



## Deep Dives and Case Studies for TELUS Priority Verticals: **Health**

Adapted from: The Socio-Economic Impacts of 5G

Deetken Insight was commissioned by TELUS to complete a comprehensive review of published research about 5G and its potential socio-economic impacts, with a particular focus on Canada. Access the full report including a bibliography here: <https://deetken.com/socio-economic-impacts-of-5g/>. We provide no opinion, attestation, or other form of assurance with respect to the completeness, accuracy, fair presentation, and findings from research of others that are presented in the report.

Copyright © 2022. Deetken Enterprises Inc. doing business as Deetken Insight has produced the information contained herein for TELUS. The ownership, use and disclosure of this information are subject to the commercial terms contained in the contract between Deetken Insight and TELUS.

Deetken Insight

500-210 West Broadway, Vancouver, BC

Ph: 1-604-731-4424

Email: [info@deetken.com](mailto:info@deetken.com)



## Key Takeaways

---

- In Canada, total health expenditures are almost 13% of total GDP, or \$308 billion. This proportion has increased steadily over the past several decades. Cost pressures continue because of Canada's aging population and the rising costs of equipment, medical supplies, and labour. Meanwhile, access to quality care is challenged by Canada's geography: almost one-fifth of Canadians live in rural communities, yet they are served by only 8% of the total number of physicians in Canada.
- 5G solutions can help address the many and diverse challenges facing Canada's health care industry. Example 5G solutions and the benefits they bring to the health care industry include:
  - Enhanced virtual care capabilities such as augmented reality-enabled medical consultations and diagnoses
  - Enhanced personalized treatment enabled by continuous monitoring devices and big data analytics
  - Remote-delivered training of medical personnel leveraging virtual and augmented reality capabilities
  - Equipment monitoring to continuously monitor equipment health to optimize utilization and reduce downtime
  - Remote-operated surgeries delivered by robots
  - Smart buildings applications to optimize energy use
- Importantly, fixed wireless access (FWA) using 5G networks will allow network operators to deliver ultra-high-speed broadband internet over a wireless network to homes and businesses in rural and remote regions where last-mile fibre is unfeasible, and will expand the reach of virtual care models to remote communities and homes. As well, 5G will deliver new interactive capabilities built on augmented and virtual reality, and artificial intelligence technologies that enhance the quality of life for those living with disabilities.
- One estimate suggests 5G will drive global productivity gains of US\$530 billion in the health care sector by 2030. A corresponding estimate for Canada is that 5G will drive between CAN\$10 billion to \$15 billion in productivity gains by 2030.

---

**Industry overview:** Access to an effective and efficient healthcare ecosystem is crucial to how individuals perceive their quality of life. The healthcare sector accounts for approximately 10% of

total global GDP.<sup>1</sup> In Canada, total health expenditure as a proportion of GDP has risen to 12.7% in 2021<sup>2</sup> from 7.0% in 1975.<sup>3</sup> Today, insufficient public funding is challenging Canadian healthcare providers and recipients. Three studies indicate that Canada's healthcare does not compare favorably to peer countries, as highlighted in the key findings summarized below.<sup>4</sup>

### Challenges faced by the healthcare industry:

1. **Escalating healthcare expenditures:** According to the World Health Organization (WHO), there is a worldwide health worker shortage that is jeopardizing social services and sustainable health systems. "The world will need 18 million additional health workers by 2030, primarily in low- and middle-income countries, including 9 million nurses and midwives."<sup>5</sup> A Fraser Institute study of 28 OECD countries<sup>6</sup> suggests that "there is an imbalance between the value Canadians receive and the relatively high amount of money they spend on their healthcare system. Although Canada ranks among the most expensive universal-access healthcare systems in the OECD, its performance for availability and access to resources is generally below that of the average OECD country, while its performance for use of resources and quality and clinical performance is mixed."<sup>7</sup> The study finds that, after adjusting for age, "Canada ranks second highest for healthcare expenditure as a percentage of GDP and 10<sup>th</sup> highest for healthcare expenditure per capita."<sup>8</sup>
2. **Fewer human and capital medical resources per capita:** Canada has fewer human and capital medical resources per capita when compared to other high-income OECD countries with universal healthcare. The Fraser Institute Study finds that, after adjusting for age, "Canada ranks 26<sup>th</sup> for physicians, 13<sup>th</sup> for nurses, 26<sup>th</sup> for curative (acute) care beds (out of 27), and 25<sup>th</sup> for psychiatric care beds per thousand population."<sup>9</sup>

<sup>1</sup> Link to source: <https://data.worldbank.org/indicator/SH.XPD.CHEX.GD.ZS>

<sup>2</sup> Link to source: <https://www.cihi.ca/en/national-health-expenditure-trends-2021-snapshot/>.

