

How 5G Influences

3.2 Remote Diagnosis

3.2.1 Home Healthcare with Real-time Monitoring

In Canada, both the patients and the medical institutions are looking forward to new approaches that simplify the arrangements and procedures of medical treatment (Fraser Institute, 2017) (see Figure 9). The main reason lies in the tension between the higher pace of life and the lower medical care efficiency. Many patients cannot get rid of long wait times and high costs at hospitals, while the hospitals find arranging endless appointments of receptions, consultations, and the readmission is labour- and resource-consuming.

5G will provide a secured mobile network between the paramedics and the patients to promote home healthcare. Remote monitoring technologies and devices, such as video chats and various of IoTs, will be more frequently harnessed.

We raise two examples to illustrate how remote diagnosis can be conducted:

a) *Remote Injury Aid*. If one gets injured, the caregiver will instantly get to know the injury situation with the more transparent and detailed connection. As a result, the patient can get timely treatment and prevent further injury or complications.



Figure 9. Long waits for surgery and medical treatment cost Canadians \$1,759 per patient in lost wages in 2016. Adapted from "The Private Cost of Public Queues for Medically Necessary Care," by Fraser Institute, 2017. Retrieved from <https://www.asianjournal.ca/historically-long-health-care-wait-times-cost-canadians-1-7-billion-last-year>

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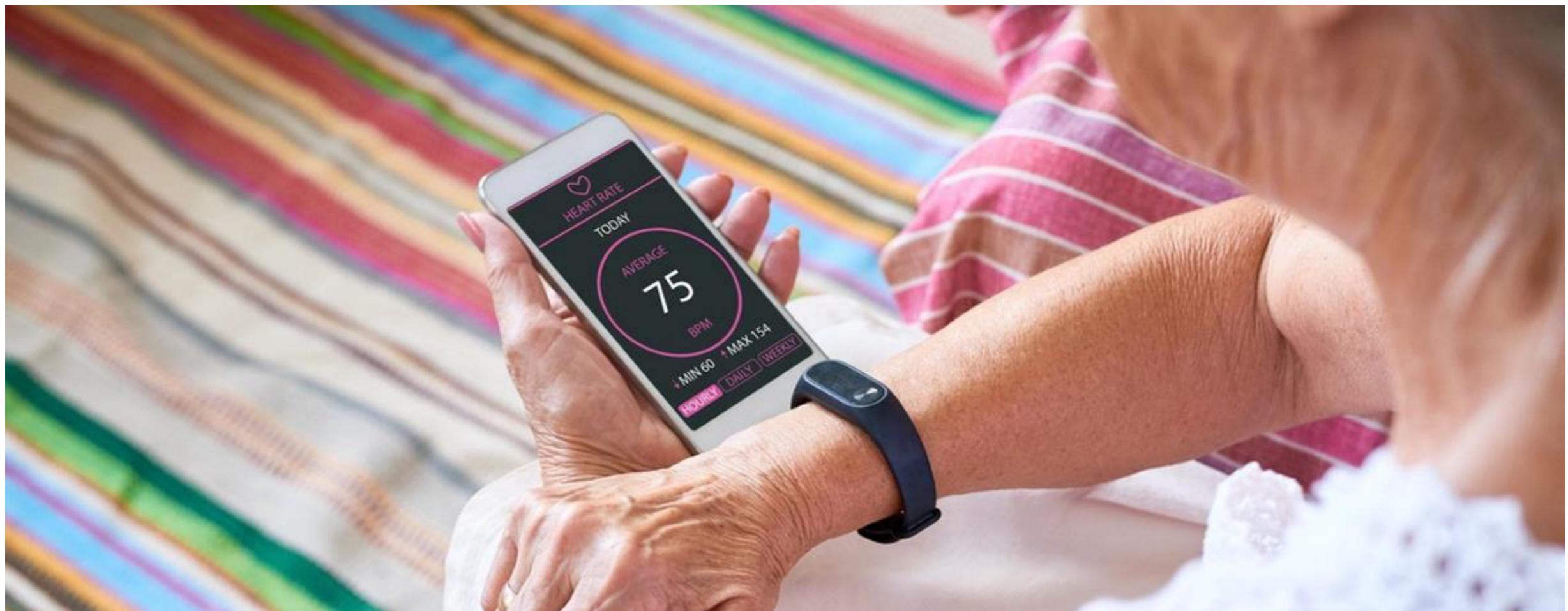


