

## Cutting-edge technology application for prostate disease management in Indonesia: implementation of Healthcare 5.0 towards Indonesia's Golden Vision 2045

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Indonesia is moving towards its vision for “Indonesia Emas 2045,” aiming to stand alongside developed nations and be a top-five global economic power by its centennial. The country hopes to enhance productivity through a demographic bonus. However, the projected nearly 20% increase in the elderly population by 2045 is a significant concern,<sup>1</sup> leading to issues like non-communicable diseases.

Prostate diseases, occurring predominantly in men aged 50 and above, pose a growing problem. In Indonesia, benign prostatic hyperplasia (BPH) has reached around 3.5 million cases, an increase of 75% in the last 20 years.<sup>2</sup> Prostate cancer has become more prevalent with a nearly 400% cases rise, adding an estimated 13,000 new cases annually.<sup>3,4</sup> Moreover, this surge in cases is accompanied by a nearly 300% increase in prostate cancer-related deaths.<sup>3</sup>

The global prostate health market analysis reveals it reached USD 31.8 billion in 2021 and is projected to grow 8.8% annually, reaching an estimated USD 48.9 billion by 2026. Prostate cancer management contributes significantly to this market, driven by the widespread use of robotic surgeries and advancements in diagnostics and medications,<sup>5</sup> particularly in the Asia-Pacific region, which is expected to experience the most substantial market growth due to its large and aging population.

### The role of advanced technology in Healthcare 5.0

The development in advanced countries is determined by implementing technological advancements, namely the Industrial Revolution. In 2020, the industrial revolution has entered the phase of Industry 5.0.<sup>6</sup> While Industry 4.0 facilitates the creation, collection, storage, and analysis of vast information, Industry 5.0 continues the development

of manufacturing and production systems, combining cutting-edge technology with human intelligence and skills.<sup>6</sup> This revolution also impacts healthcare, known as Healthcare 5.0, focusing on personalized and predictive patient-centered services by integrating advanced technology, artificial intelligence (AI), and genomic examinations (Figure 1).<sup>7</sup>

Aligned with the Healthcare 5.0 principles, one of *Indonesia Emas 2045*'s visions is utilizing the latest science and technology.<sup>8</sup> Since the 1990s, laser technology for BPH has been developed to minimize bleeding and shorten catheter use, making patient's recovery times faster. Laser technology and the latest surgical techniques, including prostate enucleation, are gaining popularity over conventional methods, such as transurethral resection of the prostate.<sup>9,10</sup>

The pioneering use of robotic technology in urology globally has brought advancements in radical

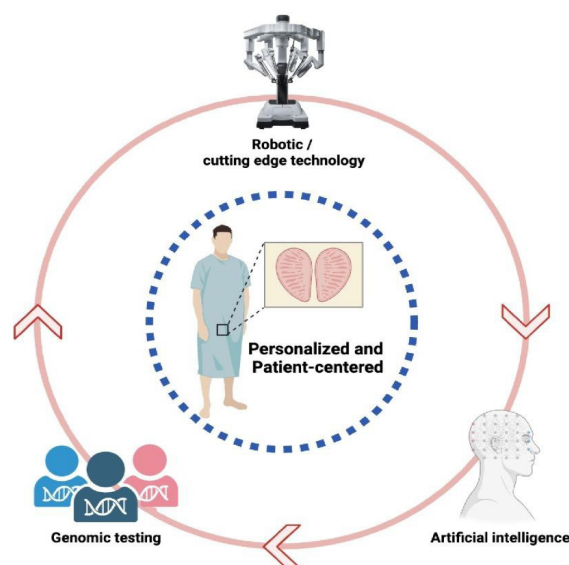


Figure 1. Healthcare 5.0 principles

prostatectomy. Robotic radical prostatectomy offers advantages such as lower blood loss, transfusion rates, and complications, faster recovery, and shorter hospital stays.<sup>11</sup> Despite facing stagnation in robotic surgery development due to limited early detection of prostate cancer in the past, various efforts have revived the technology in Indonesia.