<sup>3</sup> Link to source: <https://www.cihi.ca/sites/default/files/document/nhex-trends-narrative-report-2019-en-web.pdf>.

<sup>4</sup> Link to sources: 1) <https://www.fraserinstitute.org/sites/default/files/comparing-health-care-countries-2019.pdf>; 2) <https://www.commonwealthfund.org/publications/fund-reports/2021/aug/mirror-mirror-2021-reflecting-poorly>; 3) <https://www.fraserinstitute.org/sites/default/files/waiting-your-turn-2020-execsum-national.pdf>. The challenges identified for the healthcare sector are more specific to Canada as opposed to other industry sectors in this report where the challenges are more generalized. Key factors that may be responsible for this underperformance are: 1) 5th highest rural population among G10 nations; 2) lowest population density among G10 nations; 3) highest population growth amongst G10 nations; and 4) 2nd highest migrant population amongst G10 nations.

<sup>5</sup> Link to source: <https://www.who.int/news-room/photo-story/photo-story-detail/urgent-health-challenges-for-the-next-decade>.

<sup>6</sup> The countries included for comparison in this study were chosen based on the following three criteria: 1) must be a member of the OECD; 2) must have universal (or near-universal) coverage for core-medical services; 3) must be classified as a "high-income" country by the World Bank. Of 35 OECD members in 2017 considered for inclusion, the OECD (2017) concluded that six countries - Chile, Greece, Mexico, Poland, the Slovak Republic, and the United States did not have universal (or near-universal) coverage for core medical services. Of the 29 countries remaining for consideration, Turkey does not meet the criteria of being classified in the high-income group (in 2017) according to the World Bank (2019). The remaining 28 countries that meet the three criteria above are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Slovenia, Spain, Sweden, Switzerland, and the United Kingdom.

<sup>7</sup> Link to source: <https://www.fraserinstitute.org/sites/default/files/comparing-health-care-countries-2019.pdf>.

<sup>8</sup> Ibid.

<sup>9</sup> Ibid.



3. **Fewer technology and diagnostic imaging resources:** Canada has, on an age-adjusted basis, fewer medical technologies than the average high-income OECD country with universal healthcare for which comparable inventory data is available. The Fraser Institute Study finds that, on a per million population basis and after adjusting for age, “Canada ranks 21<sup>st</sup> (out of 26) for MRI units, 21<sup>st</sup> (out of 27) for CT scanners, 17<sup>th</sup> (out of 22) for PET scanners, 2<sup>nd</sup> (out of 21) for Gamma cameras, and 12<sup>th</sup> (out of 19) for Mammographs.”<sup>10</sup>
4. **Mediocre performance on use of resources:** Canada’s performance in terms of resource efficiency is mixed. The Fraser Institute Study finds that, after adjusting for age, “Canada ranks 9<sup>th</sup> (out of 26) for the number of doctor consultations per capita, 28<sup>th</sup> (out of 28) for hospital discharge rates per 100,000 population, 14<sup>th</sup> (out of 25) for MRI examinations per thousand population, and 12<sup>th</sup> (out of 25) for CT scans per thousand population.”<sup>11</sup>
5. **Low performance on timeliness and access to resources:** Canada’s timeliness of healthcare access ranks relatively low against other countries with universal healthcare systems. According to the Fraser Institute study, “Canada is tied for last place (out of 10) for the percentage of patients able to make a same-day appointment when sick and ranks 4<sup>th</sup> (out of 10) for the percentage of patients who report that it is very or somewhat easy to find care after hours. Canada placed last among 17 countries ... on the percentage of patients who reported waiting more than four weeks for an appointment with a specialist. Canada also ranked worst (10<sup>th</sup> out of 10) for the percentage of patients who reported waiting two months or more for a specialist appointment and worst (10<sup>th</sup> out of 10) for the percentage of patients who reported waiting four months or more for elective surgery.”<sup>12</sup> Moreover, “Canada performed worse than the 10-country average on the indicator measuring the percentage of patients who found that cost was a barrier to access, ranking 7<sup>th</sup> out of 10.”<sup>13</sup> Canada also has the lowest hospital discharge rate per 100,000 population of the 28 countries evaluated in the study.<sup>14</sup>
6. **Ageing global population puts yet another pressure on the healthcare system:** Populations in the West and the East are aging rapidly. The number of people aged 65+ years is projected to increase from 8.5% of total global population in 2015 to 12% of total global population by 2030 and to 16.7% by 2050.<sup>15</sup> According to the 2021 Census, roughly 22% of working age Canadians are aged 55 to 64 – an all-time high in the history of Canadian censuses.<sup>16</sup> As a growing number of workers leave the workforce in the years ahead, a smaller cohort of the working-age population will need to work harder to maintain

