue and page numbers when the special issue is published. Considering the unpredictable global pandemic situation, which

undoubtedly delayed some research/clinical activities, the guest editors left sufficient wiggle room for manuscript submission. In reality, the manuscript submission deadline was around 12/31/2021, aiming at completing all peer-review process by 3/31/2022. In total, approximately 60 authors were invited to contribute to the special topic issue, and the vast majority of those invited authors agreed to contribute and submitted manuscript(s).

Research and clinical activities of nuclear medicine in China has come a very long way [3, 4]. Figure 1 shows some of the representative landmark events over the last 70 years since the People's Republic of China was founded on October 1st, 1949. The first course of nuclear medicine was officially offered in China in 1956, which represented the beginning of the field of nuclear medicine in China. However, the next 2 decades were very challenging for both researchers and the general population of China, with many devastating events happening during this period. With the Chinese Society of Nuclear Medicine (CSNM, a branch of the Chinese Medical Association) founded in 1980, and the Chinese Journal of Nuclear Medicine (CJNM) published in 1981, the field of nuclear medicine in China has got back on the right path and slowly, but steadily, started the arduous journey. With the first single-photon emission computed tomography (SPECT) system installed in China in 1983, the 1st PET and medical cyclotron in China installed in 1995, the 1st microPET in China installed in 2000, and the 1st PET/CT in China installed in 2002, the field of nuclear medicine and molecular imaging in China has steadily gained momentum and tremendous progresses have been made. After a decade (2000–2010) of learning, accumulation, investment, and hard work, the field of nuclear medicine and molecular imaging in China has entered the fast track in the 2nd decade of the twenty-first century, with the 1st PET/MR system in China installed in 2012, the “one nuclear medicine department per county” initiative established in 2016, and the 1st total-body PET/CT installed in 2019 [5]. In the same year, the 23rd International Symposium on Radiopharmaceutical Sciences (ISRS) was successfully held in Beijing, which was the first large-scale international conference in the field of nuclear medicine hosted by China.

Such dazzling development and tremendous growth over the last 2 decades were clearly evidenced by high-quality publications in the field. On 2/22/2022, we conducted a PubMed search of “Eur J Nucl Med Mol Imaging” [jour] AND “China” [Affiliation] and the results over the last 20 years were shown in Fig. 2. During the 1st decade of the twenty-first century, there were very few publications with Chinese affiliation, often only 0–2 per year. The first 5 years of the 2nd decade witnessed a significant increase in number of publications in EJNMMI; however, still no more than 10 a year (< 3% of all EJNMMI publications). Starting from 2016, the numbers increased steadily each year, reaching

Fig. 1 A brief timeline of selected and representative major events of nuclear medicine and molecular imaging in China. *CSNM* Chinese Society of Nuclear Medicine, *CMA* Chinese Medical Association, *CJNM* Chinese Journal of Nuclear Medicine, *CAS* Chinese Academy of Sciences, *SPECT* single-photon emission computed tomography, *PET* positron emission tomography, *CT* computed tomography, *MR* magnetic resonance, *CJNMMI* Chinese Journal of Nuclear Medicine and Molecular Imaging, *ISRS* International Symposium on Radiopharmaceutical Sciences, *NMMI* nuclear medicine and molecular imaging, *EJNMMI* European Journal of Nuclear Medicine and Molecular Imaging

