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Co-creation on the Future of Healthcare in UK at Innovation Think Tank Imperial College London

Trends, disease pathways, technologies & innovation best practices

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Co-creation on the Future of Healthcare in UK at Innovation Think Tank Imperial College London

Sultan Haider¹, James Moore², Stephen Brett², Ranan Dasgupta², Mark Wilson², Andrew Birch², Jayati Vasavada³, Mohd Ibney Ali³, Niharika N⁴, Apoorva Goenka⁴

Innovation Think Tank, Siemens Healthineers, ¹Erlangen, ²Imperial College London, United Kingdom, ³Gurgaon, ⁴Bengaluru

Abstract

Healthcare systems worldwide face challenges for handling increasing patient population with limited budgets. Health system in the United Kingdom (UK), continuously seeks the best ways to provide patient care. Innovation Think Tank (ITT), a part of Siemens Healthineers, engages in various regional activities to proactively address challenges and co-create innovative solutions. Following an invitation from Imperial College London (ICL), with the vision to expand innovation infrastructure and network with global ITT sites, a certification program was conducted by ITT at ICL. The goal of this program was to 1) provide innovation methodology training 2) enable interdisciplinary expertise development and capacity building via experiential learning 3) capture and validate healthcare trends in the UK 4) deep dive and identify unmet needs and solutions in the four focus areas of critical care, urology, emergency care, and perioperative care, and 5) generate proposals in the workstreams of technology, clinical innovation, and business model for future of healthcare in UK.

60 students, researchers, clinicians, industry experts and executives, coming from 20 institutions worldwide, participated during this 5-day ITT certification program (ITT CP) at ICL in hybrid format. The proposals and responses from participants were consolidated with a focus on optimizing the healthcare system of UK. The outcomes were presented to a jury, followed by a panel discussion with industry experts. With the aim to further co-implement and co-create innovative solutions, ITT envisions future engagements and collaborations through these regional activities in the country.

Keywords: Innovation Think Tank, Imperial College London, Siemens Healthineers, Healthcare System Framework, experiential learning, unmet needs

Introduction

In the United Kingdom (UK), healthcare is provided by the government through the National Health Service (NHS) which is publicly funded and financed mostly via taxation. Additionally, there is a private healthcare sector in UK, where healthcare is purchased through private health insurance and is usually paid by the patient or as part of an employer-sponsored healthcare plan [1].

The UK's healthcare system is ranked 13th in the World Index of Healthcare Innovation, thanks to its outstanding performance in Science and Technology. Local Clinical Commissioning Groups are supervised and funded by NHS England. Preventive screenings and vaccines, inpatient and outpatient hospital treatment, maternity care, mental health care, and palliative care are all provided by these organizations. While overall health expenditure in the UK seems low for European standards, at 9.8% of GDP, it is growing substantially at a time when fiscal challenges are increasing [2].

Despite this, the challenges faced by healthcare providers and payers have grown over the last decade. These include increasing healthcare needs from rising as well as aging population, rise of chronic diseases adding to the medical complexity, and maintaining cost effectiveness while healthcare demand increases. Due to staff retention and recruitment issues, there has been a lot of workforce shortage challenges too; approximately 100,000 staff inadequacies are in England alone [3]. Treatment waiting lists were already long before COVID-19, following a decade of stalled financing and a rising workforce shortage. Following the COVID-19 pandemic's high demand for care, the number of persons waiting to begin basic hospital treatment in England reached a new high of 5.1 million during summer 2021 [4]. There is a growing demand in UK healthcare system for primary care, community care, mental health care, and acute care which will require adequate numbers of healthcare providers, nursing

staff, equipment, and other related medical facilities [3].

The government is continuously striving to provide world-class health and clinical services throughout the UK. In England, the 'Help Us, Help You' campaign encouraged patients to come forward and seek essential health services, especially if they are exhibiting symptoms that could indicate a more serious diagnosis, such as cancer [5]. Critical care beds are also available within the NHS for patients who are critically ill and require round-the-clock care. There were roughly 5,400 critical care beds in 2011/12; by 2019/20, that number had climbed to 5,900. Around 70% of these are for adults, while the rest are for children and infants [6].

Efforts to protect during the pandemic resulted in a 30% reduction in accident and emergency (A&E) visits until the end of 2021, and 10% reduced general practitioner (GP) consultations in the first 12 months of the pandemic than in prior years. The recent plan for UK government involves three major areas i) addressing the electives backlog, ii) restoring the NHS's financial viability and iii) boosting the emphasis on prevention [5].

Because the NHS is essentially the sole provider for a large population, UK has one of the largest healthcare systems in the world. To accomplish the ambitions outlined in the NHS Mandate, accelerate the pace and scope of change, and provide better patient outcomes, innovation is essential for NHS England [7]. For this, it is critical to involve the most impactful stakeholders inclusive of the patient, carer, clinicians, community, and researchers in order to prioritize the most pressing issues and ensure the funding application and project approval [8]. Also, it becomes utmost important to equally involve educational institutes, hospital management, and other healthcare service providers to facilitate innovation in healthcare system.

Imperial College London (ICL) in UK is among the top ten institutions globally, with a reputation for excellence in research, engineering, business, and medicine [9]. ICL is continuously engaged in diverse and deep educational and research activities. As a result, ICL researchers have launched a number of startups that have raised funding and are accelerating towards clinical impact.

Innovation Think Tank (ITT), a part of Siemens Healthineers (SHS) leverages its co-creation activities in the region by engaging with various institutions and involving diverse healthcare stakeholders [10]. Following the global success of the Innovation Think Tank program, ITT received an invitation from ICL

with a vision to expand innovation infrastructure and to connect with global ITT sites. ICL hosted its first Innovation Think Tank Certification Program between February 21-25, 2022, where the goal was to train participants about the innovation management methodologies, enable interdisciplinary expertise development and capacity building via experiential learning. The purpose was also to identify trends, deep dive into the core areas in the UK healthcare system, identify unmet needs and propose solutions with a focus on the future of healthcare in UK. Through further engagements and collaborations, ITT aims to support the prestigious institution's future research and innovation in the healthcare industry.

Material and methods

A co-creation program was collaboratively organized by ICL and ITT with a focus on the future of healthcare in UK [Figure 1]. The program brochures were circulated on various social platforms and 100+ applications were received. The finalists were selected ensuring multidisciplinary backgrounds with respect to gender, qualifications (product and industrial design, biomedical engineering, medicine, neuroscience, electrical engineering, medical device design and entrepreneurship, computer science, bioscience enterprise, mechatronics, robotics, materials), experience, and geographical regions. These participants represented institutions from across the world (Universidad Rey Juan Carlos, Otto-von-Guericke University Magdeburg, Vellore Institute of Technology, Leibniz-Institut für Polymerforschung Dresden, Universidade de Aveiro, Trinity College Dublin, StuRa HS-Pforzheim, University of the Arts London, The National Maternity Hospital, Hochschule für angewandte Wissenschaften Würzburg-Schweinfurt, University of Cambridge, Cardiff University / Prifysgol Caerdydd, FH Aachen University of Applied Sciences, RWTH Aachen University, The Aga Khan University Hospital (Pakistan), University of Cape Town).

A total of 7 teams composed of 38 participants from 10 different institutions participated in this hybrid program, the partakers gathered in-person at the Imperial College campus and remotely from various locations within and outside UK. Participants gained learnings from the ITT methodology training, which helped them cultivate an innovative mentality, assess unmet needs of local healthcare system, and build disruptive solutions. Impulse speeches from subject matter experts on selected focus workstreams of critical care, urology, emergency care and perioperative care motivated the participants to develop their project ideas as well as implementation

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proposals in workflow optimization across these areas.

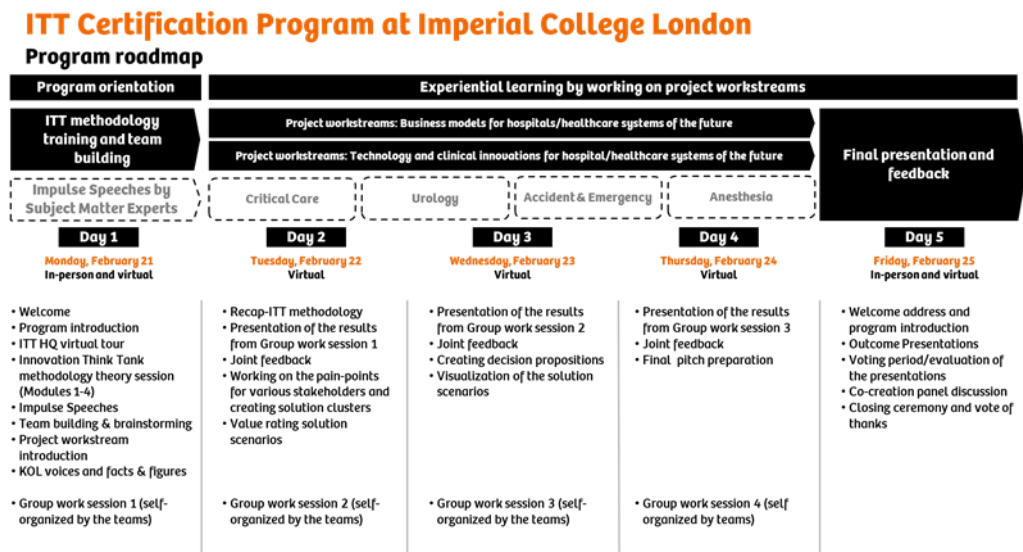


Figure 1: Roadmap for ITT Certification Program at Imperial College London

For gathering, analyzing, and verifying trends and challenges, the Innovation Think Tank Healthcare System Framework (ITT HSF) was employed. ITT HSF combines 1) Need analysis by capturing stakeholder's workflow, 2) Co-ideation by trans-disciplinary ITT teams globally and 3) Co-implementation with healthcare system stakeholders by local ITT programs [11] [Figure 2].

The template for ITT HSF was modified by taking inputs from previous surveys and customized to the specific requirements for capturing and validating healthcare trends and challenges in UK with respect to the future of health. The four focus areas mentioned previously were also incorporated into the survey.



Figure 2: Healthcare System Framework by Innovation Think Tank for capturing and validating trends

The survey consisted of 10 sections investigating the demographics, trends (healthcare, technology, clinical, business model), institutional goals and challenges, healthcare system of UK, and critical care, urology, emergency care, and perioperative care workflows. The survey was filled by the participants and the responses were collated.

The consolidated findings and the overall program outcomes were presented to a jury on the final day, followed by a panel discussion on the future of healthcare in UK with researchers, clinicians, industry experts and executives.

Results

Program outcomes

In continuation of the engagement with Imperial College London, ITT successfully completed a 5-day certification program at Imperial on February 25, 2022, with a focus on the future of healthcare in UK. As a consequence of the program, unmet needs were studied and workflows of critical care, urology, emergency care, and perioperative care were visualized by the teams, which resulted in collection and identification of 90 key opinion leader voices, 40 stakeholders, 109 pain points, and proposal of 38 solution clusters and 20 solution scenarios. Some example visualizations of the workflows along with the stakeholders and pain points are depicted in Figures 3-6. A value rating matrix of the possible

solution clusters for each of these focus areas is illustrated in **Figure 7**.

