

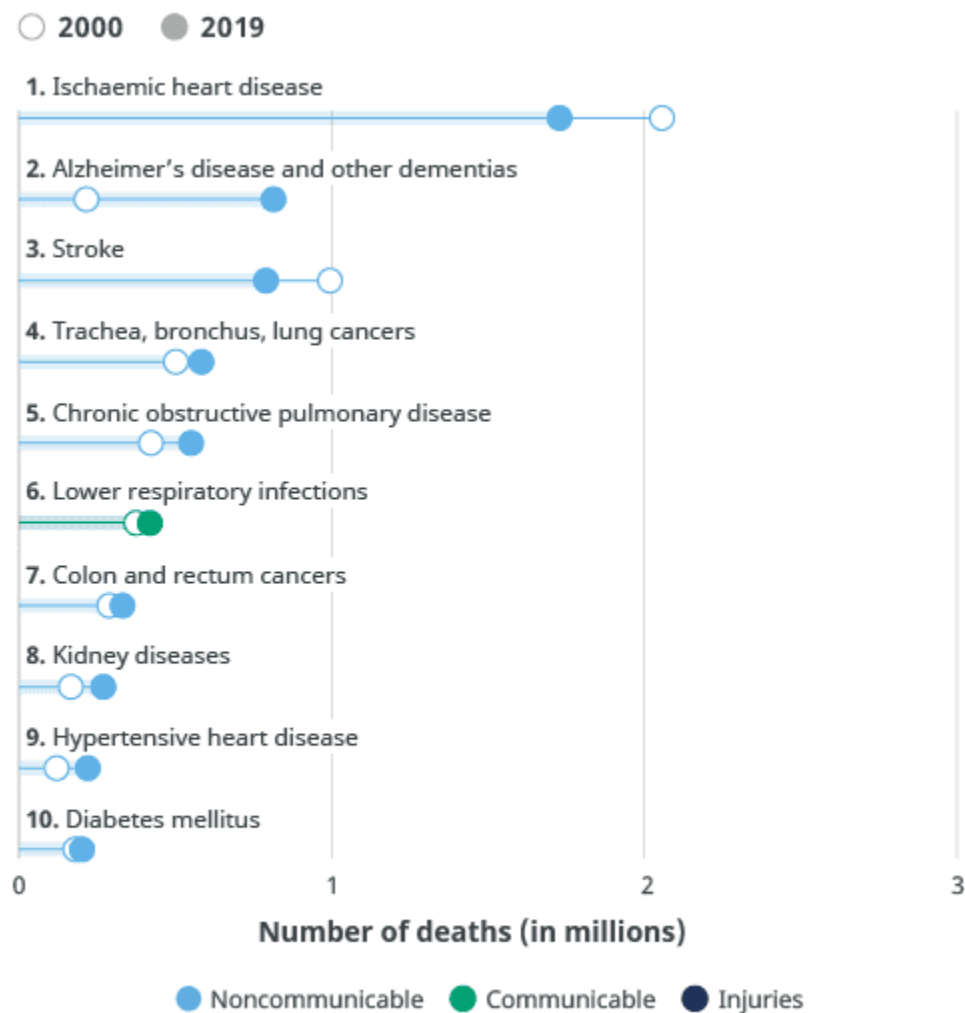
STMicroelectronics and Medtech: Enabling Personalized Healthcare and Wellness through the Integration of Electronics

The healthcare industry is experiencing significant advancements enabled by the increasing integration of new electronic technologies. One example is the development of semiconductor biosensors which have been widely adopted into wearable devices. As a result of these innovations, the U.S. Food & Drug Administration (FDA) recently created a fast-track for product development through the Medical Device Development Tool process (MDDT, 2024). In this article, we share the rationale for STMicroelectronics' (ST) deeper engagement in the healthcare and wellness industry, highlight some opportunities leveraging ST's core competencies to deliver compelling solutions, and discuss some of the challenges in this market. We will also outline some of the approaches taken to enable success in this rapidly expanding market.