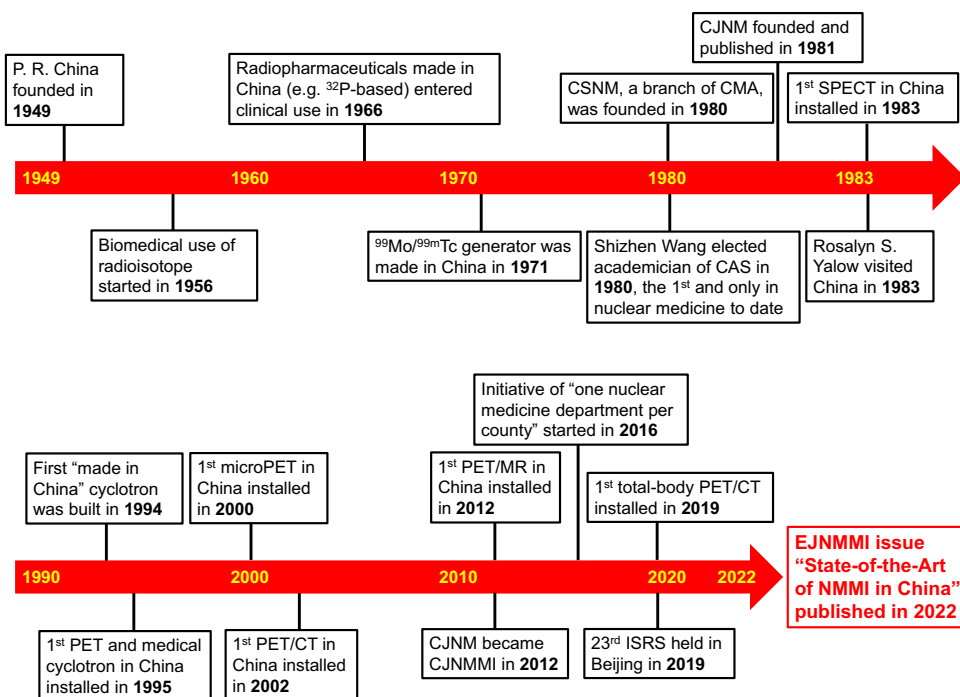
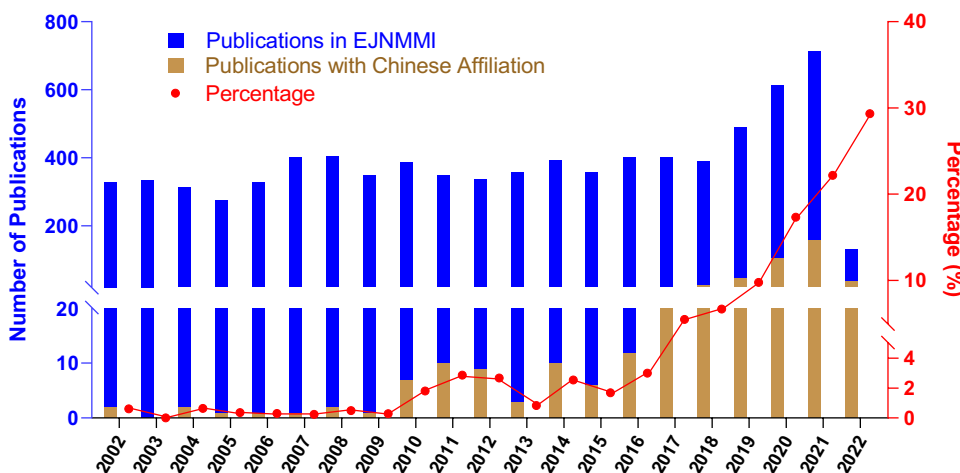


Fig. 2 Number of publications in European Journal of Nuclear Medicine and Molecular Imaging (EJNMMI), number of EJNMMI publications with Chinese affiliation, and percentage over the last 20 years. The data were from on a PubMed search on 2/22/2022, which showed a steady increase of EJNMMI publications with Chinese affiliations over time, especially during the last 5 years



22.2% in 2021 (158 out of a total of 712 EJNMMI publications have at least one Chinese affiliation). Such an increase can be attributed to a combination of many factors: the steady and unprecedented economic growth of China over the last several decades, much better hardware (e.g., scanners) than before in terms of both clinical practice and scientific research, tremendous financial investment in research and infrastructure by the Chinese government (national, provincial, and local), global recruitment of numerous established investigators and rising stars back to the country, increasing number of international collaborations and students/scientists studying abroad (before the pandemic), among many others. We predict that the upward trajectory

will remain in the foreseeable future, although the slope of increase will certainly slow down to a certain extent.