---

<sup>10</sup> Ibid.

<sup>11</sup> Ibid.

<sup>12</sup> Ibid.

<sup>13</sup> Ibid.

<sup>14</sup> Ibid.

<sup>15</sup> Link to source: [https://www.researchgate.net/profile/Paul-Kowal/publication/299528572\\_An\\_Aging\\_World\\_2015/links/56fd4be108ae17c8efaa1132/An-Aging-World-2015.pdf](https://www.researchgate.net/profile/Paul-Kowal/publication/299528572_An_Aging_World_2015/links/56fd4be108ae17c8efaa1132/An-Aging-World-2015.pdf).

<sup>16</sup> Link to source: <https://www150.statcan.gc.ca/n1/daily-quotidien/220427/dq220427a-eng.htm?CMP=mstatcan>.



Canada's standard of living, to support the production of goods and services and bear the financial burden of the increasing social service needs, including healthcare, for the aged.

7. **Climate change will continue to aggravate the health crisis we are currently facing:** According to the WHO, “air pollution accounts for approximately 7 million deaths every year, while climate change causes more extreme weather events, exacerbates malnutrition and fuels the spread of infectious diseases such as malaria. The same emissions that cause global warming are responsible for more than one-quarter of deaths from heart attack, stroke, lung cancer and chronic respiratory diseases.”<sup>17</sup>
8. **Medication errors and adverse drug events continue to drive unnecessary costs, decreased patient satisfaction and a growing lack of trust in the healthcare system:** Unsafe medication is responsible for considerable and potentially avoidable morbidity and mortality. Medication safety issues can adversely impact health outcomes, increase time spent in the hospital, increase re-admission rates, and increase overall costs to an already-expensive healthcare system.<sup>18</sup> It is estimated that preventable medication hospitalizations cost more than CA\$140 million in direct and indirect healthcare expenditures, with an additional CA\$12 million in costs stemming from lost productivity. Globally, these costs are estimated to exceed CA\$55 billion.<sup>19</sup>
9. **Rural populations continue to encounter barriers to healthcare that limit their ability to obtain the care they need:** Access to quality healthcare in remote/rural areas is another critical challenge for the world. According to the Canadian Institute for Health Information, “significant differences exist between urban and rural populations in terms of health status, health behaviors, health service use, costs and outcomes. In general, rural residents have direct access to a much smaller number and scope of health services and providers than urban residents. Decision-makers and planners frequently face challenges regarding the availability, capacity, sustainability and performance of rural health systems.”<sup>20</sup> In Canada, rural populations in Canada are generally older, less affluent and sicker. Almost one-fifth of Canadians (18%) live in rural communities, but they are served by only 8% of the physicians practicing in Canada.<sup>21,22</sup> These communities face ongoing challenges in recruiting and retaining family physicians and other healthcare professionals. People in rural areas face more difficulty accessing the healthcare system than their urban counterparts, and when they do access healthcare, they have poorer outcomes.<sup>23</sup>

<sup>17</sup> Link to source: <https://www.who.int/news-room/photo-story/photo-story-detail/urgent-health-challenges-for-the-next-decade>.