In recent years, the introduction of robotic prostate biopsy technology guided by magnetic resonance imaging (MRI) has improved cancer detection accuracy by utilizing stable robot arms.<sup>12,13</sup> This technology has been used in Indonesia since 2019; its application in Jakarta hospitals has successfully detected early-stage prostate cancer with lower prostate-specific antigen (PSA) levels and smaller lesion volumes.<sup>14,15</sup>

The effort to redevelop robotic surgery technology for prostate operations has been successful, with an increasing number of early-stage prostate cancer cases and the team's proficiency in laparoscopic radical prostatectomy. Since 2021, the team has performed robotic radical prostatectomy procedures in Indonesia and achieved significant milestones, including conducting two surgeries in a day using both laparoscopic and robotic techniques. The team predicts a resurgence of robotic surgery technology in Indonesia by 2024, applicable to urologists and other surgical specialists.<sup>16</sup>

The next phase of robotic technology development includes telesurgery or remote surgery supported by advanced telecommunication networks. Trials of telesurgery between cities and countries using 5G and 6G networks have been conducted. AI integration into robotic surgery is also under consideration, starting with data collection from global robotic surgeries and utilizing virtual reality for surgeon training. Following the Healthcare 5.0 principles, the next step is automating robotic surgery based on patient data processed by AI.<sup>17</sup>

#### **AI in the era of Healthcare 5.0: developed using databases**

AI becomes the primary driver of Healthcare 5.0,<sup>18,19</sup> helping to analyze individual data, compare it with existing databases, and conduct predictive analysis for the future. AI accelerates doctors' analyses, making them more efficient and accurate due to its ability to analyze various data quickly. This technology benefits doctors, patients, and hospitals. For instance, algorithms can comprehensively

analyze a patient's medical history, including past and current conditions, to evaluate the likelihood of a hospital return. In clinical decision-making, preventive measures can be taken to avoid undesired situations and optimize medical resource allocation based on underlying issues.<sup>20</sup>

We can develop AI training to prepare for Healthcare 5.0 with the current patient database, which is considered past knowledge in human intelligence training. The first crucial step is establishing a robust and integrated database to prevent the predictions from being incongruent when applied to different countries since AI heavily relies on the data source.<sup>21</sup> A database derived from its population is needed, especially Indonesia, which has unique characteristics.<sup>20</sup> The development of the urology cancer database in Indonesia began in Surabaya and Jakarta. From manually recording patient conditions on paper with over 1,000 recorded patients, the database has now evolved into the Indonesia Prostate Cancer Risk Calculator, utilizing over 2,000 patient data to predict prostate cancer risk.<sup>22</sup>

The substantial increase in the database's size requires the digitalization of data, a prerequisite for implementing Healthcare 5.0. Since 2016, Indonesia has collected electronic databases of various Asian countries through the Asian Prostate Cancer Study Group.<sup>23</sup> Although the database can provide insights into prostate cancer patients in Indonesia, there are limitations in recruited and monitored data. Therefore, our team is developing the Ina PRO database, aiming for broader patient coverage with unlimited follow-up duration.

The Ministry of Health has initiated the development of Indonesia's population health database through the Satu Sehat application. Collaborations with local and international researchers have led to developing a database that can be used for AI development.<sup>19</sup> On the other hand, the Indonesia Medical Education and Research Institute (IMERI), Faculty of Medicine, Universitas Indonesia has initiated the Big Data Center to assist health researchers in Indonesia with database initiation and processing. Various clusters within IMERI, such as the Medical Technology cluster and Human Cancer Research Center (HCRC) clusters, are involved in these activities and are expected to be initiators and drivers of AI development in the healthcare sector in Indonesia.<sup>24</sup> A challenge in Healthcare 5.0 development is the need for data

exchange between different databases despite various researchers' capabilities in each location.<sup>25</sup>

### **The role of multidisciplinary teams (MDT) in Healthcare 5.0**

Prostate diseases, particularly prostate cancer, are heterogeneous and complex. Therefore, applying a one-size-fits-all principle is not feasible in the Healthcare 5.0 concept that prioritizes personalization.<sup>26</sup> The diversity of prostate diseases requires collaborative management from various disciplines. Since its introduction in the early 1990s, the MDT approach in cancer care has been recognized as a crucial aspect and is considered a gold standard in cancer management worldwide.<sup>27,28</sup> Up to 45% of patients discussed in MDT meetings receive more accurate preoperative information and comprehensive cancer treatment compared to those without MDT involvement.<sup>27</sup>

MDT uro-oncology discussions at Cipto Mangunkusumo Hospital, Faculty of Medicine, Universitas Indonesia have been conducted weekly since 2017, involving various medical staff groups, including Urology, Anatomic Pathology, Radiology, Nuclear Medicine, Internal Medicine Hematology Oncology Division, and Radiation Oncology Therapy. Other medical staff groups are also frequently involved, adjusting to the discussed cases. Over 1,000 cases have been collectively discussed to date.