Figure 10. Edmonton's Cross Cancer Clinic. Adapted from "PET MR," by R. Neil, 2018. Retrieved from <https://www.ualberta.ca/medicine/departments/oncology/department-news/2018/may/pet-mr>

b) Remote In-home Care for the Elders. For another instance, 5G will benefit the life of elders. It is said that in North America, some nursing homes and senior care centres have problems maintaining assisted living facilities (Thompson and Jones, 2017), or lack passions in giving elders the best treatment (Larsen, 2018). The real-time

monitoring enables the elders to stay as long as possible in comfort with their families in their homes.

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3.2.2 Emergency Care

5G enables emergency treatment to be handled properly and timely. The ambulance transportation system is based on vehicle GPS analysis and is designed to be the most suitable route. Besides, the ambulance will cooperate with other domains, that is, “connect the health and medical emergency unit with other vehicles (V2V) or infrastructures (V2i)” (5G Barcelona, n.d., para. 1) in order to maximize the time saved.

Ambulances will also use a dedicated channel to allow patients to be treated as soon as possible. The ambulance will be equipped with a series of technologies that can combined with each other. For example, through ultrasonic technologies, the ambulance will forward the patient data in forms of imagery displayed in high definition to the specialist; meanwhile, the hospital staff will use pulses to signal the ambulance personnel (Leprince-Ringuet, 2019).

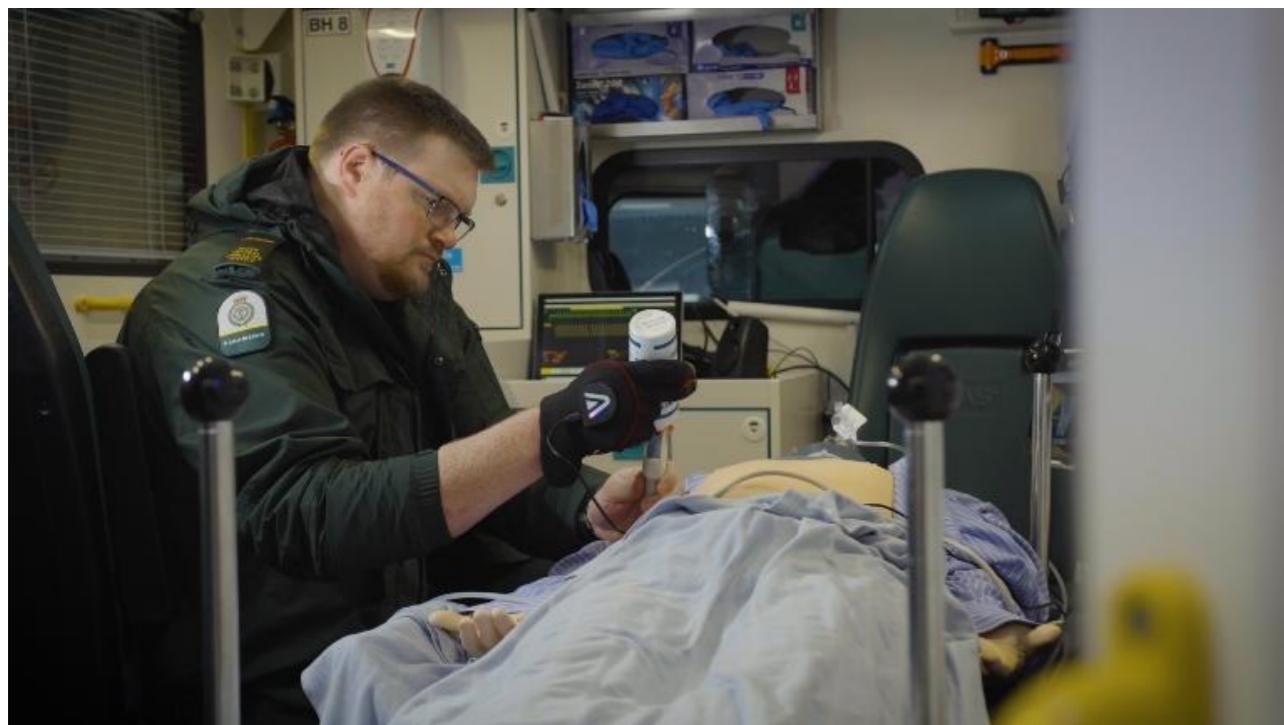


Figure 11. Using robotic gloves in emergency care. Adapted from "This 5G ambulance could be the future of emergency healthcare," by D. Leprince-Ringuet, 2019. Retrieved from <https://www.zdnet.com/article/inside-the-5g-ambulance-that-could-let-doctors-treat-you-miles-from-the-hospital/>