<sup>18</sup> Link to source: <https://www.patientsafetyinstitute.ca/en/NewsAlerts/News/pages/medication-without-harm-2018-09-14.aspx>.

<sup>19</sup> Ibid.

<sup>20</sup> Link to source: <https://www.cihi.ca/en/rural-health-care-in-canada>

<sup>21</sup> Link to source: Canadian Institute for Health Information. Supply, distribution, and migration of physicians in Canada 2015-data tables. Ottawa, ON: Canadian Institute for Health Information; 2016. Data accessed at: <https://secure.cihi.ca/estore/productSeries.htm?pc=PCC34>.

<sup>22</sup> Link to source: [https://www.cfpc.ca/CFPC/media/Resources/Rural-Practice/ARFM\\_BackgroundPaper\\_Eng\\_WEB\\_FINAL.pdf](https://www.cfpc.ca/CFPC/media/Resources/Rural-Practice/ARFM_BackgroundPaper_Eng_WEB_FINAL.pdf).

<sup>23</sup> Link to source: <https://www.doi.org/10.25318/82-003-x201900500001-eng>.



10. **Persistent and growing socio-economic gaps are driving major discrepancies in the quality of people’s health:** According to the WHO, “the global rise in noncommunicable diseases, such as cancer, chronic respiratory disease and diabetes, has a disproportionately large burden on low- and middle-income countries and can quickly drain the resources of poorer households.”<sup>24</sup> The world spends far more money responding to disease outbreaks, natural disasters and other health emergencies than it does on preparation and prevention. It is not a matter of *if* another COVID-19 type pandemic will strike, but rather *when*. Meanwhile, climate change is inducing the migration of mosquito populations into new areas and consequently causing further spread of vector-borne diseases such as dengue, malaria, Zika, chikungunya and yellow fever.<sup>25</sup>
11. **Patients demand similar experience levels with healthcare as they do with other services:** Quality of care has become very important to patients, and they have more options today as to how and with whom they get their care. They are demanding transparency of data and processes, and privacy and security assurances for personal records. Patient advocacy groups and the patients themselves, armed by social media, are pushing for deeper investigations of matters such as medication errors and hospital-acquired infections.
12. **Other healthcare challenges:** There are numerous other healthcare challenges, including a lack of transportation to healthcare centres, cumbersome hospital registration systems, and a hierarchical medical system. Another common phenomenon in developing countries and regions is overcrowding in hospitals, resulting in overloaded medical staff. An imbalance of health resources, including medical equipment and well-trained practitioners, causes large numbers of patients to travel from rural areas to urban areas seeking high-quality health service. Medical staff, in the provision of healthcare services, rely heavily on their own experience rather than data.

Enhancements to services enabled 5G such as remote robotic surgery, remote patient monitoring, telemedicine, clinical collaboration and communication, medical sensors, connected ambulances, computer-aided diagnostics, and medical imaging will allow both patients and the healthcare ecosystem to mitigate or possibly eliminate these challenges. Enhancement of current technologies and applications and the introduction of innovative technologies and applications like 5G are revolutionizing patients’ ability to prevent, diagnose and treat many diseases. This new 5G enabled ecosystem will align with the recent phenomenon of 4P medicine – predictive, preventative, personalized and participatory. 5G will also allow more rural/remote post-acute care and home-based models, with savings greater than 30% and better patient outcomes.<sup>26</sup>

Potential Digital Solutions Supported by 5G	Types of 5G Capabilities Leveraged
1. <b>Continuous monitoring</b> via wearable and other 5G-enabled sensory devices will “facilitate continuous monitoring of patients. Superior monitoring capability means that 5G can	1. <b>Ultra-low and predictable latencies with quality-of-service guarantees (URLLC)</b> - even with a heavy load and many users.

<sup>24</sup> Link to source: <https://www.who.int/news-room/photo-story/photo-story-detail/urgent-health-challenges-for-the-next-decade>.

<sup>25</sup> Ibid.

<sup>26</sup> Link to source: <https://www.accenture.com/acnmedia/PDF-146/Accenture-5G-WP-US.pdf>.



