Perspective

Ultrasound imaging for preventative services in a preventive radiology initiative

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Introduction

The disease-prevention model identifies early pre-clinical disease and subgroups at risk of developing symptoms and signs of abnormal structure and function. This model, integrating genetic, environmental, social, and other information with predictive biomarkers (biomolecular or imaging), helps monitor disease development and progression, the structural and functional integrity of organ systems, and the impact of preventive and therapeutic interventions. Medical imaging provides standardised, protocol-based, non-invasive, and relatively painless objective measurements that guide therapeutic pathways through integration with quantitative imaging and volumetric assessments. Ultrasound imaging techniques with better visualisation of structures, faster turnaround times, predictive and prognostic algorithms, and improved access and affordability through portable and point-of-care applications are currently available. These ultrasound advancements can be leveraged for ultrasound-based screening and early detection of abnormalities in the preclinical stages before the presentation with late-stage disease.

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The epidemiological transition level (ETL) provides the ratio of the disability-adjusted life years for communicable and non-communicable diseases (NCDs). A decreasing ETL ratio indicates an increasing relative magnitude of NCDs. India had an ETL of 1.56 in 1990, which decreased to 0.50 in 2016, with all states in India reporting an ETL < 1.0 in 2016 [1]. Several studies from India have reported the large prevalence of NCDs in India including 11·4% for diabetes, 15·3% for prediabetes, 35·5% for hypertension, 28·6% for generalised obesity, 39·5% for abdominal obesity, and a 32.0% prevalence of ultrasound-detected non-alcoholic fatty liver disease (NAFLD) in urban India in 2009 and 30·7% in rural India in 2016 [2-9]. The high prevalence of NCDs translates to a large population at high risk for complications of NCDs and end-organ damage in India unless they are detected early and managed appropriately through the course of NCDs.

Preventive Radiology Program in India

The Indian Radiological and Imaging Association (IRIA) started a preventive radiology initiative in 2021, positioning radiologists as an important first line for preventive and risk prediction services. This initiative promotes preventive and integrated radiology as a career path for radiologists, apart from the existing clinical and interventional radiology paths. The program uses imaging-based biomarkers for the early identification of NCDs, including metabolic disorders, to assess endothelial dysfunction, identify imaging-based criteria to guide therapeutic interventions, and monitor the progress of diseases and the impact of interventions on the structural and functional integrity of target end-organ systems. The preventive radiology program works towards these goals by establishing dedicated integrated radiology imaging diagnostics clinics with ultrasound imaging as the fulcrum for screening. Ultrasound was chosen as the primary imaging modality due to its availability, accessibility, affordability, and ability to scale up services, compared to CT or MRI imaging, and specialised biochemical or molecular tests. Ultrasound has a more rapid report turnaround time, provides objective visual reporting of structural and functional abnormalities, is non-invasive and relatively painless, and has availability, affordability and accessibility advantages compared to specialised biochemical or molecular testing, especially in rural, remote and low-resource areas.

Conceptual Structure of the Program

Several core areas in the ultrasonography curriculum and service provision must be strengthened to transition effectively to preventive radiology. Most radiologists currently offer imaging services based on demand from referring physicians. A shift towards proactive imaging based on clinical history, risk factors, and towards early detection is essential to provide preventive services. Additionally, continuous technical skill upgradation to improve the interpretative ability and the application of imaging biomarkers for screening and early identification of NCDs, expanding the reach of the program through regular offline and online learning initiatives, improving the local evidence base on imaging biomarkers, developing policy guidelines to improve synergy with other multidisciplinary stakeholders, and identifying NCD priorities based on the specific country profiles are needed.

The preventive radiology initiative in India initially focuses on metabolic syndromes, atherosclerotic cardiac diseases and strokes, cancers, and endothelial dysfunction. Each identified disease priority has an academic and training national lead, a trainer of trainers' pool at the national and state levels, and a team of multi-institutional experts who lead research appropriate for the condition and population needs. Generating local evidence on the various measurement parameters that underpin the screening algorithms used for the assessment optimisation of clinical protocols is a priority. The various aspects of the preventive radiology initiative are presented in Table 1.

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Table 1. *The various aspects of the Preventive Radiology Program.*

The various aspects of the Preventive Radiology Program
1. Creation of subcommittees and working groups to a. Organize continuous medical education programs, workshops and hands-on training, b. Develop a pool of trainer-of-trainers, c. Provide competency-based training for radiologists in the state, d. Provide competency-based training for radiology postgraduate residents at teaching hospitals, e. Provide training to start preventive radiology outpatient units, f. Generate local data on the use and integration of imaging biomarkers. g. Generate local evidence to inform algorithms, h. Develop local multidisciplinary research teams for non-communicable and chronic diseases.
2. Identification and evaluation of imaging biomarkers- organ, system, and disease-specific.
3. Evidence-based integration of imaging biomarkers with clinical and biochemical algorithms and establishment of evidence-based protocols for image-guided interventions and biopsies.
4. Integrate healthy aging, wellness and image-based screening for biomarkers.
5. Develop NCD-specific guidelines and algorithms.
6. Develop image-based biobanks.
7. Develop specific pragmatic applications for preventive radiology at the primary, secondary, and tertiary care levels.
8. Integrate with the appropriate National Digital Health Mission and health programs at the governmental level.
9. Integrate AI and deep-learning algorithms.
10. Develop a technology entrepreneurship program.
11. Health Education and Awareness: optimising the use of digital media.