These meetings serve as a teaching and learning platforms for all members, including specialist education participants. They also contribute to the advancement of knowledge and the application of current technology. For example, the development of robotic prostate biopsy techniques relies heavily on the latest MRI examinations and extensive prostate tissue examinations. This facilitates radiologists in standardizing prostate MRI examinations in Indonesia. Furthermore, detailed prostate tissue examinations help anatomical pathology colleagues develop standardized reports. Both standardizations, developed at Cipto Mangunkusumo Hospital and Universitas Indonesia Hospital, are disseminated nationwide to enhance the overall quality of prostate disease services.

MDT meetings also yield several international scientific publications. The next challenge in implementing Healthcare 5.0 is collecting and analyzing all patient data, including genetics, to generate optimal outcomes. This analysis requires a more robust infrastructure for handling large datasets.

### **Genomic examinations for individual management**

Completion of the Human Genome Project in 2003 marked a paradigm shift in disease management concepts, particularly in prostate diseases. Initially used to identify the causes of rare diseases, gene sequence analysis became more accessible and affordable in the early 2010s with the help of internet technology and big data analysis advancement.<sup>29</sup> Gene sequence analysis is currently applied to nearly all diseases, including prostate cancer. About 90% of advanced-stage prostate cancer patients exhibit mutations in several genes. Common mutations, such as in the breast cancer gene (BRCA), can be detected through genetic screening, providing insight into cancer risk.<sup>30</sup>

Genetic examinations also play a role in determining prostate cancer prognosis and aiding therapy selection. Localized prostate cancer can be managed through active surveillance to prevent overtreatment of non-aggressive/significant cancers. The presence of BRCA2 mutations in localized prostate cancer is a poor prognostic factor, indicating an increased risk of aggressive or metastatic cancer with low survival rates. Therefore, active surveillance is not recommended for localized prostate cancer with BRCA2 mutations.<sup>6,29</sup> Recent studies show that genetic testing before specific drug administration improves patient outcomes with gene mutations. In Indonesia, genetic testing for prostate cancer is still in its early stages and remains relatively costly.<sup>31</sup>

As genetic abnormalities in cancer are identified, specific drugs targeting molecules related to gene mutations have emerged. Poly(ADP-ribose)polymerase inhibitors, for instance, are systemic therapies used for metastatic castration-resistant prostate cancer (mCRPC) with castration resistance. Compared to the latest hormonal therapy mutations, these inhibitors have proven to enhance survival as a second-line therapy for patients with homologous recombinant repair mutations and mCRPC.<sup>32,33</sup>

In line with the rapid discovery of genetic abnormalities in cancer, personalized lifestyle interventions have become crucial in reducing prostate disease risk. Genomic analyses, such as nutrigenomic and sport-genomic examinations, are being developed in Indonesia to tailor an individual's lifestyle based on their genetic sequences.<sup>34</sup> Healthcare 5.0, emphasizes long-term collaboration focusing on prevention and integrates and analyzes an individual's data using AI. The analysis provides personalized lifestyle

recommendations, reducing the risk of prostate disease.<sup>19,35</sup>

#### **Development of PSA screening: enhancing independence and accessibility in the diagnostic field**

Cancer treatment in Indonesia ranks second in terms of the most expensive diseases, exceeding 3.5 trillion IDR annually, according to data from the Social Security Administration (BPJS).<sup>36</sup> The primary screening for prostate diseases, especially prostate cancer, involves testing the PSA levels in the blood.<sup>37</sup> PSA testing is convenient, requires no special preparation, and can be conducted during routine annual check-ups. Challenges in healthcare provision, including political policies, financial availability, and diverse demographic characteristics in Indonesia, resulting in uneven healthcare facility development across the country. PSA testing is available only in select healthcare facilities such as type A government hospitals, private hospitals, and some private laboratories. The offered quantitative tests using serum samples from patient blood range in cost from 500 thousand to 2 million IDR.<sup>38</sup>

Given the recommendation for PSA testing for about 30 million data population for Indonesian males aged 50 and above, the associated cost is around 15 trillion IDR.<sup>39</sup> However, due to capacity and resource limitations, PSA testing cannot include the entire Indonesian population that needs an examination. Additionally, PSA testing highly depends on imported materials, leading to unpredictable cost increases.

Another principle of Healthcare 5.0 is affordable personalized care.<sup>40</sup> As part of the health transformation pillar, collaboration with the HCRC and the Medical Technology IMERI aims to develop a more affordable, domestically produced PSA test. The research involves creating a PSA screening device using immunochromatographic assay or electrochemical biosensor principles. While qualitative development using lateral flow immunoassay (LFIA) has been undertaken, the utilization of poly(acrylic acid)-modified gold magnetic nanoparticles in the LFIA system allows quantifying PSA results with a magnetic reader in 15 min.<sup>41,42</sup>

Therefore, a domestically produced PSA screening device could address accessibility and cost limitations, serving as a solution in various countries, including Indonesia. Increased early detection will improve outcomes and cost-effective prostate cancer management globally.