<p>substantially increase the effectiveness of preventative care. By doing so, it can lower the burden of chronic disease [on] healthcare systems in the developed world.”<sup>27</sup></p> <ol style="list-style-type: none"><li><b>Predictive analytics</b> capability harnesses the data generated from continuous monitoring and augments it further. “While continuous monitoring will power the development of new data streams, the use of distributed computing – the processing of patient data nearer to the patient – will power predictive analytics and intelligent care based on those new data streams.”<sup>28</sup></li><li><b>Remote diagnosis and imaging</b> enable the application of virtual reality, “which can have important benefits in the delivery of medical care (e.g., in the diagnosis and treatment of critical medical episodes such as strokes).”<sup>29</sup></li><li><b>Remote surgery</b>, also known as telesurgery, enables a doctor to perform surgery on a patient even though they are not physically in the same location. It is a form of telepresence; a robot surgical system generally consists of one or more arms (controlled by the surgeon), a master controller (console) and a sensory system giving feedback to the user.<sup>30</sup></li><li><b>Image transfer</b> enables medical image sharing to facilitate transfers between other care facilities that may or may not be on the same network and to referring physicians in the community, as well as directly to patients.<sup>31</sup></li><li><b>AR/VR-enabled healthcare</b> enables applications including medical training, surgical planning, pain management, patient care management and mental health treatment.<sup>32</sup></li><li><b>Drone-enabled medical service delivery</b> enables the fast delivery of vaccines, medications and supplies right to the source. This capability could help avoid unnecessary direct contact between individuals and limit outbreaks of life-threatening communicable diseases.<sup>33</sup></li><li><b>Equipment monitoring</b> enables “hospital management [to] continuously monitor technology readiness and functional status of devices. ... Additionally, the hospital equipment management</li></ol>	<ol style="list-style-type: none"><li><b>Extremely high bandwidth for data transmission (eMBB)</b>, enabling transfer and download of massive data files, high-resolution images, videos and supporting AR/VR.</li><li><b>Massive IoT (mIoT)</b> - 5G will be able to facilitate a large network of IoT devices and sensors.</li><li><b>Fixed wireless access (FWA)</b> - ubiquitous and low-cost networks in rural areas.</li><li><b>More deployment flexibility</b> for sparse and dense options.</li><li><b>Mobility capabilities to ensure a smooth handover</b> between base stations.</li><li><b>Reliability of device interoperability</b> and low device cost at scale.</li><li><b>Location awareness</b> for navigating, real-time locating, and positioning.</li></ol>
--	--

<sup>27</sup> Link to source: <https://haas.berkeley.edu/wp-content/uploads/5g-mobile-impact-on-the-health-care-sector.pdf>.

<sup>28</sup> Ibid.

<sup>29</sup> Ibid.

<sup>30</sup> Link to source: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7136105/>.

<sup>31</sup> Link to source: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8764898/>.

<sup>32</sup> Link to source: <https://healthtechmagazine.net/article/2020/11/what-does-future-hold-ar-and-vr-healthcare>.

<sup>33</sup> Link to source: [https://healthmanagement.org/uploads/article\\_attachment/autonomous-deliver-of-medical-material-through-drones-in-a-future-pandemic.pdf](https://healthmanagement.org/uploads/article_attachment/autonomous-deliver-of-medical-material-through-drones-in-a-future-pandemic.pdf).