With such a dramatic increase in number of (EJNMMI) publications with Chinese affiliation(s) over the last 5 years, it is perfect timing for this special issue. With ~60 invitations, we received manuscript submissions from the vast majority of invited senior authors (some with multiple submissions). All manuscripts underwent rigorous peer-review process with at least 2–3 reviewers, and a significant percentage was rejected based on reviewer’s comments. In the final published special issue, there are more than 40 articles total, which include 6 review articles [4, 6–10] and this editorial, with the remaining being research articles. According

to the standard EJNMMI list of topics, these research articles were divided into the following categories: advanced image analyses [11–13], preclinical imaging [14–26], translational research [27–30], neurology [31, 32], cardiology [33], and oncology [34–47]. Due to the large number of accepted manuscripts, which is significantly more than the typical number of articles per EJNMMI issue, many invited contributions were published in various issues before this EJNMMI special issue, which include 2 review articles [48, 49], many research articles [50–62], and 1 invited editorial [63].

In addition to the original goal of highlighting some of the emerging research trends and advances in nuclear medicine and molecular imaging from China, this special issue also aims to reflect the diversity of nuclear medicine and molecular imaging research in China and its interface with various disciplines of science and technology. The scope of this special issue is very broad, which includes nuclear medicine research, non-radionuclide-based imaging/therapy, as well as nanobiotechnology. Many of the hot topics of recent research and clinical practice were also adequately represented, such as PSMA and FAPI (many articles of this special issue), artificial intelligence, exosome, cancer immunotherapy, PET/MR, total-body PET, among others.

Currently, there are > 1000 Departments of Nuclear Medicine, > 400 PET/CT, > 20 PET/MR, > 300 SPECT, ~ 500 SPECT/CT, > 10 total-body PET, and > 120 cyclotrons in China [64]. The number of annual PET/CT scans have reached 1 million, annual SPECT scans have surpassed 2.5 million, and the total number of nuclear medicine professionals have reached 12,000 (with > 5400 as nuclear medicine physicians). With such a large body of workforce, state-of-the-art preclinical/clinical equipment, and increasing funding support from various entities to nuclear medicine and molecular imaging research, we are living in the best era in the history of nuclear medicine and molecular imaging, not only in China, but also internationally. We look forward to future exciting developments in this vibrant area, and the future is brighter than ever. The golden age of nuclear medicine and molecular imaging in China has arrived, and it is here to stay.

EJNMMI is the leading forum for the exchange of clinical and scientific information for the nuclear medicine community and allied professions involved in the functional, metabolic, and molecular investigation of various diseases. The journal highly emphasizes translational work, with a very broad scope that covers all areas of molecular imaging. With the dazzling speed of development and tremendous advances of nuclear medicine and molecular imaging in China over the last 2 decades, the findings/results obtained by the Chinese clinical and research community should be of high value to the international readers of EJNMMI. In addition to top-quality work performed at some of the leading hospitals and academic institutions,

which is certainly of high interest to most researchers/clinicians/workers in the field, the 1.4 billion population of China can also be further explored for various scientific and clinical discoveries. With such a large population base, there are many different types of rare diseases with significant number of patients (may not be the case in Europe, North America, and other developed countries), which will provide numerous opportunities for future biomedical research as well as clinical patient management.

With the ever increasing scientific and clinical caliber of research personnel and clinicians in China, we firmly believe their findings will greatly benefit the international nuclear medicine and molecular imaging community, and this special issue (as well as potentially future special issues) will undoubtedly increase the global impact of EJNMMI in the long run. We sincerely hope you will enjoy reading this special issue as much as we do, and that you will find useful and usable information for your research enterprise and daily clinical practice. If the feedback of this EJNMMI special issue is overwhelmingly positive (please feel free to reach out to us to provide feedback and we welcome all comments/suggestions, regardless of whether they are positive or negative), we may consider organizing and guest editing another special issue on a suitable topic in 3–6 years.

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Studies with human participants or animals

This article does not contain any studies with human participants or animals performed by any of the authors.

Declarations

Conflict of interest Weibo Cai is a scientific advisor, stockholder, and grantee of Focus-X Therapeutics, Inc. All other authors declare no conflict of interest.

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