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EDITORIAL / *Research and new developments*

Tomorrow's medical imaging builds on today's foundations - Prevention, care and innovation at the service of patients: A program for radiology and medical imaging

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Tomorrow's medicine starts today. But stopping at a mere statement is not enough. We must be aware of the importance of the challenges that we are confronted with and subsequently develop a well-thought-out strategy. It is hence necessary to work along the three following lines:

- to develop a more preventive, more predictive and more individualized practice of medicine especially regarding chronic diseases, induced by the greater number of aging patients;
- to promote minimally invasive and image-guided interventional treatments;
- to reassess our organizations and bring about the necessary changes, which implies using the latest digital improvements and to back medical training reforms.

Medical imaging plays a critical role in this setting, paving the way for a key role of radiologists to address these three crucial challenges. The future of radiology and medical imaging should provide solutions to these issues, with a defined strategy following three leads. One is a better and easier access to medical imaging throughout the territory, which will make France a leader in the fields of early stage imaging and prognosis imaging. The second is the development and the organization of interventional radiology (IR). The third is the anticipation of a new digital revolution thanks to targeted investment in research involving well-structured databases [1—5].

Providing patients better access to medical imaging will give them high quality medicine

Cross-sectional imaging is one of the most important medical breakthroughs ever but in France, it amounts to hardly one third of the imaging-related expenses [6]. The substitution of conventional imaging to cross-sectional techniques should be favored, in order to anticipate the changes triggered by modern care pathways based on quicker and more precise diagnoses.

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Comprehensive and diversified equipment units (*i.e.*, ultrasound, X-ray, computed tomography [CT], magnetic resonance imaging [MRI] and positron emission tomography [PET]/CT), all networked together, must be encouraged to ensure expertise sharing. This will enable specialized radiologists and radiographers to manage patients as thoroughly and quickly as should be and provide relevant care. Unnecessary or redundant procedures will thus be avoided, patient transport less frequently needed, as well as sick leave extensions, in its turn improving healthcare efficiency [7].

This expansion is first and foremost a response to a true expectancy from patients. It must give new scope for morphological and functional imaging. These technologies are indeed vital if we want to develop preventive medicine, as well as the early detection of diseases and prognosis imaging in France both of which being particularly useful for oncology and chronic disease care, now unavoidable affections among ageing populations [8].

This expansion of imaging must go hand in hand with a strong job-creating policy for radiologists. This is justified by a substantial rise in the amount of diagnostic and IR procedures, of 24/7 healthcare services and emergency care activity. The fact that whole promotions of French radiologists who graduated in the 1980s are getting close to retirement time should not be overlooked either.

In the current era of outpatient approach in medicine, radiology and surgery, such efforts in favor of more radiology specialists and equipment are absolutely necessary to facilitate therapeutic alternatives. Meeting the demographical and equipment challenges in radiology is mandatory to reduce inpatient bed turnaround time, thereby ensuring access to newcomers in need of care, and reducing the number of patients in hospital emergency services.

Because of the current undersized stock of modern equipments that we have in France, a CT or MRI scanner is expensive to operate. This leads to longer operating schedules with medical teams who often have to work from 7 AM to 9 PM plus Saturday mornings. This is an obvious cause of unattractiveness for the job, and it does not encourage fundraising either. These operating schedules should be the same as those of non-emergency operating theaters and can be adapted to local requirements, as is the case in many other countries, whether in Europe or elsewhere in the world.

Development of IR

IR is now fully embedded within the National French Training Program (R3C, DES Radiologie et Imagerie Médicale) [9]. Level 1 procedures are taught to all residents, while advanced procedures are trained within 2 years of advanced IR training specialization program, resulting in a full 6 years residency program. An academic development of IR must be further encouraged, because no specialty has ever been developed without the participation of university professors, together with fellows and staff.

Young radiology residents must be spurred to IR and clinical training for an efficient care of their patients. This implies a clearer mention of the uses of these innovative technologies in graduate courses in medical schools, as well as a widened access to the advanced IR specialization in radiology studies during its build up phase. This can only be achieved with the assistance of the Collège des Enseignants de Radiologie France.

Special equipment must be devoted to IR to make the development of new image-guided therapies possible at last [10]. The increase in indications for IR procedures goes together with a growing demand in the field of diagnostic imaging. This means that more IR equipments should be available, in accordance with the authorisations granted for IR activity. The economic model can arise from shorter average stays in hospital wards, as well as fewer morbidity and handicap cases. Such elements can be taken into consideration in the ongoing discussions related to the granting of diagnostic and IR activity authorisations. IR doctors and operators must get into structures with a 24/7 operating capacity if need be, without impairing diagnostic imaging.