<p>system gathers other parameters such as localization of the tools, intrahospital mobility and usage rates.”<sup>34</sup></p> <p>9. <b>Interactive smart pharmaceuticals</b> promote medication compliance. “Smart inhalers or insulin pens and similar devices equipped with an embedded subscriber identity modules (eSIM) can record their application. Additionally, these devices might implement sensors and algorithmic functions to estimate the medication effect on the patient and consequently predict critical situations. These devices may also support personalized medication dose management and precision medicine.”<sup>35</sup></p> <p>10. <b>Digital twin</b> enables location-independent patient assessment by retrieving patient data from different repositories, including “ad hoc retrieval and volume rendering of extensive image volume data and bidirectional communication for dynamic and interactive research of dedicated aspects on remote devices.”<sup>36</sup></p> <p>11. <b>Distributed AI</b> enables services for personalized medicine by leveraging AI and patient data algorithms to provide personalized treatment.<sup>37</sup></p> <p>12. <b>Tele-assistance and telecare</b> allow healthcare operators to provide service to individuals in logistically challenging areas, particularly remote/rural areas. “5G-based, hands-free augmented reality technology has a strong potential for remote medical consultations in real-time under hygienic conditions.”<sup>38</sup></p>	
Potential Operational Benefits	Potential ESG Benefits
<ol style="list-style-type: none"> <li><b>Facilitate a transition from volume-based fee-for-service models of medical delivery to outcome-based models</b> with the support of superior health informatics.</li> <li><b>Decrease medication and medical errors</b> while simultaneously increasing medication compliance with enhanced informatics and interactive smart pharmaceuticals.</li> <li><b>Train new surgeons or guide a surgeon in a remote area through a complex operation in real-time</b> with the support of high-resolution image feeds from operating room cameras.</li> <li><b>Allow physicians and researchers to access aggregated information and accumulated knowledge on the latest evidence, diagnosis,</b></li> </ol>	<ol style="list-style-type: none"> <li><b>Delivery of healthcare services to rural and underserved communities</b> which have poor access to healthcare; Doctors, especially specialists, have limited areas in which they practice, but by using telemedicine, primary care doctors on-location can consult with specialists anywhere in the world. 5G enables safe, secure and state-of-the-art telesurgery. [U.N. SDG - 1, 2, 5, 8, 10 and 14]</li> <li><b>Decrease medical waste, energy use and, thereby, GHG emissions</b> with better supply chain forecasting, more efficient facilities and equipment maintenance, and climate controls. [U.N. SDG - 12]</li> </ol>

<sup>34</sup> Link to source: <https://5g-health.org/wp-content/uploads/2020/11/5G-Health-Whitepaper-V1.pdf>.

<sup>35</sup> Ibid.

<sup>36</sup> Ibid.

<sup>37</sup> Ibid.

<sup>38</sup> Ibid.



<p><b>and treatment trends</b> through the transfer of high-resolution scans, tests and data-heavy files instantly using cloud-based solutions like Share XR. This creation and rapid movement of data, combined with predictive analytics and machine learning, will not only advance the state of medicine and health outcomes but our understanding of the human condition itself.</p> <p>5. <b>Save money for hospitals and healthcare facilities by</b> helping medical practitioners work from home for some tasks; This frees up facility office space, provides access to doctors and nurses who work outside of the area, and facilitates online training and collaboration opportunities.</p> <p>6. <b>Reduce costs through higher usage, lower downtime and more effective and efficient equipment maintenance</b> through real-time monitoring and diagnosis of hospital equipment and devices.</p> <p>7. <b>Eliminate some human steps</b> by delivering medicine to the bedside of a patient from the pharmacy with the help of small indoor drones. This would lead to more rapid and less error-prone administration of medications. Nurses and pharmacists can work more efficiently as supplies can be summoned to the bedside instead of the time-consuming task of gathering necessary items. Drones could also deliver medications and supplies to patients being cared for in the home instead of in a hospital-based setting. The future will see more outpatient care and even home-based care that used to be delivered in the hospital. For many conditions, drone technology may make it easier and safer to provide this home-based care.</p>	<p>3. <b>Improved worker health and safety</b> by using robots and drones for tasks where human involvement may be tedious or dangerous. [U.N. SDG - 3]</p> <p>4. <b>Shift of skills</b> and access to better professional jobs; empower patients, informal carers and lesser qualified professionals; in-field AR support for e-learning and expert advice in remote areas. [U.N. SDG - 8]</p> <p>5. <b>Improved patient outcomes and satisfaction while potentially reducing readmissions</b> by interlinking health and social care and engaging care in proactive healthcare and wellness. [U.N. SDG - 3]</p> <p>6. <b>Increased transparency of data, treatment and decisions</b> (access, audit trail, better reporting of data security, third party access); ability to restrict information to needs. [U.N. SDG - 3]</p>
Estimated Economic Benefits	Example Metrics Potentially Impacted by 5G
<p>1. 5G applications in healthcare could add an estimated US\$530 billion<sup>39</sup> to global GDP by 2030. Extrapolating the study's results to Canada, estimated productivity gains could be between CAN\$10 billion to \$15 billion by 2030.<sup>40</sup></p> <p>2. Virtual care can generate up to \$150 million on cost savings annually for Canada, by reducing travel times to appointments, missed appointment, and unnecessary emergency room visits.<sup>41</sup></p>	<p>1. Access to the 5G network</p> <p>2. Number of 5G-enabled digital solutions implemented</p> <p>3. Estimated total value realized from 5G enabled digital solutions implemented</p> <p>4. Decrease in patient wait times</p> <p>5. Decrease in the number of mistake events</p> <p>6. Decrease in readmission rate</p> <p>7. Decrease in medication errors</p> <p>8. Decrease in the rate of complications</p> <p>9. Decrease in the post-procedural death rate</p> <p>10. Decrease in the average length of stay</p> <p>11. Increase in bed/room turnover</p>