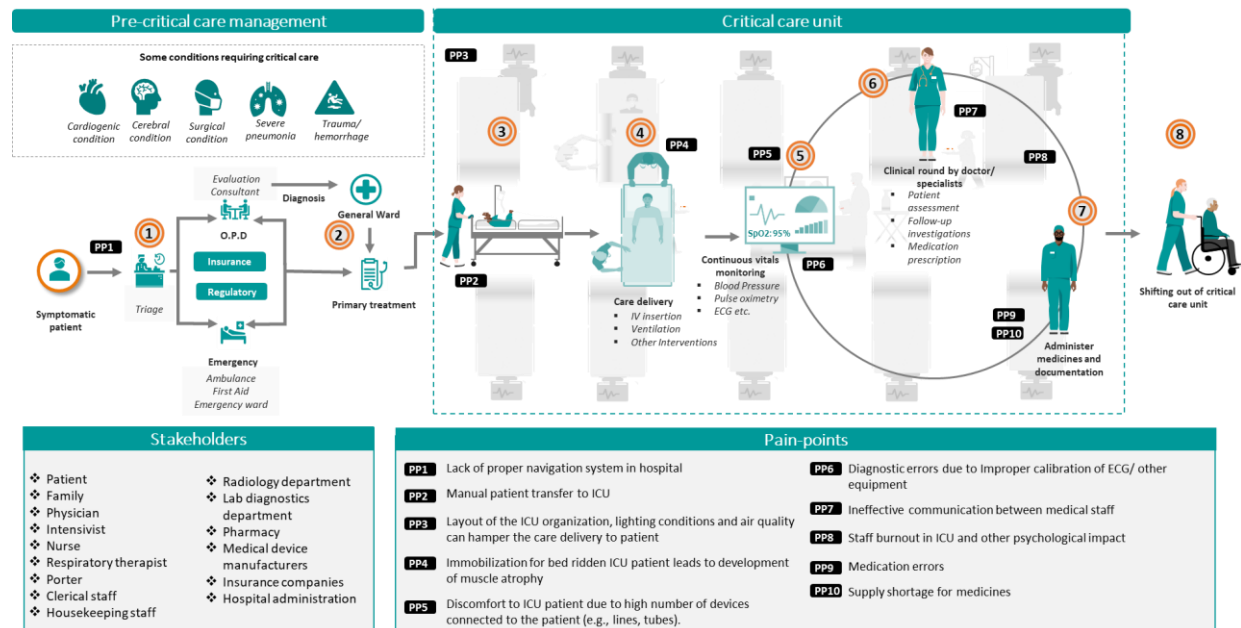


Figure 3: Example workflow visualization of the critical care department along with the stakeholders and pain points.

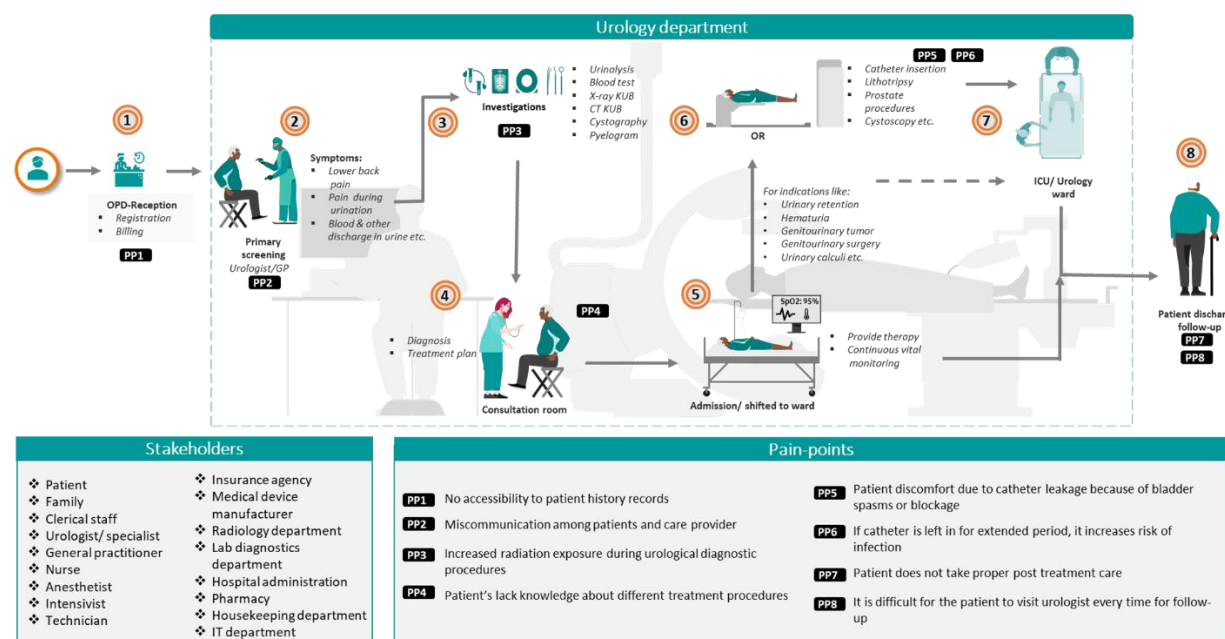


Figure 4: Example workflow visualization of the urology department along with the stakeholders and pain points.

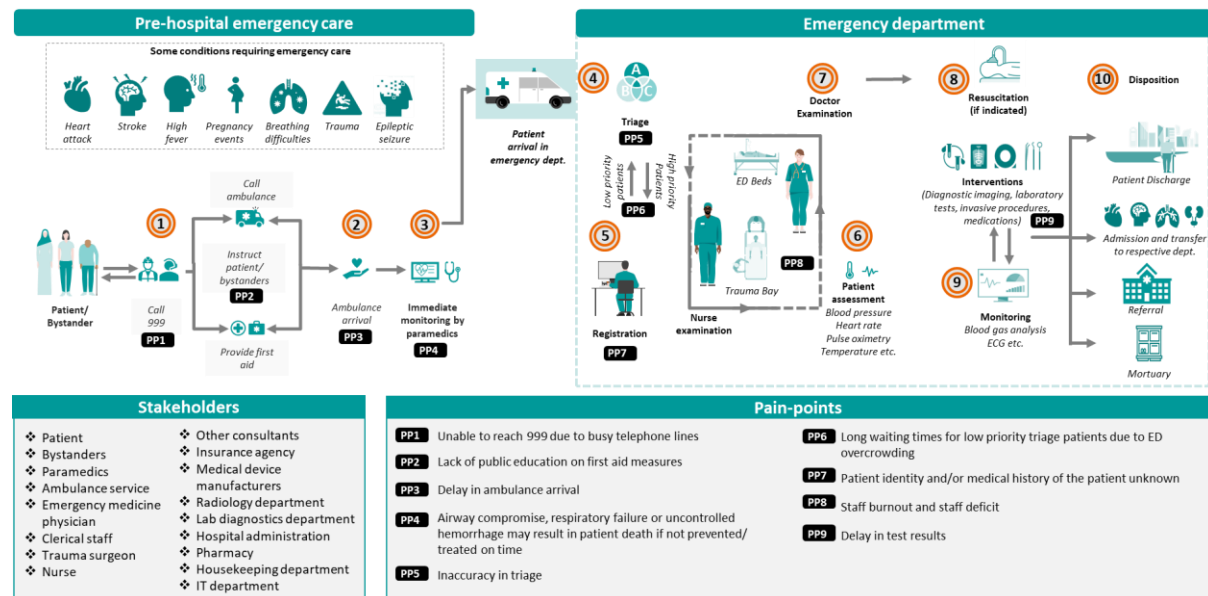


Figure 5: Example workflow visualization of the pre-hospital and emergency care department along with the stakeholders and pain points.

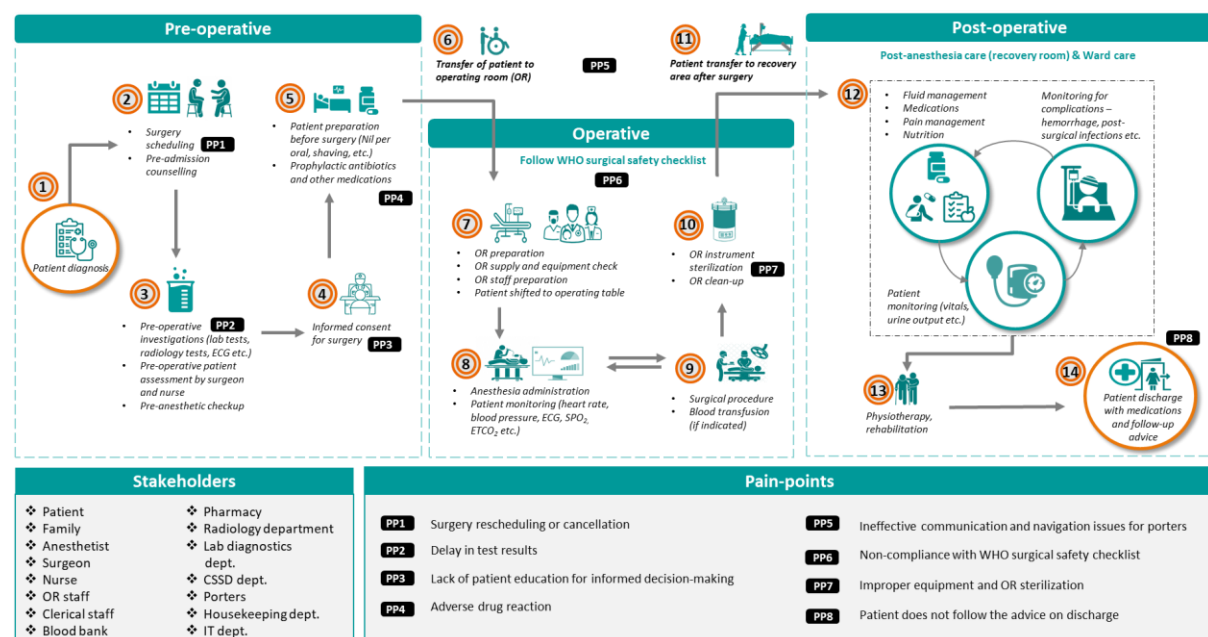


Figure 6: Example workflow visualization of the perioperative department along with the stakeholders and pain points.

