Nuclear cardiac imaging between implementation and globalization: The key role of integration

Alberto Cuocolo, MD,a Carmela Nappi, MD, PhD,a Wanda Acampa, MD, PhD,a,b and Mario Petretta, MD, FAHA,c

a Department of Advanced Biomedical Sciences, University Federico II, Naples, Italy
b Institute of Biostructure and Bioimaging, National Council of Research, Naples, Italy
c IRCCS SDN, Naples, Italy

Received Apr 7, 2021; accepted Apr 8, 2021
doi:10.1007/s12350-021-02633-7

It has now been 5 years since we had the privilege of writing our first annual Editor Page. Since then, many things have changed in the world of science, from diagnostics and prognostic stratification to therapeutic approaches. Nevertheless, above all changes due to successful scientific research activities, during the last 2 years Covid-19 pandemic has dramatically and radically modified the way we interact and establish relationships with colleagues and patients, as well as our own family members. While Covid-19 outbreak has pushed the maximum towards social distancing, at the same time it has highlighted how much the globalization process has now breached, perhaps irreversibly, in the daily life of each of us, for better and for worse.

The pandemic has severely affected all areas of health care. The impact has been terrific especially in preventive medicine, limiting the access to diagnostic investigations, including cardiac imaging modalities, such as single-photon emission computed tomography (SPECT) and positron emission tomography (PET). On the other hand, the increasingly extensive use of World Wide Web for medical information on patient side and the widespread utilization of digital technologies and artificial intelligence algorithms from physician side have contributed to revise the traditional doctor-patient relationship. Therefore, though artificial intelligence techniques aim to improve precision medicine approaches, there is concern on emerging concept of a depersonalized patient, where diagnostic advice and therapeutic choices are centered on representations of the average stereotype of the patient who is hardly ever present in clinical reality.

In this contest, while handling advances on radio-pharmaceuticals development, software, hardware and algorithms implementation, also nuclear cardiology has been inevitably overwhelmed by pandemic tsunami, whereas the choice between different methods for the evaluation of coronary artery disease (CAD), such as coronary computed tomography angiography (CCTA) and nuclear cardiac imaging (SPECT and PET), became even more conflicting. As Randall C. Thompson recently pointed out in his message as President of ASNC: “There is also a theory that variability is bad and wasteful and, therefore, standardization will be good. We are even seeing campaigns promoting specific modalities first, for example #CTFirst in CAD diagnostic workups” highlighting the concept that a #PatientFirst Society would be more necessary. In this respect, the contribution of truly personalized medicine tools, such as the use of dedicated cadmium-zinc-telluride gamma cameras, to tailored diagnosis goal achievement made the #PatientFirst Society idea even closer to real practice.

Beyond this debate on a multimodality wise and aware use of available cardiac imaging techniques, another task that must be addressed is a reliable estimation of the pre-test likelihood of CAD for subjects without known history of disease. The classic approach proposed by Diamond and Forrester in 1979 has been revised over years with different alternative models. Yet, the best pre-test approach choice is still a matter of debate. The main issue to take into account in such a complex dispute is that with pre-test estimation method improvements over time, also the target population changed. The Diamond and Forrester algorithm was estimated on a mostly male population with a mean age of 50 years and typical angina while current diagnostic
activity faces with older patients, in prevalence females with atypical symptoms. In fact, in recent decades there has been a decline not only in the pre-test probability of obstructive CAD but also in the frequency of stress-induced ischemia at myocardial perfusion imaging (MPI). This could be due to the combined effect of reduced in the prevalence of CAD and the more extensive and widespread early use of non-invasive cardiovascular imaging techniques. Past retrospective and post-mortem angiography studies have suggested that many patients with ST-elevation myocardial infarction (STEMI) had only mild to moderate stenosis of the infarct-related artery, supporting the hypothesis that the acute event may often be due to rupture of small non-obstructive plaques with secondary thrombosis. The problem becomes even more complicated in the light of the growing incidence, beside type 1 myocardial infarction of atherothrombotic nature, of both type 2 myocardial infarction due to the imbalance between oxygen supply and demand without significant coronary atherosclerosis and myocardial infarction with non-obstructive coronary arteries (MINOCA). Thus, all these considerations underline the importance of building algorithms capable of predicting, for both gender and for young and old, not only the presence of coronary stenosis but also the possible future incidence of cardiovascular events in absence of significant coronary atherosclerosis. In this direction, the artificial intelligence applications on both pre-test likelihood of disease estimations and data obtained from cardiac imaging tests is extremely appealing. The Registry of Fast Myocardial Perfusion Imaging with Next Generation SPECT (REFINE SPECT) is providing information of considerable value, both in the diagnostic and prognostic fields. The decade that has just begun calls us out to new tasks. There is an urgent need to standardize artificial intelligence methods to provide a coded and universal language for univocal interpretation. It becomes clear that, alongside methodological evolution, a wise knowledge transfer across generations is a crucial assumption.

Further, Covid-19 experience and the continuous challenge to deal with emerging SARS-COV2 variants dramatically taught us the fundamental lesson that globalization brings with it the need to leave no one behind for the sake of humanity. This lesson should be applied to nuclear cardiology techniques, taking into account that it is essential duty of more advanced Countries to spread worldwide consolidated knowledge and expertise. Overall, a greater effort in spreading imaging systems set-up should go together with shared platforms to read images with experts across the world, thus taking advantage of the recent improvements on telemedicine. In this way, modalities integration and globalization may express a patient-centered winning match for the next generation.