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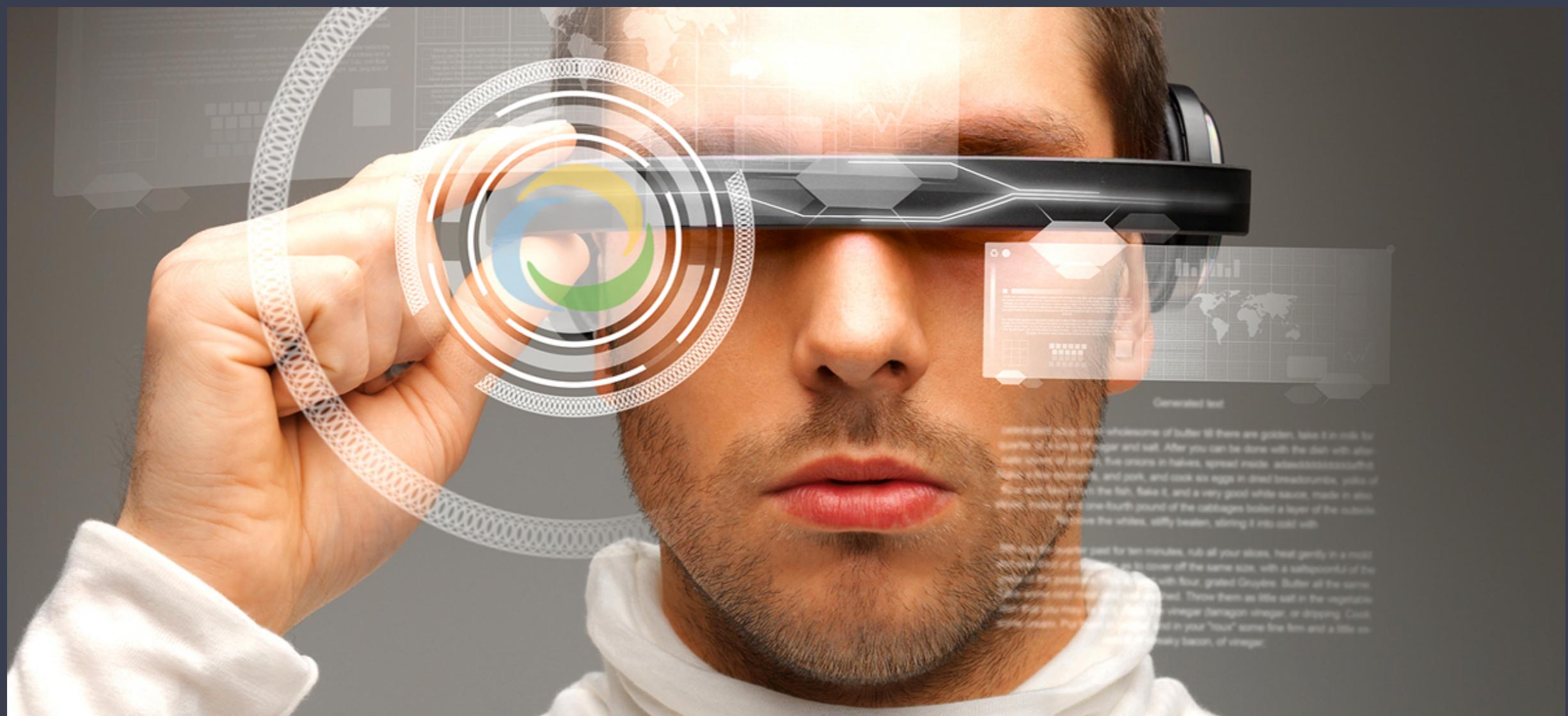


Figure 12. VR is an overwhelming majority of tech giants are poised to help define the next generation of computing (Source: UploadVR)

3.3 VR Medical E-Training

A human body seems to be complicated, structured and delicate machines. Repairing this machine is never simple knowledge to learn nor easy skills to practice. The interns may be required proficient practical skills, such as surgery,

to become qualified doctors, while the medical institution may need to hire specialists to train the future backbone medical talents.