Value rating matrix

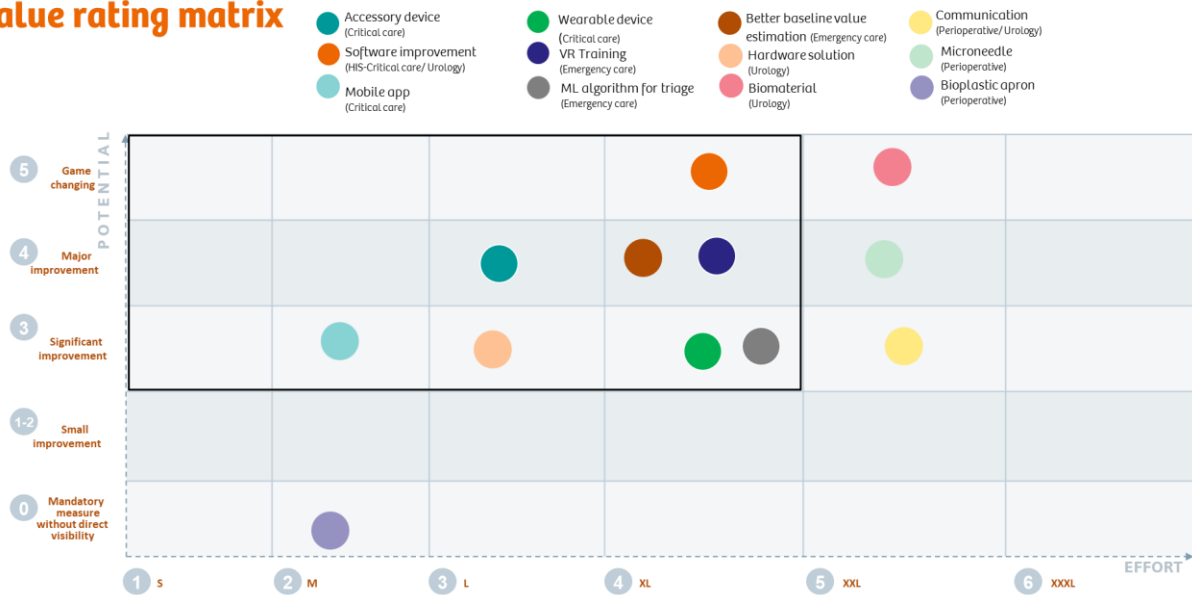


Figure 7: Example illustration of value rating matrix with the proposed solution clusters for the four focus areas of critical care, urology, emergency care and perioperative care. The clusters were created by the teams individually for their respective focus areas to address the identified pain points. These were then mapped on the value rating matrix by analyzing efforts required versus market potential. The above visualization is an amalgamation of the top solution clusters proposed by the teams during the ITTCP at ICL.

Survey findings

The participants responded to the survey on the healthcare system in UK. The consolidated findings are presented in the following categories:

Category 1: *The key current trends that will transform healthcare delivery in UK and the degree of their impact on the healthcare system in UK*

Healthcare trends

Participants rated the healthcare trends in UK based on their perceived degrees of impact [Figure 8]. Most of the participants (88.5%) rated data driven health innovation as having a high impact, followed by individualization of diagnosis and treatment (76.9%), fully integrated care solutions (57.7%), and rising demand of access to care (50%), all of which were rated to have a high impact by more than 50 percent of the participants. On the other end, 69.2% participants voted for focus on medical tourism as

having a low impact. Additional healthcare trends identified were inclusion medicine, effect of social media on healthcare, medical education, hybrid models of care delivery, mental health, digital transformation in healthcare, automated solutions, difficulties in integration of newer technologies within NHS, and burnout of healthcare personnel.

Clinical trends

Figure 9 illustrates the degrees of impact on clinical trends as per the responses received. The top three clinical trends with a high impact were increase in chronic diseases (73.1%), targeted drug delivery (69.2%), and intelligent cancer care (65.4%). Emphasis on geriatric care had a relatively moderate impact, whereas decentralization of hospital services had a relatively low impact. Increase in multi-morbidity conditions and minimally invasive guided procedures were the other clinical trends identified.

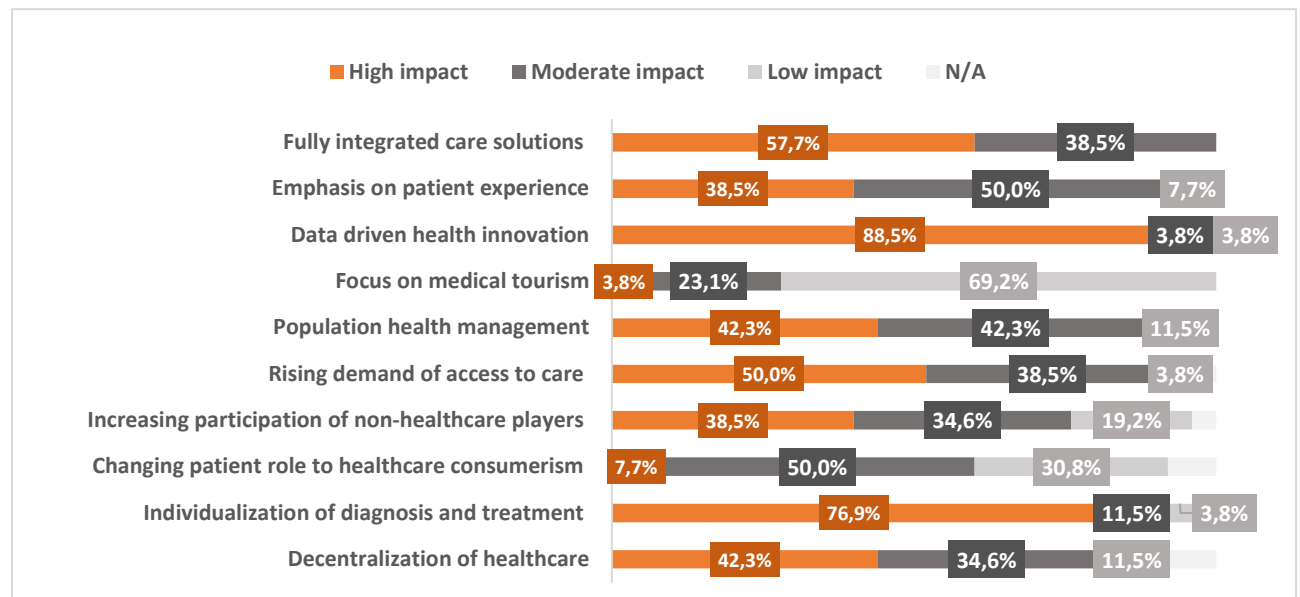


Figure 8: Healthcare trends outcome analysis

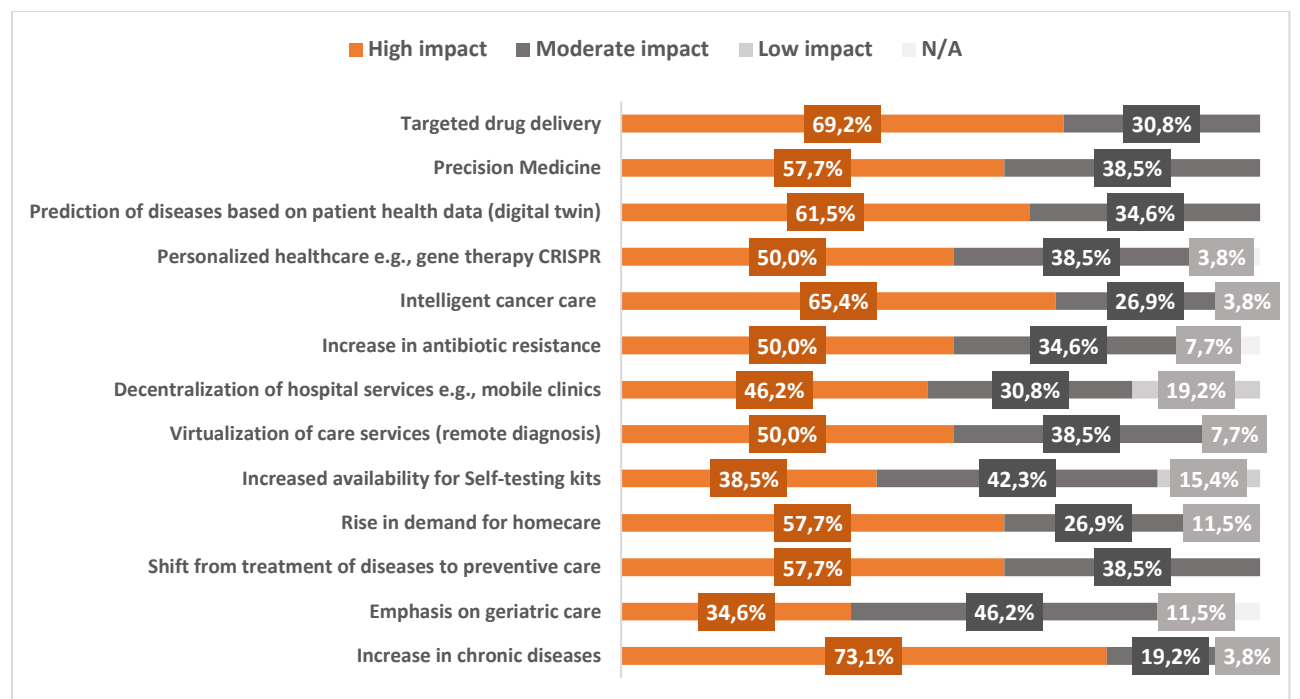


Figure 9: Clinical trends outcome analysis

Technological trends

Technological trends and their associated degrees of impact as voted by the responders are depicted in **Figure 10**. Trends with the highest impact were digitalization of healthcare and artificial intelligence (AI) based services (80.8% each), followed by optimizing healthcare operations through big data

analytics (73.1%). Increased use of healthcare applications, radiogenomics in healthcare, and vocal biomarkers for diagnosis had a relatively moderate impact. Quantum computing in future healthcare was perceived to have a low impact by 26.9% of responders. Additional technology trends such as wearables and smart operating rooms were also recognized by the participants.