Early Results from India

The preventive radiology initiative has published the standardised techniques for ultrasound shear wave elastography of the liver, the first published normative distribution of liver stiffness measurements in this population, and liver stiffness-based prevalence of non-alcoholic fatty liver disease in India [10-12]. Nineteen hands-on training workshops focused on US-SWE liver imaging (60 participants per workshop), and 218 webinars (mean 162±18 participants per webinar) on liver, cancer, stroke, breast cancer, musculoskeletal and neurological conditions have been conducted since 2021 to upskill radiologists in preventive radiology practices using ultrasonography. The risk stratification and predictive capabilities of fetal Doppler and trimester-specific ultrasound-based protocols focused on preterm preeclampsia (PE), fetal growth restriction (FGR) and comprehensive pregnancy assessments were integrated with antenatal care to address perinatal mortality (PMR) in India, which led to a substantive reduction in the magnitude of PE, FGR and PMR in India, as reported in published studies [13-18]. The preventive radiology initiative has collaborated with the state government of Kerala, local non-governmental organisations, and healthcare stakeholders to develop a comprehensive cancer screening program integrating medical imaging for early identification of pre-cancerous lesions.

A dedicated preventive radiology clinic, established a year ago within an integrated diagnostics radiology centre, at Kochi in the southern Indian state of Kerala, offers walk-in services for persons seeking screening for early signs of NCDs and lifestyle diseases. The clinic has so far screened 1,181 persons with a mean age of 44.33 ± 10.03 years (range 29 to 62 years). Most of the screened population were females (69.44%), 41.47% had a body mass index (BMI) ≥25 to 30 kg/m2, 31.79% had a BMI ≥30 kg/m2, 26.20% had hypertension, and 32.23% had diabetes mellitus. Liver stiffness measurements (LSM) using ultrasound shear wave elastography were between 7 to 9 kPa in 22.79%, and 14.29% had LSM >9 kPa. Screen positive persons (for LSM abnormalities) were recommended dietary and lifestyle changes and triaged for referral to a multidisciplinary hepatology unit for further care. These early results in this opportunistic screening highlight the potential for preventive lifestyle interventions, especially concerning metabolic dysfunction-associated steatotic liver disease (MASLD) in nearly one-fourth of the screened population. These are early interim results focused on the liver and obesity from this OPD, and the OPD is currently expanding to include other NCDs in the screening and early detection of structural and functional abnormalities.

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Preventive Radiology for the ASEAN Region

The ASEAN region shares several characteristics with the South Asian region in the context of healthcare priorities, including an epidemiological transition with increasing NCD prevalence, and a declining yet persistent prevalence of communicable diseases, perinatal mortality, and undernutrition [19,20]. Nearly two-thirds of all deaths in the ASEAN region were attributable to NCDs in 2021, and over half of these deaths occurred in persons aged 30-69 years [19.20]. Cardiovascular diseases, cancers, diabetes and chronic respiratory diseases were the major contributors to the NCD magnitude in the ASEAN region [19,20]. Metabolic risk factors such as raised blood pressure, high body mass index or waist-to-hip ratio, high blood sugar levels and abnormal serum lipid concentrations are common in the ASEAN region [19]. Similar to South Asia, urbanization, industrialization, demographic transition to an aging population, increased life expectancy, dietary changes and sedentary lifestyles contribute to the increasing prevalence of NCDs in the ASEAN region [19]. Governments in the ASEAN region have initiated several programs based on global and regional action plans and WHO action plans, to address the growing magnitude of NCDs in the ASEAN region. However, similar to South Asia, progress towards meeting acceptable targets has been slow.

The preventive radiology program has the potential to scale up early identification of NCDs in the ASEAN region, incorporating early interventions, including lifestyle and therapeutic interventions to reduce progression to late-stage disease and complications. Ultrasound is widely available and can be developed as a first-line screening tool in the ASEAN region. The screening potential of CT and MRI can be optimized in regions where these are widely available, affordable and accessible in the region, however, there is a wide disparity in the availability of these services, similar to South Asia. The early results from the preventive radiology model in India suggest that a similar model may be considered in the ASEAN region to complement and supplement existing healthcare systems in the region. However, the model must adapt to consider local contexts, healthcare needs, available infrastructure and resources, including trained personnel and training programs.

Conclusion

Radiologists focused on ultrasound practice can develop dedicated clinics focused on early identification, risk stratification, individualised prediction and prognostic paths that bridge the gap between primary and tertiary care. Early identification through these clinics can reduce the absolute number of cases identified at late stages, and baseline objective measurements are useful to assess interventional impact and progress. This approach will be useful in initiating care pathways earlier in rural areas that do not have access to specialised biochemistry or molecular labs, and can minimise issues with the storage and transport of samples. The radiology curriculum must be revised to include these preventive possibilities to offer newer career pathways for radiologists as an integral part of the healthcare system. Operator skill dependency is a limitation with ultrasound (as it is for laboratory tests) that is offset to a certain degree with the newer machines, techniques like elastography that provide operator and vendor-neutral results, and AI-integrated algorithms. Radiology can develop as the proactive fulcrum around which more effective integrated service delivery systems are developed for preventive and follow-up care in rural areas, which remain a challenge in the healthcare system.

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