<sup>39</sup> Link to source: <https://www.pwc.com/gx/en/tmt/5g/global-economic-impact-5g.pdf>.

<sup>40</sup> Based on World Bank and Statistics Canada data, and Deetken analysis.

<sup>41</sup> Link to source: [https://www.rand.org/content/dam/rand/pubs/research\\_briefs/RBA1200/RBA1274-1/RAND\\_RBA1274-1.pdf](https://www.rand.org/content/dam/rand/pubs/research_briefs/RBA1200/RBA1274-1/RAND_RBA1274-1.pdf).

	<ol style="list-style-type: none"> <li>12. Decrease discharge process time</li> <li>13. Increase in equipment utilization rate</li> <li>14. Decrease in equipment maintenance costs</li> <li>15. Decrease in response times for patient transport services</li> <li>16. Increase in patient confidentiality</li> <li>17. Decrease in energy usage</li> <li>18. Decrease in average cost per discharge</li> <li>19. Decrease in average treatment cost</li> <li>20. Decrease in the number of patient complaints filed</li> <li>21. Increase in overall patient satisfaction</li> <li>22. Increase in percentage of medical documents translated</li> <li>23. Increase in training per department and percentage of employees that find internal training useful</li> <li>24. Increase in care access to remote/rural areas</li> </ol>
--	---

### Select case studies:

Virtual Reality Training for Healthcare Workers <sup>42</sup>	
Background	<ul style="list-style-type: none"> <li>▪ A 2017 survey of 107 orthopaedic surgeons found that 80% would like to use VR frequently for training and 90% would suggest VR training to their peers.</li> <li>▪ The Johnson &amp; Johnson Institute has launched a new global VR training programme for surgeons and nurses, with more than 50 sets of VR equipment worldwide. The programme includes VR training modules that allow surgeons to improve their techniques across three types of orthopaedic surgery: total knee replacement; total hip replacement with direct anterior approach; and hip fracture treatment with a proximal femoral nail.</li> </ul>
Improvement areas	<ul style="list-style-type: none"> <li>▪ 5G mobile broadband capabilities allow for the simulation of a real-world experience in the operating room, including anatomical accuracy, via all the instruments and implants featured in VR training.</li> <li>▪ VR training is highly scalable and can thus reduce time and resources spent on training overall.</li> <li>▪ VR training programs reduce the need to travel to receive training.</li> </ul>
Economic and societal impacts	<ul style="list-style-type: none"> <li>▪ VR training provides cost savings for patients due to greater local availability of medical skills.</li> <li>▪ VR training modules provide advanced skill enhancement for doctors and support staff and drive greater patient outcomes. <a href="#">[U.N. SDG 3]</a></li> <li>▪ The acquisition of new professional skills can lead to increased revenue opportunities.</li> <li>▪ The use of VR reduces carbon emissions due to reduced travel requirements to attend training programmes.</li> </ul>
5G capabilities used	<ul style="list-style-type: none"> <li>▪ eMBB</li> </ul>
CapEx requirements	<ul style="list-style-type: none"> <li>▪ VR headsets, motion control devices, surgical training tools and digital infrastructure.</li> </ul>

<sup>42</sup> Link to source: [https://www3.weforum.org/docs/WEF\\_The\\_Impact\\_of\\_5G.pdf](https://www3.weforum.org/docs/WEF_The_Impact_of_5G.pdf).