Another isue is that a subset of hospital beds should be dedicated to IR patients. IR is a good way to reduce procedure length, but it must rely on a reasonable amount of resources, such as an acceptable number of outpatient beds for IR patients, who wish to have the same IR referring team before, during and after the procedures, a team of specialists capable of providing consistent explanations and being in charge of the whole process. As a result, each radiological department must set-up its own ambulatory care sector, with beds dedicated to day-care, mandatory to be able to cope with the increasing number of patients referred for minimally invasive treatments. This also relies on the set-up of a larger number of radiologic—especially IR - consultations, and access to dedicated consultation and diagnosis disclosure rooms within radiology departments.

How to anticipate the new digital revolution in relation with medical imaging

The medical procedure that is teleradiology must be included in telemedicine projects as described by the renewed charter of radiology provided by the French Professional Council of Radiology (also known as G4) and taken over by the Haute Autorité de Santé (HAS) [11]. The French Professional Council of Radiology advocates that teleradiology cannot be considered as an exclusive activity for a radiologist because direct contact with patients, technicians and referring physicians, favors good practice and should be encouraged. Hence the French Professional Council of Radiology encourages local or regional collaborations (''territorial collaborations'') — whether with private or public radiologists — especially when dealing with continuity of care. This will make radiologists full members of multidisciplinary healthcare teams, as opposed to models of disorganized interpretative coverage disconnected from usual medical procedures. One should think of the successful example of stroke telemedicine, which markedly increases patients' possibility to get thrombolysis and/or thrombectomy.

Innovations and fields of research that use imaging databases must be favored. They are the indispensable cornerstones for the development of artificial intelligence (AI).

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All this must be done in accordance with ethics and law, and follow the suggestions debated in AI and database specialists' committees. DRIM France IA, a national initiative supported by the French Professional Council of Radiology wishes to address these rising issues as such research can lead to new work organization models, and to a better response to requirements. Improvements made in the field of AI medical programs should eventually lead to earlier, more precise diagnoses, at stages when recovery chances are best; this will be all the truer in oncology, where AI programs should make it possible to shift from a phenotypic description of a tumor to its tissue characterization, with a possible decrease in the need for invasive biopsies in many instance. Such tissue characterization will be obtained by resorting to adapted algorithms fed with massive amounts of data provided by clinical, biological and imaging-initiated observations.

Conclusion

These three 3 challenges are today's challenges. Bound together, all components of French Radiology are devoted to pursue these objectives, in order to bring tomorrows expectations to everyday practice.

Author contributions

All authors attest that they meet the current International Committee of Medical Journal Editors (ICMJE) criteria for Authorship.

Disclosure of interest

The authors declare that they have no competing interest in relation with this article.

References

[1] Beregi JP, Zins M, Masson JP, Cart P, Bartoli JM, Silberman B, et al. Radiology and artificial intelligence: an opportunity for our specialty. Diagn Interv Imaging 2018;99:677—8.
[2] Thomassin-Naggara I, Balleyguier C, Ceugnart L, Heid P, Lenczner G, Maire A, et al. Conseil national professionnel de la radiologie et imagerie médicale (G4). Artificial intelligence and breast screening: French Radiology Community position paper. Diagn Interv Imaging 2019;100:553—66.
[3] Waymel Q, Badr S, Demondion X, Cotten A, Jacques T. Impact of the rise of artificial intelligence in radiology: what do radiologists think? Diagn Interv Imaging 2019;100:327—36.
[4] Lassau N, Estienne T, de Vomecourt P, Azoulay M, Cagnol J, Garcia G, et al. Five simultaneous artificial intelligence data challenges on ultrasound, CT, and MRI. Diagn Interv Imaging 2019;100:199—209.
[5] SFR-IA Group, CERF, French Radiology Community. Artificial intelligence and medical imaging 2018: French Radiology Community white paper. Diagn Interv Imaging 2018;99:727—42.
[6] Fuchs VR, Sox HC. Physicians' views of the relative importance of thirty medical innovations. Health Aff (Millwood) 2001;20:30—42.
[7] Dewey M. The future of radiology: adding value to clinical care. Lancet 2018;392:472—3.
[8] Sarwar A, Boland G, Monks A, Kruskal JB. Metrics for radiologists in the era of value-based health care delivery. Radiographics 2015;35:866—76, http://dx.doi.org/10.1148/rg.2015140221.
[9] Décret n° 2016-1597 du 25 novembre 2016 relatif à l'organisation du troisième cycle des études de médecine et modifiant le code de l'éducation. Available at: https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000033479390&categorieLien=id.
[10] Charalel RA, McGinty G, Brant-Zawadzki M, Goodwin SC, Khilnani NM, Matsumoto AH, et al. Interventional radiology delivers high-value health care and is an Imaging 3.0 vanguard. J Am Coll Radiol 2015;12:501—6.
[11] Haute Autorité de santé — Recommandations pour la qualité et la sécurité des actes de réalisation d'un examen d'imagerie à distance et de téléexpertise en imagerie médicale 2019. Available at: https://www.has-sante.fr/upload/docs/application/pdf/2019-07/guide_teleconsultation_et_teleexpertise.pdf.

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