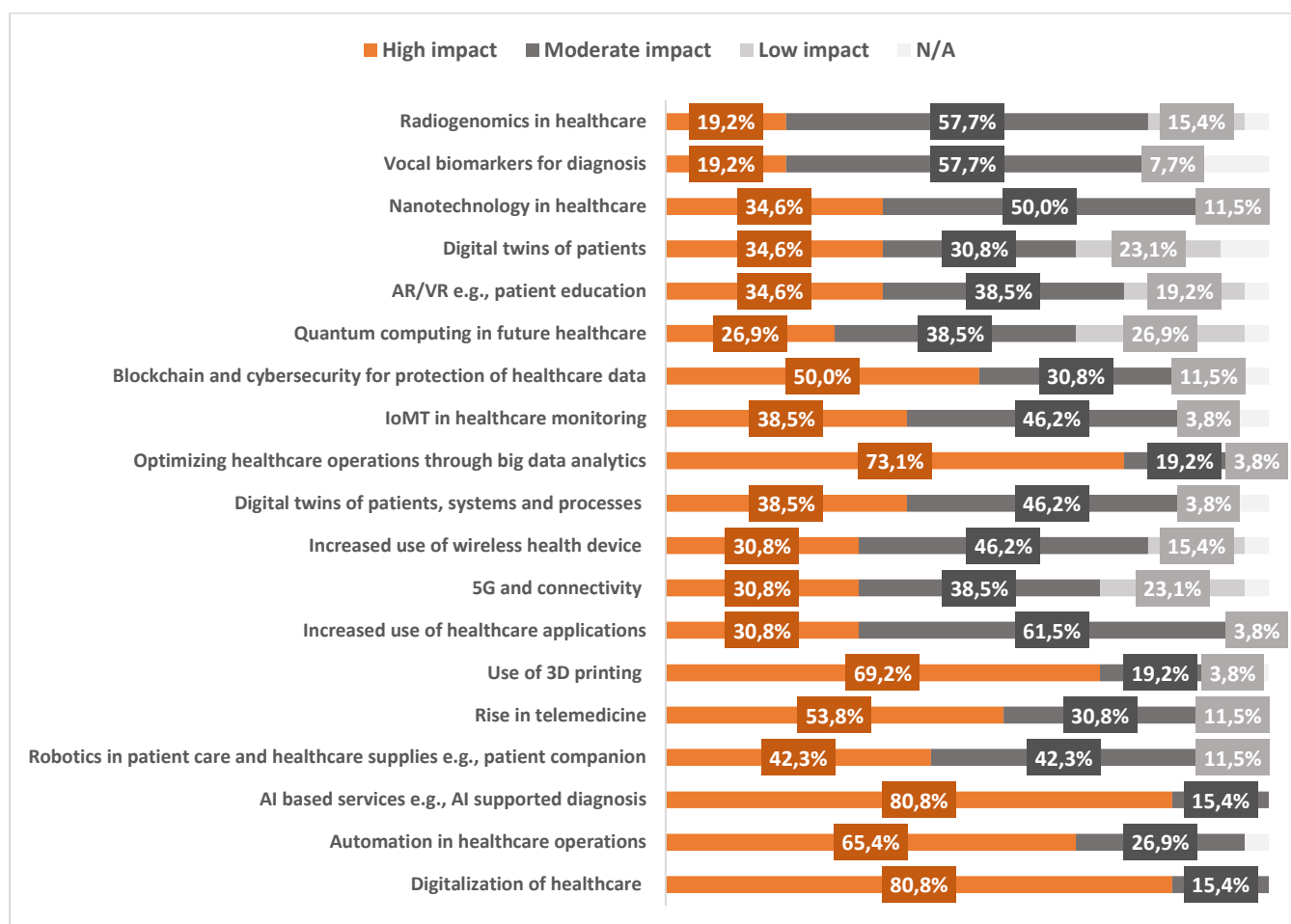


Figure 10: Technological trends outcome analysis

Disruptive technology areas

According to more than 60% participants, single drop blood testing (65.4%) and full body portable ultrasound (61.5%) had a high impact, as shown in **Figure 11**. Other disruptive technology areas with a relatively high impact (50%) were fetal MRI doppler ultrasound gating device, portable breast cancer screening, non-invasive and highly accurate CT-FFR, and AI POC diagnostic tool. Fluorescence imaging with NIR- Quantum dots had a relatively moderate to low impact. Magnetic resonance fingerprinting and textile integrated electronics were the other disruptive technology areas mentioned by the participants

Business Model trends

Business model trends with their degrees of importance are shown in **Figure 12**. 76.9% participants voted for interconnecting healthcare providers (hospitals/ clinic chains), while 65.4% voted for healthcare start-ups focusing on healthcare challenges in the UK as having a high impact. As per 53.8% participants, cost sharing in healthcare had a relatively moderate impact. A lower impact was recognized for mergers and acquisitions, and fee for service, pay per scan (30.8% each).