The future of nuclear cardiology is linked to scientific and technological progress, especially in terms of eco-sustainability and increased cost-effectiveness of its applications. We hope, indeed we are certain, that the Journal of Nuclear Cardiology will continue, as it has done all these years, to play a leading role in stimulating new ideas and promoting the dissemination of the most significant results in both basic and clinical research in all countries.

Disclosure

A. Cuocolo, C. Nappi, W. Acampa, and M. Petretta declare that they have no financial conflict of interest.

References

1. ASNC stands for #PatientFirst imaging. J Nucl Cardiol 2021 Feb 28. https://doi.org/10.1007/s12350-021-02571-4.
2. Diamond GA, Forrester JS. Analysis of probability as an aid in the clinical diagnosis of coronary-artery disease. N Engl J Med 1979;300:1350-8.
3. Genders TS, Steyerberg EW, Hunink MG, Nieman K, Galema LH, et al. European Society of Cardiology-Recommended Coronary Artery Disease Consortium pretest probability scores more accurately predict obstructive coronary disease and cardiovascular events than the Diamond and Forrester score: The Partners Registry. Circulation 2016;134:201-11.
4. Bittencourt MS, Hulten E, Polonsky TS, Hoffman U, Nasir K, Abbara S, et al. A clinical prediction rule for the diagnosis of coronary artery disease: Validation, updating, and extension. Eur Heart J 2011;32:1316-30.
5. Genders TS, Steyerberg EW, Hunink MG, Nieman K, Galema TW, Mollet NR, et al. Prediction model to estimate presence of coronary artery disease: Retrospective pooled analysis of existing cohorts. BMJ 2012;344:e3485.
6. Baskaran L, Danad I, Gransar H, Ö Hartaigh B, Schulman-Marcus J, Lin FY, et al. A Comparison of the updated Diamond-Forrester, CAD Consortium, and CONFIRM history-based risk scores for predicting obstructive coronary artery disease in patients with stable chest pain: The SCOT-HEART coronary CTA cohort. JACC Cardiovasc Imaging 2019;12(7 Pt 2):1392-400.
7. Juarez-Orozco LE, Saraste A, Caspodanno D, Prescott E, Bax JJ, et al. Impact of a decreasing pre-test probability on the performance of diagnostic tests for coronary artery disease. Eur Heart J Cardiovasc Imaging 2019;20:1198-207.
8. Gibbons RJ, Miller TD. Declining accuracy of the traditional Diamond-Forrester estimates of pretest probability of coronary artery disease: Time for new methods. JAMA Intern Med 2021. https://doi.org/10.1001/jamainternmed.2021.0171.
9. Rozanski A, Gransar H, Hayes SW, Min J, Friedman JD, Thomson LE, et al. Temporal trends in the frequency of inducible myocardial ischemia during cardiac stress testing: 1991 to 2009. J Am Coll Cardiol 2013;61:1054-65.
10. Iskandrian AE, Hage FG. Declining frequency of ischemia detection using stress myocardial perfusion imaging. J Am Coll Cardiol 2013;61:1066-8.
11. Megna R, Assante R, Zampella E, Gaudieri V, Nappi C, Cuocolo R, et al. Pretest models for predicting abnormal stress single-photon emission computed tomography myocardial perfusion imaging. J Nucl Cardiol 2019. https://doi.org/10.1007/s12350-019-01941-3.

12. Megna R, Zampella E, Assante R, Nappi C, Gaudieri V, Mannarino T, et al. Temporal trends of abnormal myocardial perfusion imaging in a cohort of Italian subjects: Relation with cardiovascular risk factors. J Nucl Cardiol 2020;27:2167-77.

13. Mann JM, Davies MJ. Vulnerable plaque. Relation of characteristics to degree of stenosis in human coronary arteries. Circulation 1996;94:928-31.

14. Thygesen K, Alpert JS, Jaffe AS, Chaitman BR, Bax JJ, Morrow DA, et al. Executive Group on behalf of the Joint European Society of Cardiology (ESC)/American College of Cardiology (ACC)/American Heart Association (AHA)/World Heart Federation (WHF) Task Force for the Universal Definition of Myocardial Infarction. Fourth Universal Definition of Myocardial Infarction (2018). Circulation. 2018;138:e618-e651. Erratum in: Circulation 2018;138:e652.

15. Shrestha S, Sengupta PP. Machine learning for nuclear cardiology: The way forward. J Nucl Cardiol 2019;26:1755-8.

16. Nappi C, Cuocolo A. The machine learning approach: Artificial intelligence is coming to support critical clinical thinking. J Nucl Cardiol 2020;27:156-8.

17. Slomka PJ, Betancur J, Liang JX, Otaki Y, Hu LH, Sharir T, et al. Rationale and design of the REgistry of Fast Myocardial Perfusion Imaging with NExt generation SPECT (REFINE SPECT). J Nucl Cardiol 2020;27:1010-21.

18. Miller RJH, Sharir T, Otaki Y, Gransar H, Liang JX, Einstein AJ, et al. Quantitation of post-stress change in ventricular morphology improves risk stratification. J Nucl Med 2021. https://doi.org/10.2967/jnumed.120.260141.

Publisher’s Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.