#### **Increased awareness in prevention and early detection in Healthcare 5.0 era**

The principle of prevention, a key focus of Healthcare 5.0, still requires high awareness from individuals. Increasing awareness is also a major global cancer management strategy.<sup>43</sup> Heightened awareness of the importance of a healthier lifestyle enables individuals to adopt healthy habits, reducing the risk of prostate disease. Since 2019, the Ministry of Health has initiated the CERDIK movement to lower cancer risks.<sup>44</sup> Indonesia continues to face a rising number of cancer cases, including advanced-stage prostate cancer, emphasizing the crucial need for public awareness. Global data shows an increased incidence of prostate cancer in the more productive age group of 50–60 years. Awareness of prostate diseases, especially prostate cancer, poses a challenge in Indonesia due to its occurrence in older age. Cultural beliefs view it as a disease of old age that requires no intervention and has no impact on life expectancy, thus needing to be addressed through various awareness-raising efforts across media channels.<sup>37</sup>

Lack of awareness about prostate cancer screening leads to a higher risk of detecting prostate cancer at later stages, significantly reducing life expectancy. A more aware society seeks treatment earlier, resulting in increased survival rates and a reduced disease burden.<sup>45</sup> Early-stage prostate cancer management is less burdensome than managing advanced-stage cases, thereby aiding in reducing the national burden on the social security system.<sup>46</sup> Globally, prostate disease awareness campaigns are conducted twice a year, with September designated Prostate Cancer Awareness Month (PCAM) and November as Men's Reproductive Health Awareness Month (including prostate health).<sup>47</sup> Educating the public about prostate cancer risk factors, such as unhealthy diet patterns, lack of physical activity, and family history, can help communities adopt healthier lifestyles. Various countries have shown that efforts to increase awareness lead to early detection of prostate cancer.<sup>48</sup>

Since 2016, we have initiated prostate cancer awareness activities in September, observing PCAM at Cipto Mangunkusumo Hospital. Despite the pandemic from 2020–2022, we continued virtual awareness activities, attracting more participants interested in learning about prostate diseases. The virtual activities began with education and, with support from private companies, evolved into offering free PSA screenings.

Additionally, support from the Indonesian Urology Association expanded these awareness activities from Jakarta to nationwide. The prostate cancer awareness initiative also highlights the success of advanced technology applications in prostate cancer management in Indonesia, aiming to boost public confidence in domestic healthcare capabilities comparable to those abroad.<sup>47</sup>

Furthermore, prostate cancer awareness can positively impact the psychosocial well-being of patients and their families. Understanding the disease comprehensively allows the community to provide better support to those affected by prostate cancer. This support extends beyond emotional assistance to practical aid, such as facilitating access to medical care and other resources.

### The role of journals in the development of Healthcare 5.0

The development process of Healthcare 5.0 requires a considerable amount of time and heavily depends on ideas, efforts, and research outcomes. Efforts to advance Healthcare 5.0 globally need to be disseminated for exchanging information, ensuring more efficient acceleration of Healthcare 5.0 applications in healthcare services. Information exchange can occur through various online media, such as publishing research findings in journals, especially those internationally indexed. One advantage of journal publications is that the data presented is the latest and most objective information from a study. High-quality journals maintain the integrity of their published articles through a rigorous peer-review system, where comments are solicited from external reviewers to ensure unbiased evaluation and contribute to the publication of high-quality and objective data.<sup>49</sup> Ultimately, this objective data is expected to serve as inspiration for further improvement and development of the Healthcare 5.0 system in the future.

Efforts to achieve Indonesia's Vision 2045 must align with the global advancements in medical technology. The principles of implementing Healthcare 5.0, such as the collaborative use of cutting-edge technology, AI, and genomic examinations, can guide the development of healthcare services, particularly in managing prostate diseases, which are on the rise in Indonesia. As mentioned earlier, Indonesia still has much to do to catch up with implementing Healthcare 5.0. Nevertheless, the direction and transformative

potential of healthcare services in Indonesia are currently on a path of global change. Accelerating the adoption of Healthcare 5.0 requires a shared vision, cooperation, and collaboration among all stakeholders (government, educational institutions, and public healthcare institutions). The acceleration of this implementation is expected to provide the best healthcare services and education, especially in the management of prostate diseases, delivering optimal and personalized outcomes for every individual suffering from prostate disease in Indonesia.

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