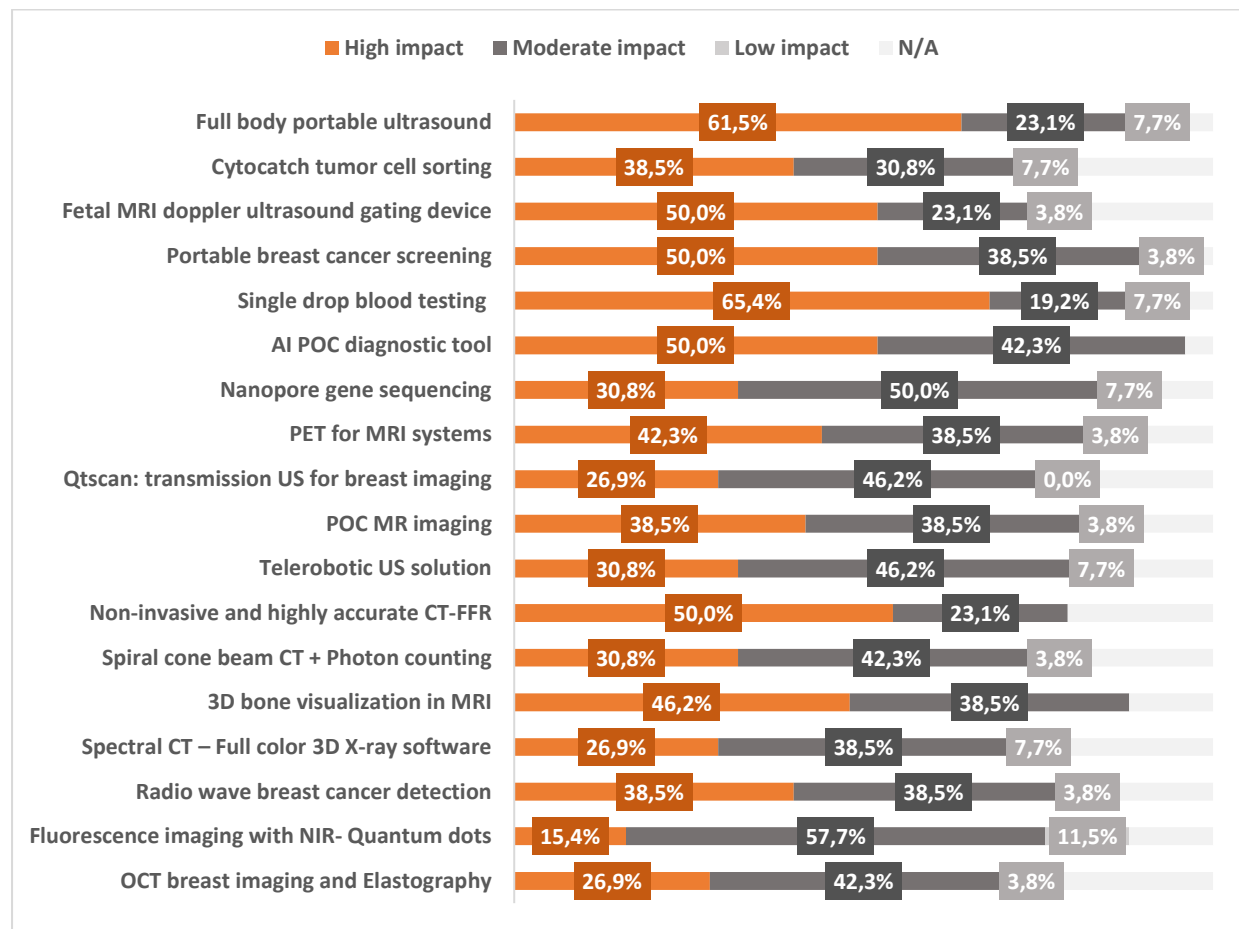


Figure 11: Disruptive technologies outcome analysis

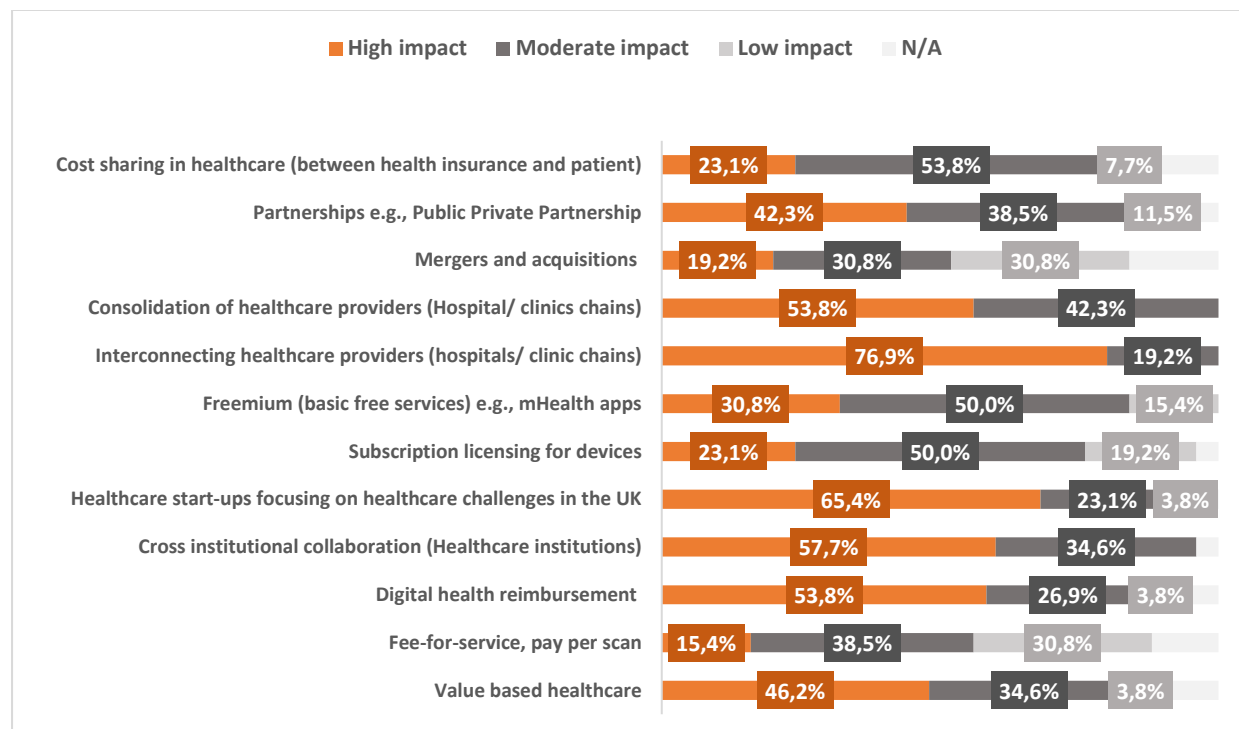


Figure 12: Business model trends outcome analysis

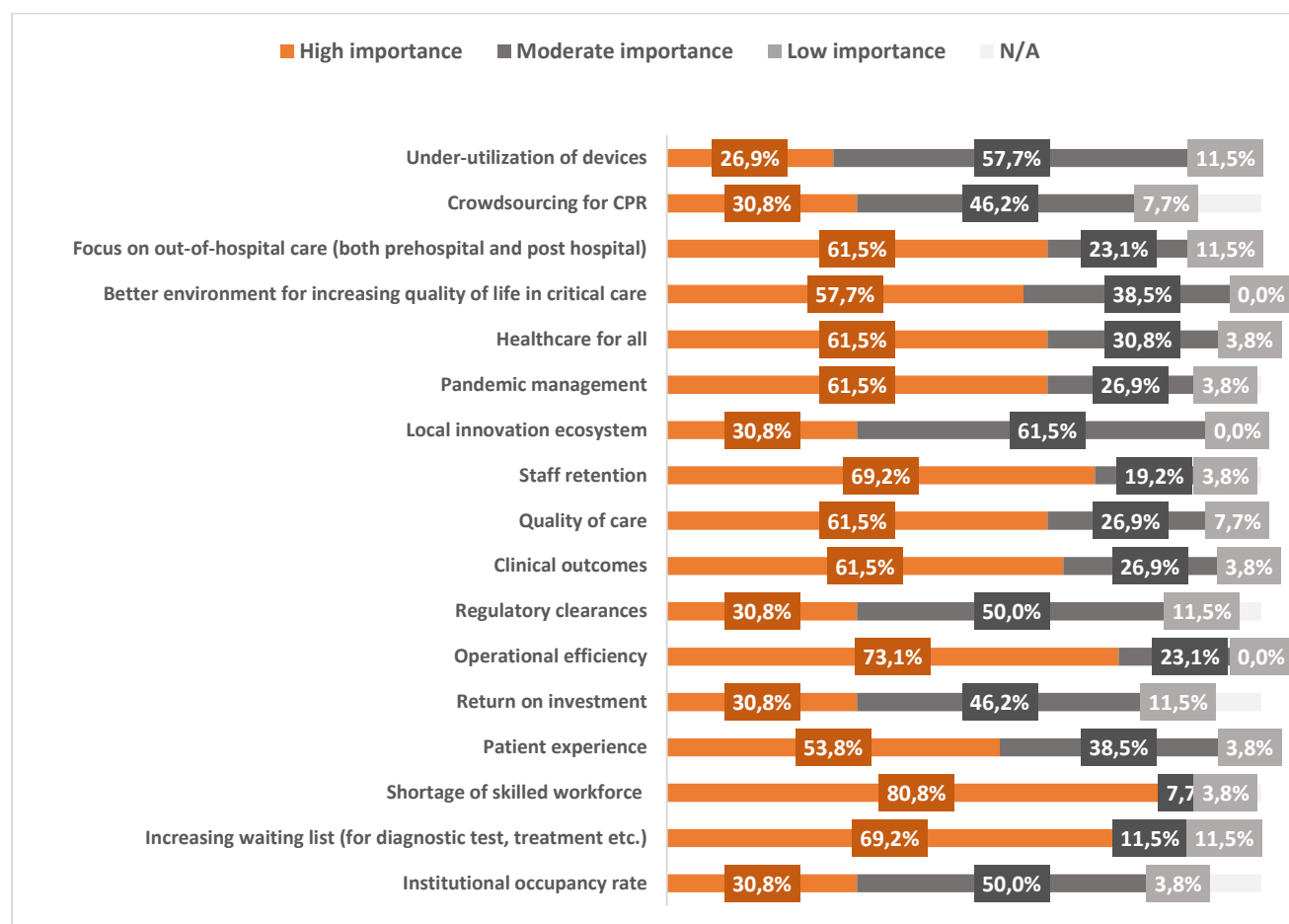


Figure 13: Institutional challenges outcome analysis

Category 2: Institutional challenges and goals of hospitals, healthcare system in UK and their degrees of importance

When asked to rank the challenges or goals from institutional challenges based on their degrees of importance, 80.8% participants ranked shortage of skilled workforce as the biggest challenge [Figure 13]. This was followed by operational efficiency (73.1%), increasing waiting list and staff retention (69.2% each). Local innovation ecosystem and under-utilization of devices had a comparatively moderate impact. Additional challenges identified were lack of funding, poor infrastructure, non-environment friendly plastics, waste management, and ethics code for doctors and nurses.

Category 3: UK Healthcare System

A visualization of the UK Healthcare System was created and shared with the participants [Figure 14]. It illustrated the patient pathway in UK, various stakeholders involved and their interdependencies, healthcare expenditure in the UK, insurance, workforce available etc. Based on their observations

or research on the UK healthcare system, the participants provided their feedback. The key highlights were as follows:

- The NHS offers an alternative to the emergency number 999. By calling 111, non-urgent cases can be tackled, thereby reducing the load on the emergency service 999.
- Transport via ambulance or porters is not depicted in the diagram. It is an integral part of the healthcare system.
- Private clinics are an important component of the UK healthcare system.
- The impact of home care and geriatric care in retirement homes is rising.
- Healthcare digitalization, data analytics, health IT, cybersecurity, personal health apps also play an important role.
- Differences in needs exist between the geographic areas.
- Interdependencies between the patient and pharmacy, rehabilitation center and pharmacy can be depicted.

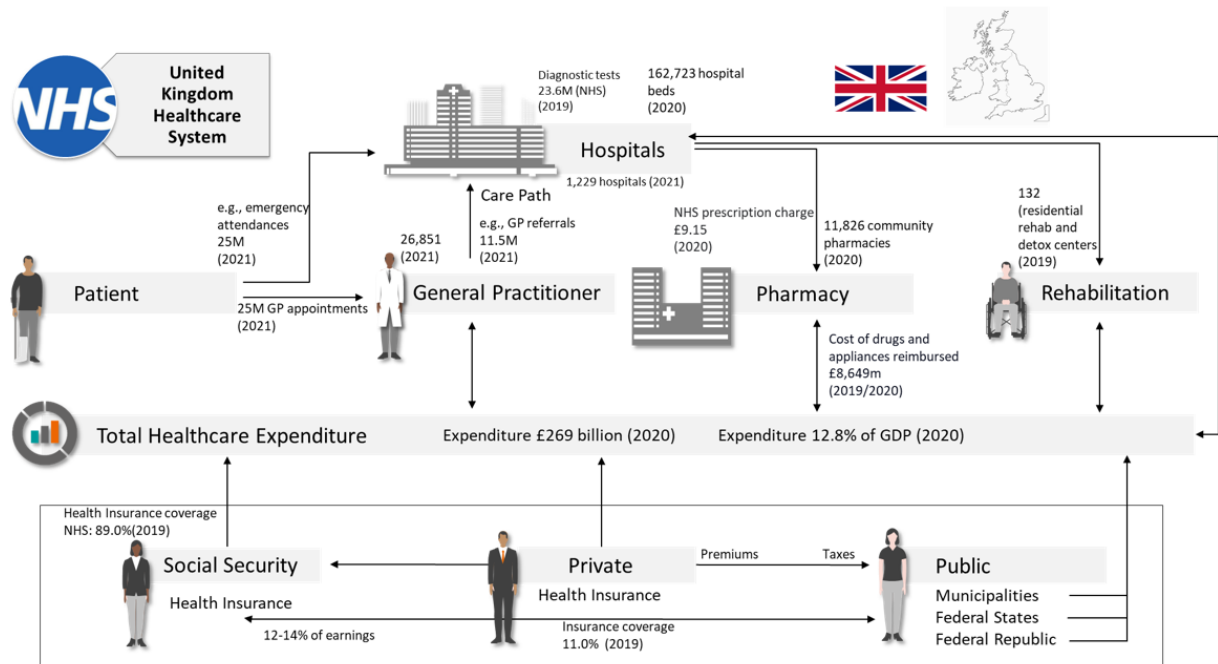


Figure 14: UK Healthcare System Framework

Category 4: Workflow validation – challenges and trends in critical care, urology, emergency care, perioperative care

Critical care

Challenges

Figure 15 illustrates the challenges identified in critical care and their impact ratings by the participants. Most participants (61.5%) thought that lack of workforce management and skill development had a high impact on critical care. Moreover, over 50% participants voted for noisy environment, bed occupancy, lack of skilled healthcare personnel, and sleep deprivation for patients in ICU as having a high impact. ICU biomedical waste management and

space issue for heavy instruments had a relatively lower impact on critical care as per the participants.

Trends

Participants also ranked the key trends in critical care based on their impact [Figure 16]. The trends with a high impact rating of over 70% were integrating smart technologies for optimization in critical care (80.8%), remote patient monitoring, and centralized data system (73.1% each). Some of the trends rated with a relatively moderate impact were need of ICU fleet management and automated patient guidance system. Additionally, VR based staff training in critical care was suggested by one of the participants.