The adoption of semiconductor technologies and devices in the healthcare market has been relatively slow compared to other markets such as personal electronics and automotive. Personal electronics take 1-2 years for a device to get to market (Oliver, Deweberry, & Dostaler, 2020) while medical devices take 3-7 years to get to market. (Carol, 2022) The regulatory complexities, the long time-to-market, and the market knowledge overlap with domain experts is relatively low. From a semiconductor industry point-of-view, traditional approaches of relying on the sales of devices or components do not adequately capture the complex system aspects and requirements of healthcare products.

STMicroelectronics is an Integrated Device Manufacturer focused on delivering semiconductor components in the automotive, industrial, and personal electronics markets. We focus on markets with good volume, good margin, long product life cycles, and high barriers to entry. Historically, the medical market meets some of those criteria but generally with much lower volumes than desired. The typical advancements in the electronics industry; enabling devices with low power, small form factor, and high performance, are now coupled with the rise of sophisticated sensor technologies and the beginnings of Artificial Intelligence (AI). We are witnessing a revolution where electronics are now truly personal, increasingly providing health information to the consumer through wearables such as watches, rings, ear buds, patches and

more. This represents a significant step toward enabling cost-effective healthcare. If we consider the relative expense of healthcare where a healthy individual cost is 1X, the cost for dealing with a chronic disease is typically



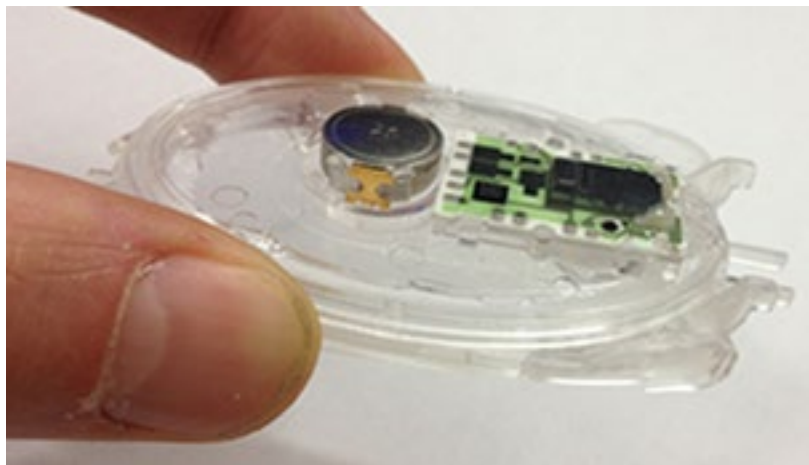
Source: WHO Global Health Estimates. Note: World Bank 2020 income classification.

100X, and if there is need for acute care, then the cost rises higher to 1000X. This aligns with the proverb 'an ounce of prevention is worth a pound of cure'. According to a study by the World Health Organization (2024), in upper middle- and upper-income countries of the world, 9 of the top 10 causes of death were due to non-communicable disease. These were preventable illnesses such as heart disease, pulmonary disease, and diabetes and are typically considered lifestyle diseases.

As we noted above, the *treatment costs*, i.e. 'the cure', for individuals and healthcare systems are massive. On the other hand, if individuals have personal indicators of their state of health at any given time, so-called biomarkers or vital sign monitors, then they have the opportunity to make

personalized decisions - not only to mitigate illnesses, but to promote a healthier lifestyle and eventually prevent illness altogether. We believe that the rise of wearable devices and technologies are at the forefront of enabling a future where healthcare is personalized and integrated with wellness. This comes at an opportune time, during a prolonged decrease in the number of healthcare workers. Having the ability to monitor health indicators remotely facilitates the ability to diagnose and treat conditions remotely which further improves the efficacy of telemedicine.

Before delving into wearable and related devices, it might be instructive to look at an example of the complexities of medical products development. ST partnered with a company for over 12 years to develop and attempt to bring a