Virtual Reality Training for Healthcare Workers <sup>42</sup>	
Maturity timeline	<ul style="list-style-type: none"> <li>Current state: 4K streaming and faster delivery of training programmes.</li> <li>Short-term: gamified training simulations that lead to immersive surgery techniques.</li> <li>Long-term: enhanced remote training opportunities using the internet of medical skills combined with haptic feedback and robotics</li> </ul>

5G-enabled Healthcare Solutions for Hospitals <sup>43</sup>	
Background	<ul style="list-style-type: none"> <li>Hospitals have rigid demands to improve patient healthcare services. More than 20 new services, with more demanding requirements, are expected to enter the new medical ecosystem.</li> <li>Clinical information is not shared across medical institutions due to inconsistent information system standards, thereby resulting in low utilization of medical data resources.</li> <li>Futian Medical Consortium (FMC), China Mobile, Huawei and other organizations have jointly developed a variety of 5G smart healthcare projects in Shenzhen since 2019. These projects have been carried out in all medical institutions – seven hospitals and 83 community health centres – across the district.</li> </ul>
Improvement areas	<ul style="list-style-type: none"> <li>5G technology, along with multi-edge computing and network slicing, has allowed FMC to utilize a virtual private network that runs on the public network. This solution allows hospitals to quickly scale their services and meet the real-time transmission needs of the large volume of medical devices and applications supported by the network.</li> <li>Use of 5G-enabled tablets and medical carts allow medical staff to perform ward rounds and other daily routines efficiently and conveniently, as well as quickly send and receive medical images and data.</li> <li>Regionally connected smart emergency carts in community health centres support one-click activation and enable users to request remote rescue guidance from experts in superior institutions.</li> <li>5G networks enable ambulances to offer in-hospital-like services such as patient registration and medical record setup. A patient's vital signs and electrocardiogram, as well as the ambulance's location information, can be transmitted to the hospital's emergency command centre in real-time so that hospital staff can be ready prior to the patient's arrival.</li> <li>5G-enabled devices allow experts to provide remote consultations anytime and anywhere, thus breaking restrictions in time and location and improving healthcare access for those in more rural locales.</li> </ul>
Economic and societal impacts	<ul style="list-style-type: none"> <li>The telemedicine market was valued at roughly US\$80 billion in 2020 and is expected to grow to US\$397 billion by 2027.<sup>44</sup></li> <li>5G networks expand medical coverage to rural/remote areas and allow medical personnel and specialists to provide immediate care to patients. [U.N. SDG 3]</li> <li>Transport of patients is reduced due to the availability of 5G-enabled healthcare services from experts at local satellite facilities.</li> </ul>

<sup>43</sup> Link to source: <https://www.gsma.com/greater-china/wp-content/uploads/2021/02/5G-Use-Cases-for-Vertical-China-2021-EN.pdf>.

<sup>44</sup> Link to source: <https://www.fortunebusinessinsights.com/industry-reports/telemedicine-market-101067>.



5G-enabled Healthcare Solutions for Hospitals <sup>43</sup>	
	<ul style="list-style-type: none"><li>5G technology increases capacity for research and innovation. [U.N. SDG 9]</li></ul>
5G capabilities used	<ul style="list-style-type: none"><li>eMBB</li><li>URLLC</li><li>Security critical</li></ul>
CapEx requirements	<ul style="list-style-type: none"><li>Backbone connectivity, AI and big data solutions, data analytics applications, robotics and wearables.</li></ul>
Maturity timeline <sup>45</sup>	<ul style="list-style-type: none"><li>Current state: faster data processing for enhanced and efficient remote patient monitoring.</li><li>Short-term: AR/VR-based healthcare solutions using multi-edge computing.</li><li>Long-term: real-time health systems leveraging the internet of medical skills and machine learning.</li></ul>

<sup>45</sup> Link to source: [https://www3.weforum.org/docs/WEF\\_The\\_Impact\\_of\\_5G.pdf](https://www3.weforum.org/docs/WEF_The_Impact_of_5G.pdf).