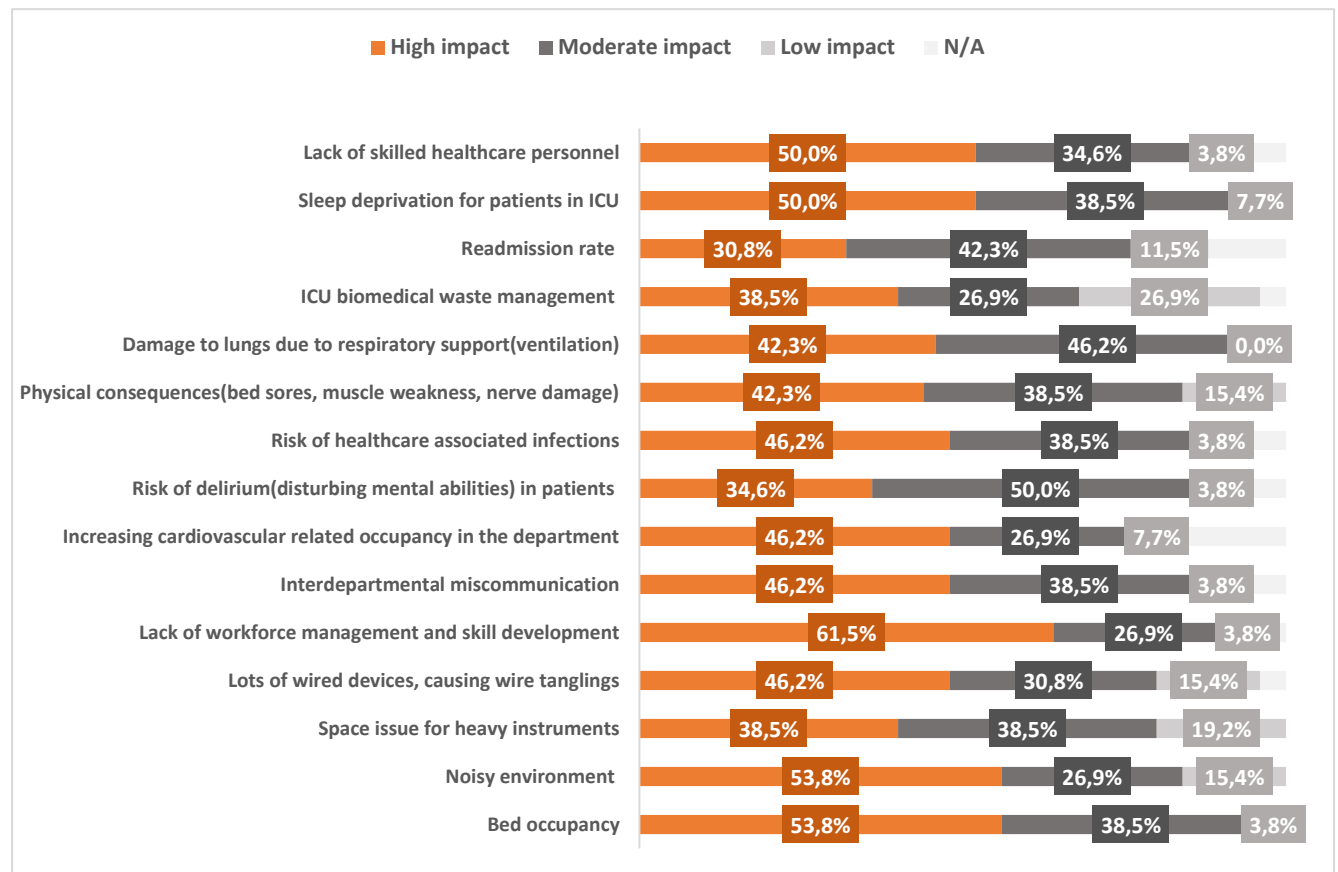


Figure 15: Challenges in critical care

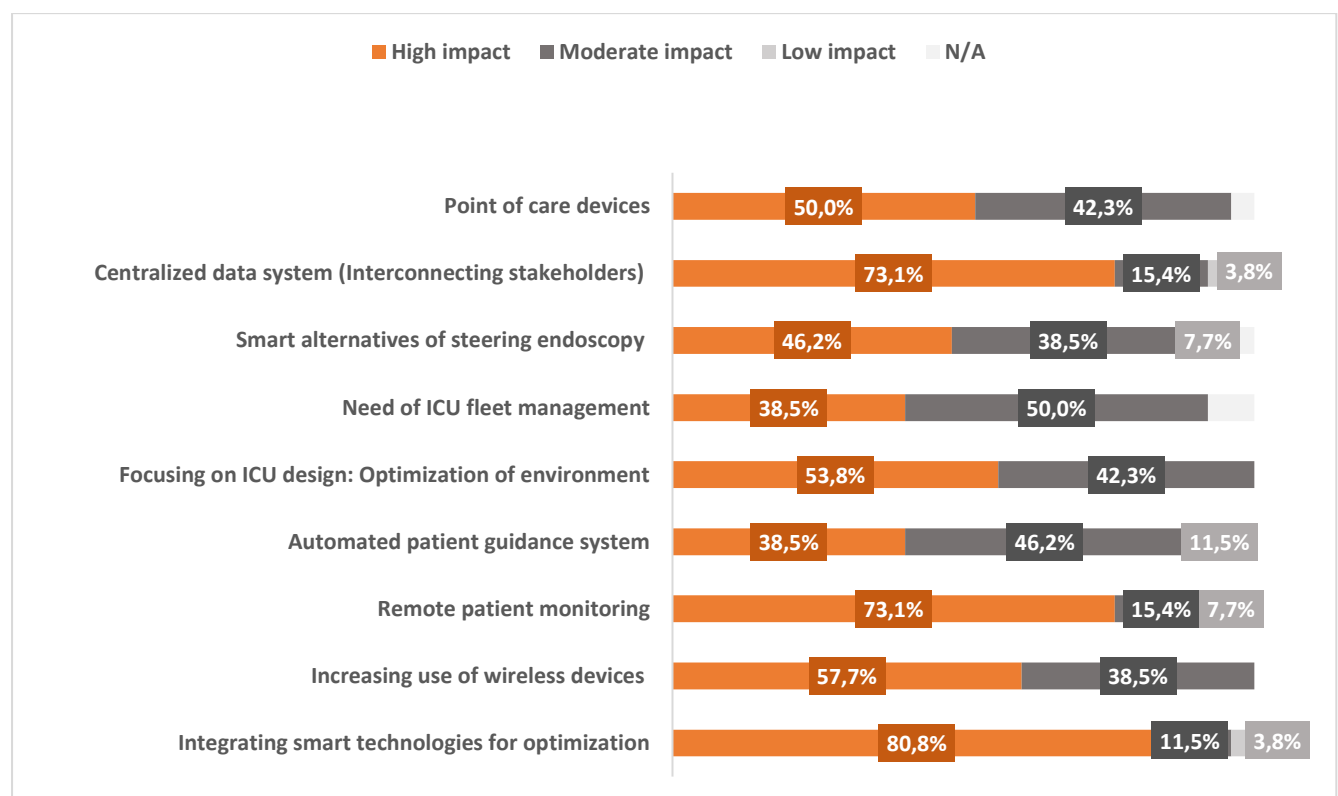


Figure 16: Trends in critical care

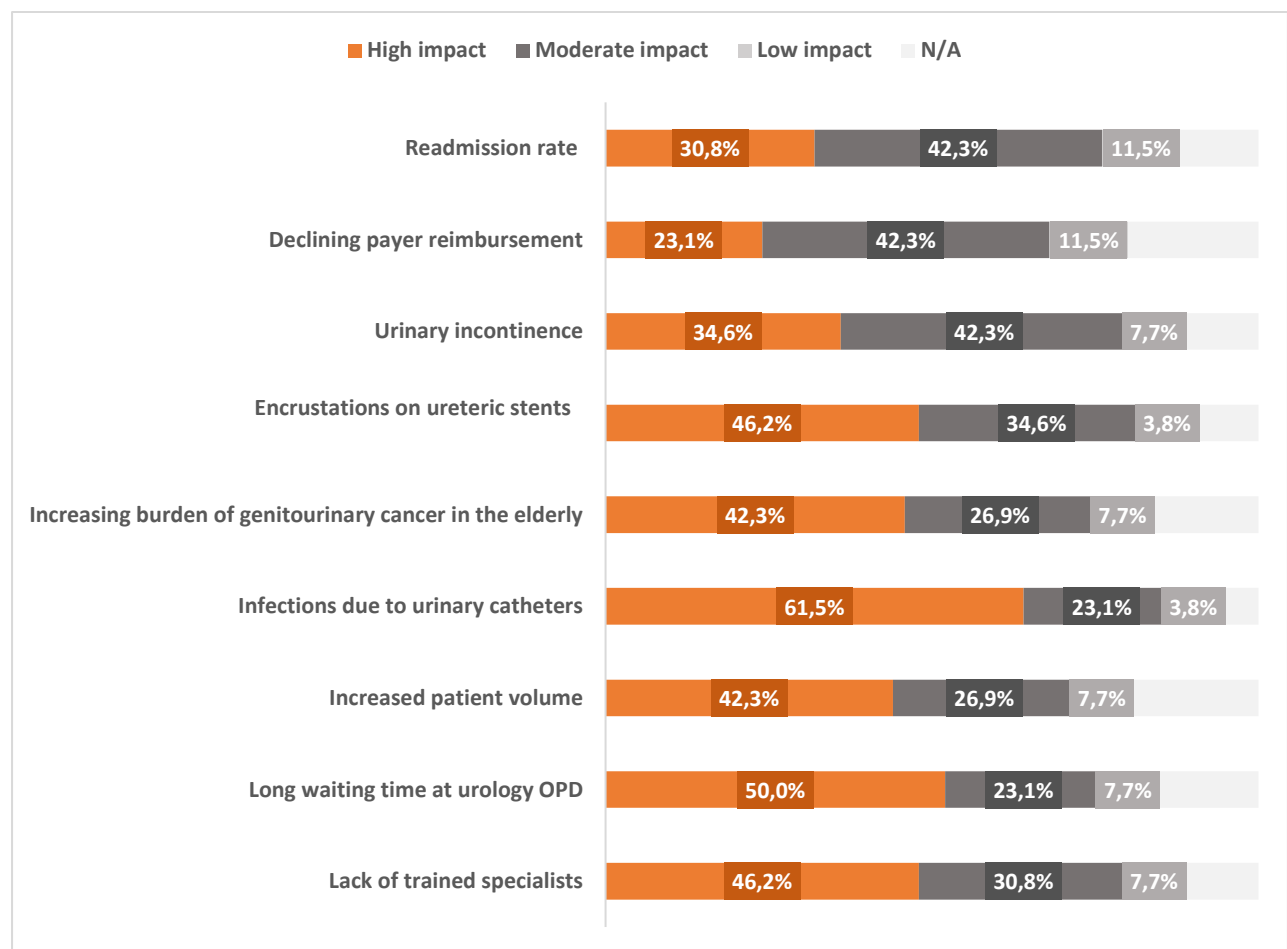


Figure 17: Challenges in urology

Urology

Challenges

Figure 17 showcases several challenges and their degrees of impact in urology. Infections due to urinary catheters had the highest impact (61.5%), followed by long waiting time at urology OPD (50%), encrustations on ureteric stents, and lack of trained specialists (46.2% each). Readmission rates and declining payer reimbursements had a relatively moderate to low impact. Participants also identified the need to encourage students to take up urology specialty in NHS.

Trends

Participants ranked the urology trends based on their impact **[Figure 18]**. The highest impact was observed for minimally invasive surgical approach (76.9%) and following that were novel therapy techniques and enabling patients to monitor bladder volumes (53.8% each). Telemedicine and telerobotic in urology had a relatively moderate to low impact. Participants also mentioned about nanotechnology in urology as an upcoming trend.

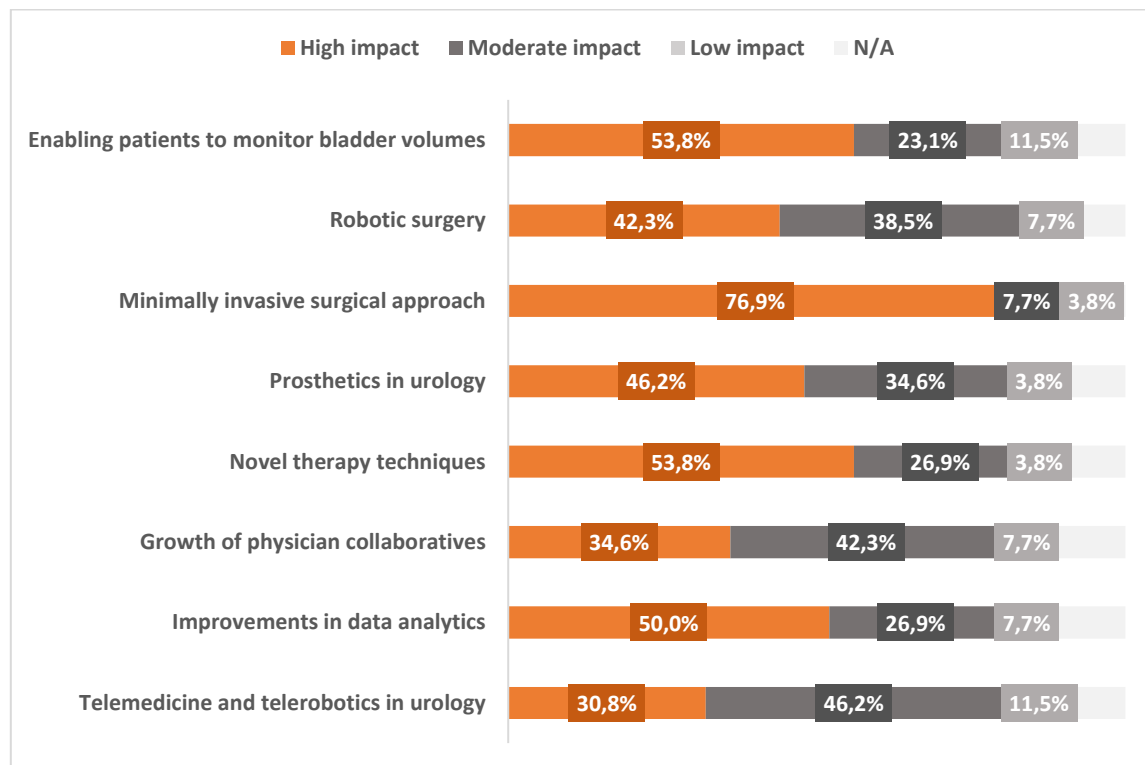


Figure 18: Trends in urology

Emergency care

Challenges

Emergency care is an integral part of the healthcare system, and we asked the participants to rank the various challenges in emergency care [Figure 19]. Delays in emergency care was a major challenge according to 76.9% of participants. Delay in ambulance arrival (65.4%), lack of patient data (61.5%), and staff burnout (57.7%) were other challenges with high impact on emergency care. 50% participants voted for pharmaceutical supply shortage to have a moderate impact. Reimbursement issues in emergency care had a relatively moderate to low impact.