How 5G Influences

VR Medical E-Training could be a white-hot tendency and it has been de facto already adopted by the Faculty of Health Sciences at Queen's University, Canada (Howes, 2018). VR brings a revolutionary brand-new user interface that immerses the learner into a digital 3D environment instead of watching a display. Computer-generated imagery aims at simulating a real presence through senses including sight, hearing and touch.

The imagery received by the learner will also be synchronously forwarded to the other side, where the specialist or mentor can guide and assess the learner's operation. The learning process that overcomes the geographical obstacles is ensured by 5G network. With these devices and simulator software, the interns can practice surgery and land their mistakes before actually going to the operation room.

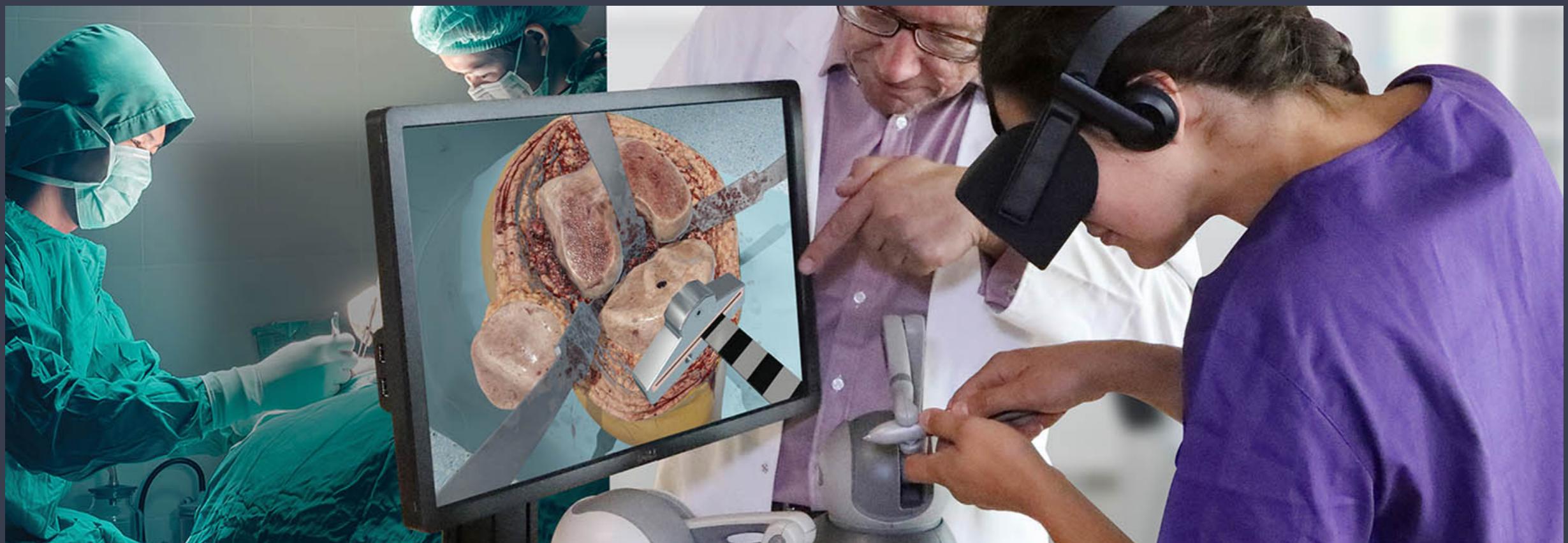


Figure 13. Simulating surgery using VR. Adapted from "Queen's University Launches Canada's First VR Medical Training Centre," by D. Howes, 2018, Queen's University Faculty of Health Sciences, Retrieved from <https://healthsci.queensu.ca/administration>



Part 4

CHALLENGES & CONCLUSIONS

- Authorities and technicians must consider the challenges on costs, technical limitation and various of security issues
- Challenging though its deployment will be, 5G will be witnessed to turn many things non-fictional

Challenges & Conclusions

4.1 Challenges

4.1.1 Costs

The table below shows that the equipment established for 5G technology is costly. It requires the deployment and long-term maintenance provided by skilled engineers (E. J. Oughton, Z. Frias, S. van der Gaast, R. van der Berg, 2019).