Trends

Several trends in emergency care were identified and the participants rated them based on their degree of impact [Figure 20]. The highest impact was observed for AI supported management (69.2%), followed by portable POC diagnostic devices (61.5%). Other trends with a relatively high impact (50%) were intensive care services within ambulance, telemedicine, clinical decision support system, and increased demand for emergency medical records. Apps streamlining emergency care had a relatively moderate impact, while driverless ambulances had a low impact. Participants also identified the need to improve triage in emergency care, e.g., by using machine learning.

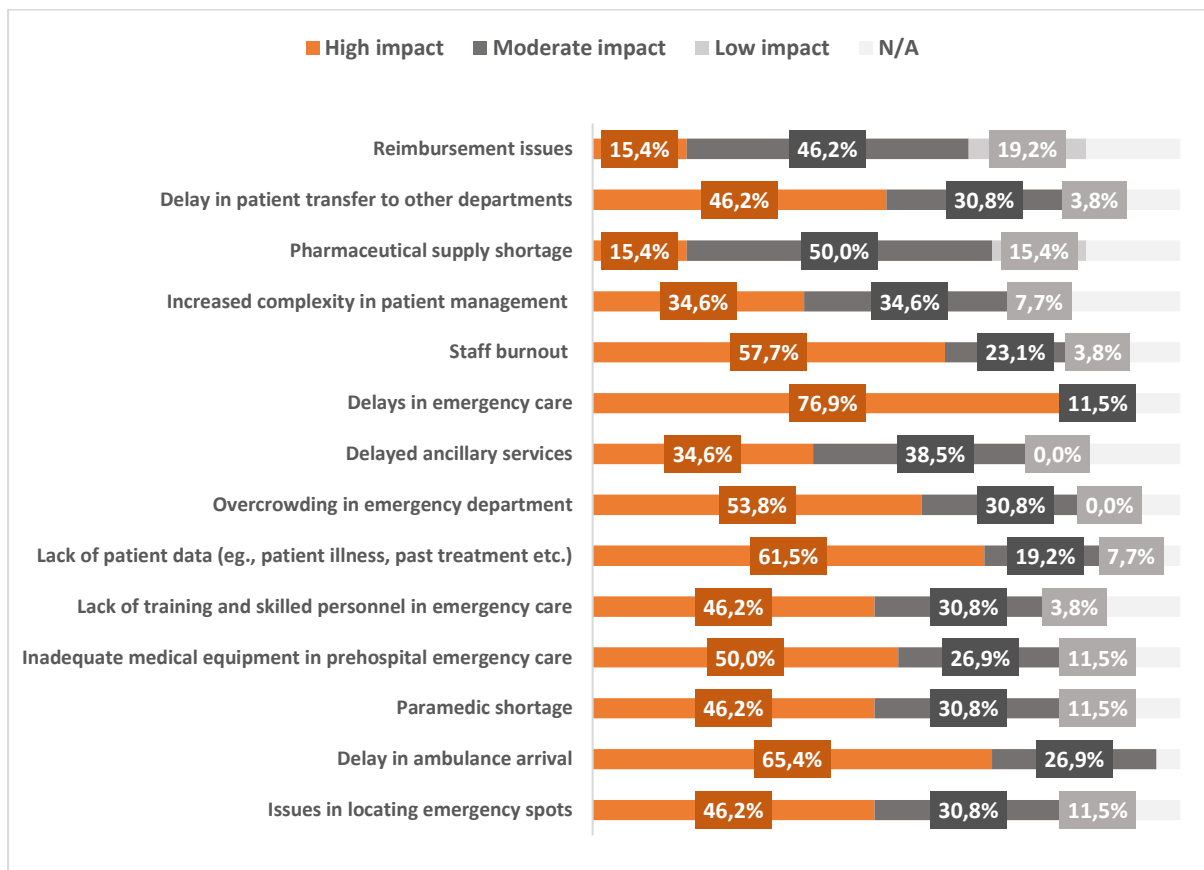


Figure 19: Challenges in emergency care

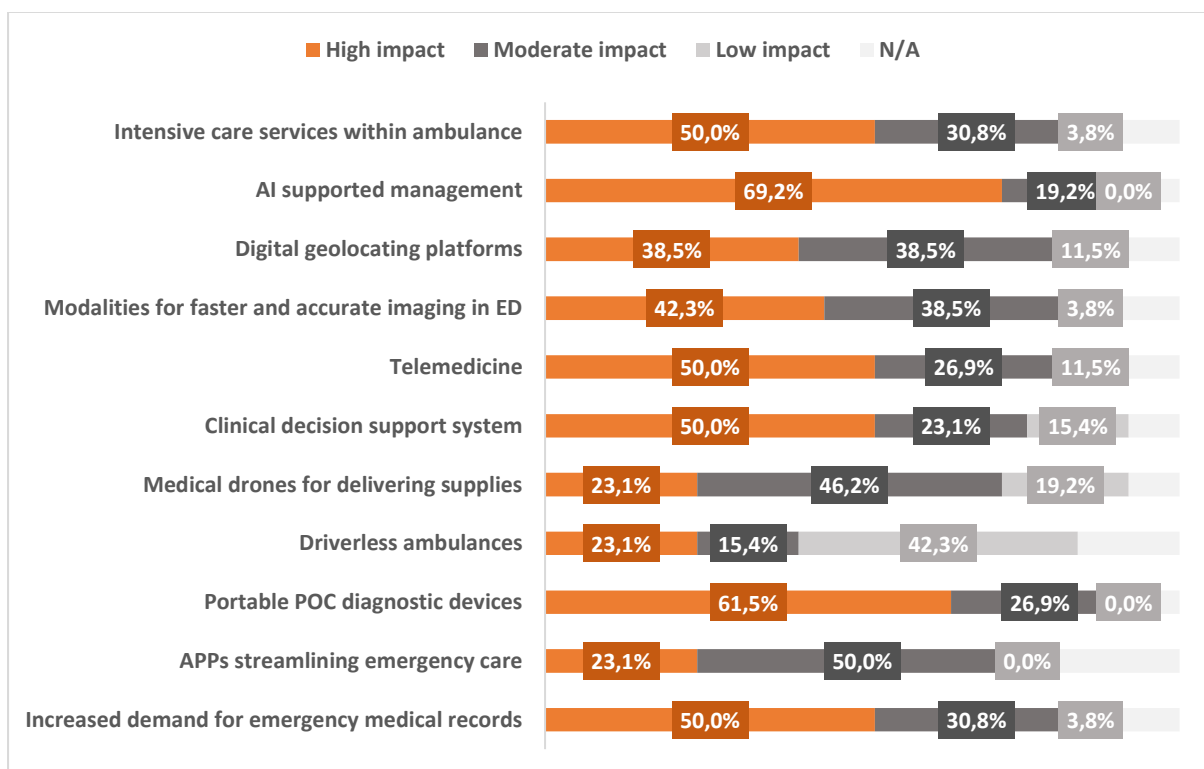


Figure 20: Trends in emergency care

Perioperative care

Challenges

Figure 21 depicts various challenges in perioperative care and their degrees of impact as rated by the participants. Challenges identified as having a high impact by over 50% participants were high workload reducing quality care to patients (65.4%), intensive care occupancy (57.7%), and patient no-shows and missed appointments (53.8%). Lack of pre-operative visits had a moderate impact according to 65.4% responders. Lack of patient safety was not a major challenge in perioperative care as per 11.5% responders.

Trends

Similar to the trends in the focus areas mentioned above, participants also voted for the trends in

perioperative care. **Figure 22** shows that 80.8% responders voted for minimally invasive diagnostic and therapeutic procedures as having a high impact, followed by electronic health records (76.9%), defining treatment approach using patient digital twin (57.7%), and augmented reality/ virtual reality assisted surgeries (53.8%). Pre-operative exercise training programs were thought to have a moderate impact by 69.2% responders. Telesurgery, digital twin in surgical practice, and better navigation system in hospitals had a relatively low impact on perioperative care.

Additional ideas on perioperative care proposed by the participants were immediate physiotherapy, pain management and enhancing emotional support to improve patient outcomes and reducing the waste generated during the perioperative process.

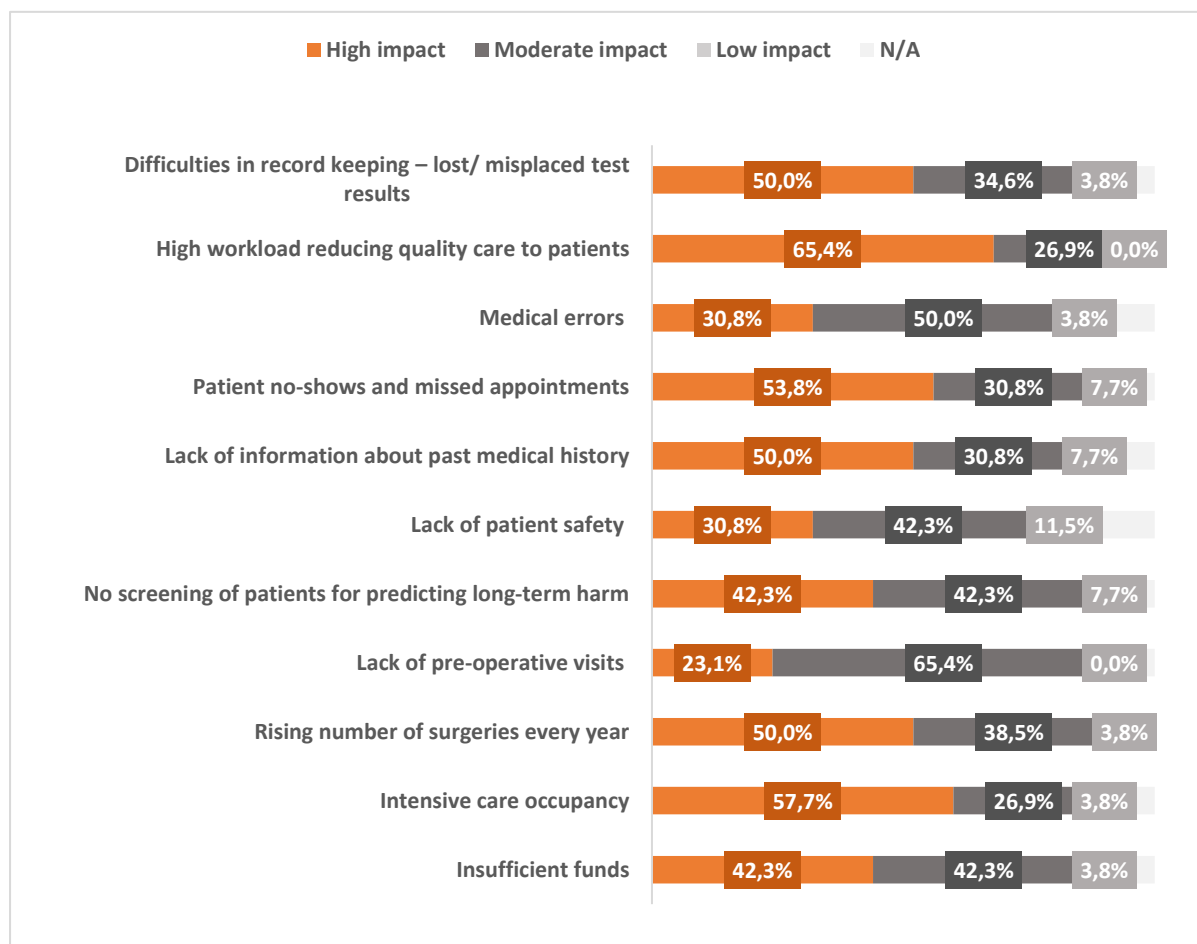


Figure 21: Challenges in perioperative care

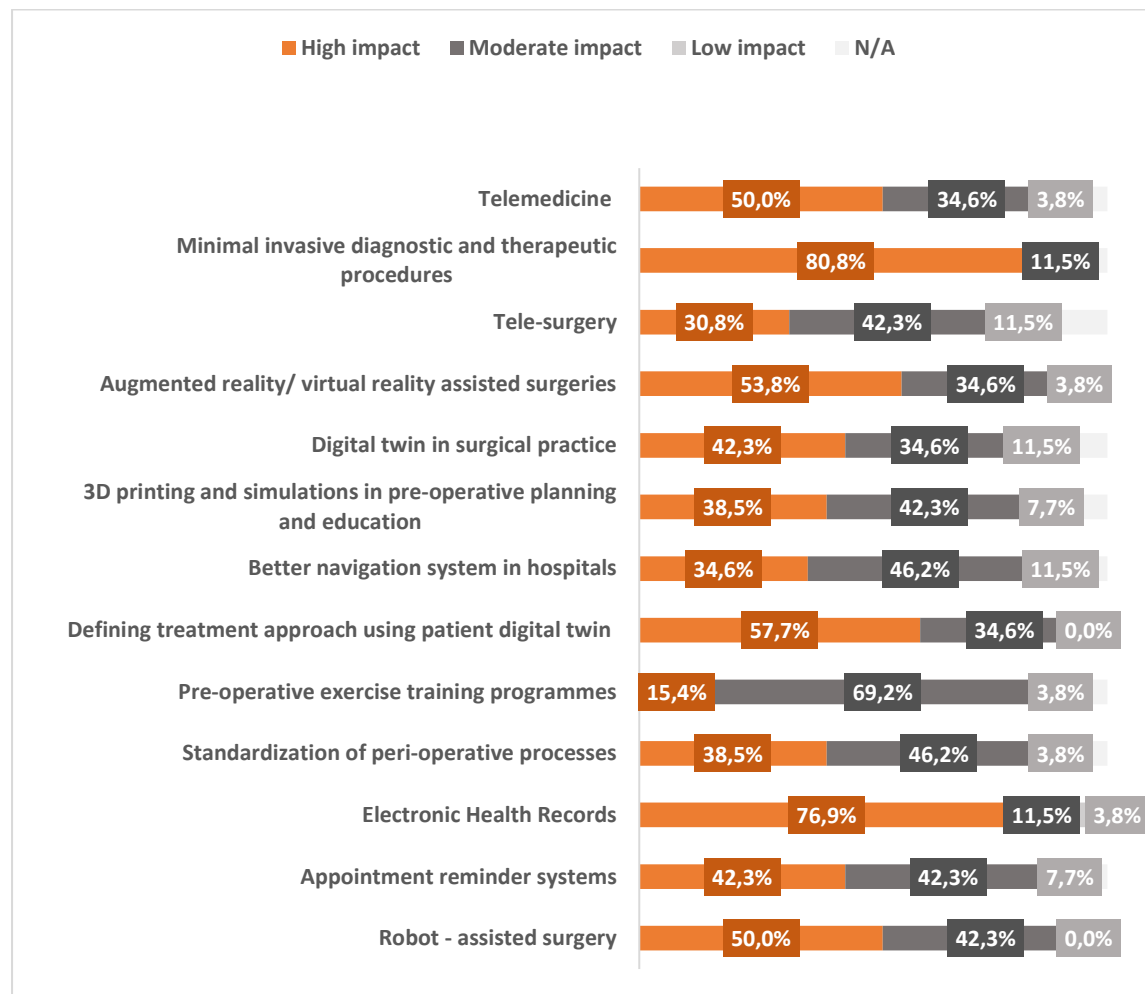


Figure 22: Trends in perioperative care

Discussion

With a focus on the future of healthcare in UK, the outcomes from the ITT HSF survey help us identify the most impactful challenges and trends in the country. Even though access to care is guaranteed by the NHS funded public health system in UK, several challenges like shortage of skilled staff, long waiting lists, and lack of funds exist, which are also evident from the institutional challenges depicted in the results. To overcome these challenges, highly rated healthcare and technological trends like data driven health innovations, fully integrated care solutions, digitalization, AI based services, and wearables can add benefit to some extent. Moreover, business model trends like interconnecting healthcare providers, healthcare startups focusing on the challenges in UK health system, and cross institutional collaborations would enable provision of high-quality patient care, improve patient outcomes, reduce risk, and share costs.

In the past few decades, there has been an increase in the number of people suffering from chronic diseases globally. This is also supported by the clinical trend analysis from the survey. In the UK, Alzheimer's and other dementias have been growing rapidly. Prediction of diseases based on patient health data, targeted drug delivery, personalized healthcare and intelligent cancer care were some other highly rated clinical trends, and these can support in early diagnosis and better management of such chronic diseases. A rising demand is also witnessed for prevention of diseases, and it is best to be proactive rather than reacting after disease development and emphasizing on diagnosis and treatment.

During the course of the ITT CP at Imperial College London, unmet needs were identified, trends studied, and solutions proposed in the areas of critical care, urology, emergency care, and perioperative care. Lack of skilled workforce, high workload and delays compromising quality care were

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the common challenges in these areas, as evident from the survey results. Besides this, specific pain points in each area were analyzed via the certification program and the survey results, which instigated the participants to develop solution scenarios for each focus area. Trends such as integrating smart technologies for optimization in critical care, minimally invasive diagnostic and therapeutic approach in perioperative care and urology, and AI supported management in emergency care were the highest rated, and these impactful trends can aid in achieving process efficiency, workflow optimization, and ultimately a better patient experience.

ITT HSF for UK healthcare system was integrated during the certification program conducted at ICL. Over the course of this 5-day certification program, the participants not only received core insight into the innovation methodology, but also developed skills like team building, out of the box thinking, big

picture analysis, creating trust, and appreciating efforts of others.

In continuation with its engagement with ITT, ICL plans to have an ITT corner to exhibit different healthcare models and prototypes. For the ITT corner at ICL, ITT team created a 3-floor precision medicine model showcasing the current and future care plans for diseases like lung cancer and coronary artery disease [Figure 23]. The top floor displays the entire healthcare ecosystem in UK with the NHS, ITT, SHS, ICL, hospitals and industries as some of the stakeholders. Level 1 and 2 display the various hospital departments like laboratory diagnostics, radiology, emergency room, outpatient department, surgery suite, tumor board, administration, and interdependencies between the stakeholders, pain points and solutions in these departments. Such a model will provide a big picture and framework for customization of healthcare, with medical decisions, treatments, practices, or products being tailored to the individual patient.



Figure 23: Precision medicine model for ITT corner at Imperial College London

With UK harboring some of the top medical institutes, and being an important hub for research and innovation, incorporating such certification programs in the curriculum can benefit the students as well the society. Findings from such co-creation events and surveys can aid in co-implementation and deployment of solutions that address the pain points affecting the country's healthcare system.

The study was carried out as a part of the certification program conducted by ITT at Imperial College London. A major limitation of the study is its small sample size. We plan to utilize the ITT HSF to constantly update the new challenges and trends in the region and encourage further research on the solution proposals presented during the program, thereby reshaping the future of healthcare in the UK.

Conclusion

With growing population and changing disease patterns, the unmet needs of healthcare in UK are rising, thereby impacting accessibility and quality of care delivery. By leveraging technological, clinical, and business innovations, local challenges can be addressed which will result in optimization of the healthcare system of UK. Through proactively engaging institutions as well as establishing innovation infrastructure in the region, ITT, as a part of Siemens Healthineers has been responding to the UK's growing desire to strengthen the country's healthcare economy and entrepreneurial culture. The certification program outlined in this paper was conducted collaboratively with Imperial College London with a focus on providing innovation methodology training, and further utilizing the experiential learnings to address unmet needs for boosting future of healthcare in UK. The trends, institutional challenges and workflows of focus areas (critical care, urology, emergency care, perioperative care) were captured and validated by integrating ITT HSF framework during the program. The compiled responses and solution proposals from this event will contribute to implement further co-creation activities for initiating disruptive innovations within the local healthcare system.

Acknowledgements

We are thankful to our ITT SHS colleagues for their support in developing the framework and organizing the program at ICL. We would also like to show our appreciation to the team at ICL for successfully organizing and hosting the event. We would like to express our heartfelt gratitude to Prof. James Moore for his kind invitation and support to establish ITT at the prestigious institution, Imperial College London. We would like to convey our special thanks to subject matter experts Prof. Stephen Brett (Critical care), Dr. Ranan Dasgupta (Urology), Prof. Mark Wilson (Emergency care and Neurosurgery), Dr. Andrew Birch (Perioperative care) for sharing their insights and guiding participants on the unmet needs of healthcare. Moreover, we would like to acknowledge our panelists and jury members Dr. Gifty Tetteh, Prof. Michael R. Moreno, Prof. Ian Weeks, Prof. Dimitris Grammatopoulos, Prof. Milos Ljubisavljevic, Dr. Craig Buckley, Dr. Isabel Ramos for sharing their visions and providing valuable feedback during the program. Finally, we would like to recognize our participants

for their enthusiasm, efforts, inputs and solution proposals during the certification program on the future of healthcare in UK.

Authors Statement

SH has conceptualized the framework of the paper as well as guided and initiated the context. JM has provided the vision and insights for creation of the healthcare system framework and implementation in the UK. JV and AG collected, analyzed, and interpreted the data, and prepared the manuscript draft. All authors contributed towards the paper's drafting, reviewed the results, and approved the final version. The authors do not declare any competing interests.

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Siemens Healthcare GmbH
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Contact: innovationthinktank.team@siemens-healthineers.com