On the other hand, costs on the smartphones that support the 5G network will also grow higher. The manufacturers have to invest more in 5G smartphone technological researches and product lines. Moreover, although devices offered in bundled packages vary from one market to another, researchers estimate that monthly payment on 5G plans would be "around \$89 compared with \$68 for 4G" (Safikhani, 2019, para. 9), due to the growth of the need of cellular data browsing.

Strategy	Spectrum integration on macrocellular network				Network densification through small cells			
Cost type	5G multicarrier BS	Additional carrier on current BS	Civil works	Fibre backhaul	Small cell equipment	Small cell civil works	Small cell backhaul	
Unit	BS	Carrier	Cell site	Kilometre	Cell site	Cell site	-	
Capex(€)	45,673	16,750	20,101	22,334	2,791	14,852	-	

Figure 14. Infrastructure Cost of Horizon 2020 5G Norma Project in Netherland. Adapt from "Assessing the capacity, coverage and cost of 5G infrastructure strategies: Analysis of the Netherlands," by E. J. Oughton, Z. Frias, S. van der Gaast, R. van der Berg, 2019, Telematics and Informatics, p. 58.

Challenges & Conclusions



Figure 15. China Unicom is seeking ways to optimize the technology of accessing new media cloud service platform through 5G network. Adapt from "The impact of 5G era on cloud computing," by Huawei Cloud Community, 2019. Retrieved from <https://bbs.huaweicloud.com/blogs/118772>

4.1.2 Technical Limitation

The research and development of 5G and IoTs are still under process (Safikhani, 2019). Besides the tech limitation of 5G itself, some relevant techs such as cloud computing technology need to keep pace with the 5G (Huawei Cloud Community, 2019). As we have explained before, the caregivers need to fetch data from the cloud storage that can be shared with all the stakeholders in medical care processes. The popularization of mature 5G network technology requires the collaboration of cloud storage of high data rate, large capacity and low latency, which might be difficult to reach based on current cloud computing technologies.

Challenges & Conclusions

4.1.3 Security Issues

Recent studies show that IoTs are still considered insecure since it may hurt the patient's privacy. Huge majority of IoT consumers do not trust IoTs and want to know and control what personal information is being collected, and they are concerned that their privacy may be invaded, and their civil rights are about to be threatened (Paul, 2018; Josefsson, 2019).

Another security concern involves the patient's physical security. Thinking of the particularity of the medical care industry, an error or a bug from the mobile application may cause irreversible consequences.



Figure 16. IoTs are not trusted devices and may expose your tracking information some time. Adapted from "3 ways we can boost IoT security," by B. Josefsson, 2019. Retrieved from <https://www.ericsson.com/en/blog/2019/1/3-ways-we-can-boost-iot-security>



Figure 17. Big data sometimes means big chance of being "invaded". Adapted from "People are really worried about IoT data privacy and security—and they should be," by F. Paul, 2018. Retrieved from <https://www.networkworld.com/article/3267065/people-are-really-worried-about-iot-data-privacy-and-securityand-they-should-be.html#nww-fsb>

Challenges & Conclusions

4.2 Conclusion

In summary, the 5G cellular network system will improve and diversify the use of mobile apps, including the software on IoTs, in the medical care industry and will have dramatic impacts on healthcare data management, remote diagnosis and VR medical skill training.

5G is such a beast that will transform all economic sectors and spurs the application and implementation of more new technologies and the rise of new industries. Challenging though its deployment will be, 5G will be witnessed to turn many things non-fictional, and we will enjoy living in all possibility that 5G is going to create.



Figure 18. A technician checks an antenna for the 5G mobile network service on the rooftop of a building in Seoul. Adapted from "Is 5G bad for your health?" by K. R. Foster, 2019. Retrieved from <https://www.brinknews.com/is-5g-bad-for-your-health/>

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