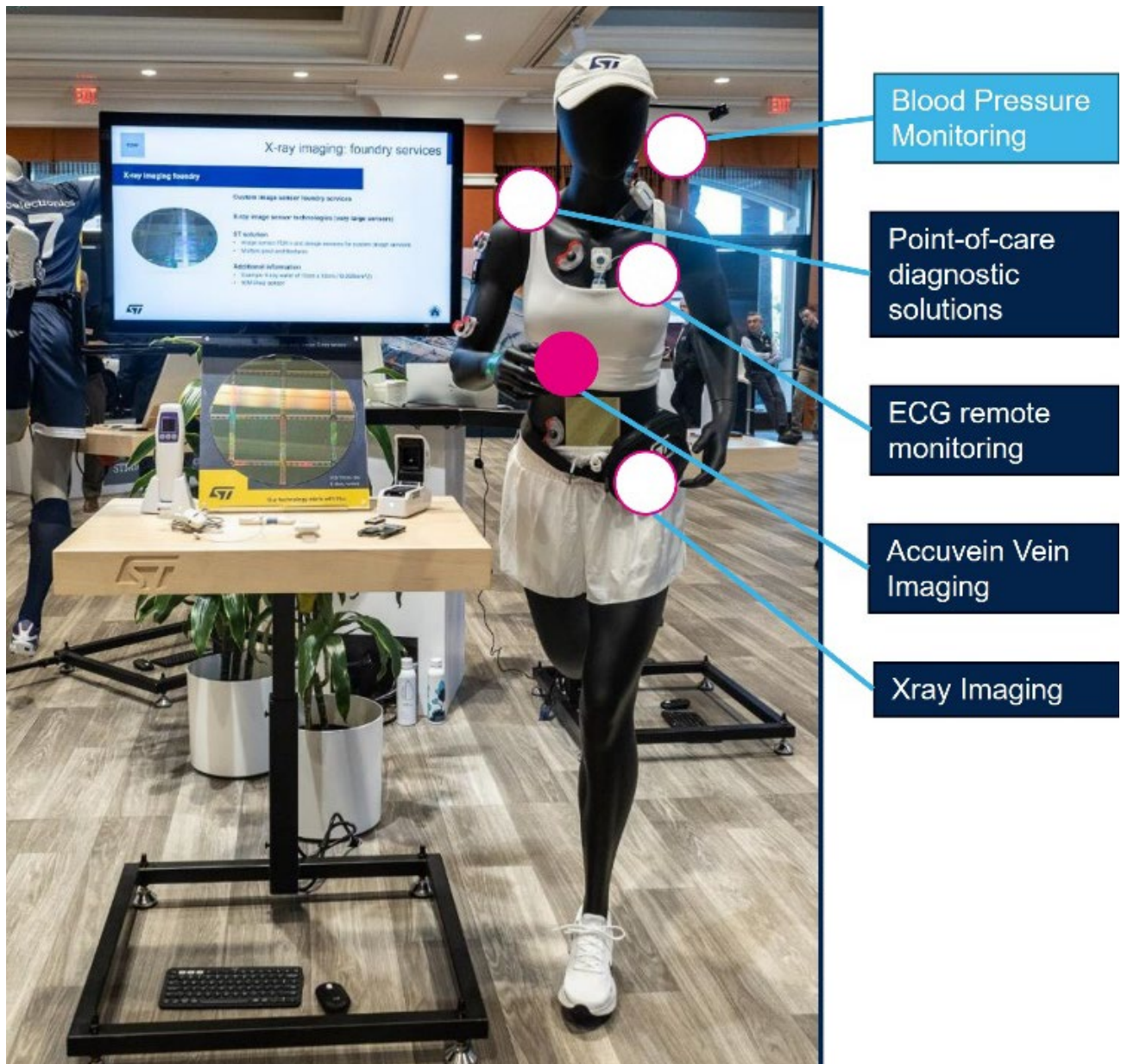
MEMS-based insulin pump to market. The need for multiple development cycles, extensive testing, and significant manufacturing hurdles over an extended time epitomized the challenge of developing 'medical' devices within the company. This included multiple fab

transitions, glass to silicon redesigns, and retirement of entire process modules. Spending a dozen years in development for a single product goes against the grain of the semiconductor industry. On top of this are the complex regulatory requirements involving costly and time-consuming clinical trials. This example shows that, while there is a space for semiconductor type components in medical devices, emphasizing work in wearable devices may provide a better industry fit.

The recent proliferation of wearable devices, many with a high degree of technological sophistication, can facilitate the transition from dedicated medical products to wearable products that integrate specific healthcare or wellness applications - the so-called consumerization of medicine. This can avoid some of the rigorous medical requirements, taking full advantage of the rapid learning curve in semiconductor manufacturing, and devices can evolve with the semiconductor development cycle. An interesting analogy is how the defense and aerospace industry is leveraging civilian technologies,

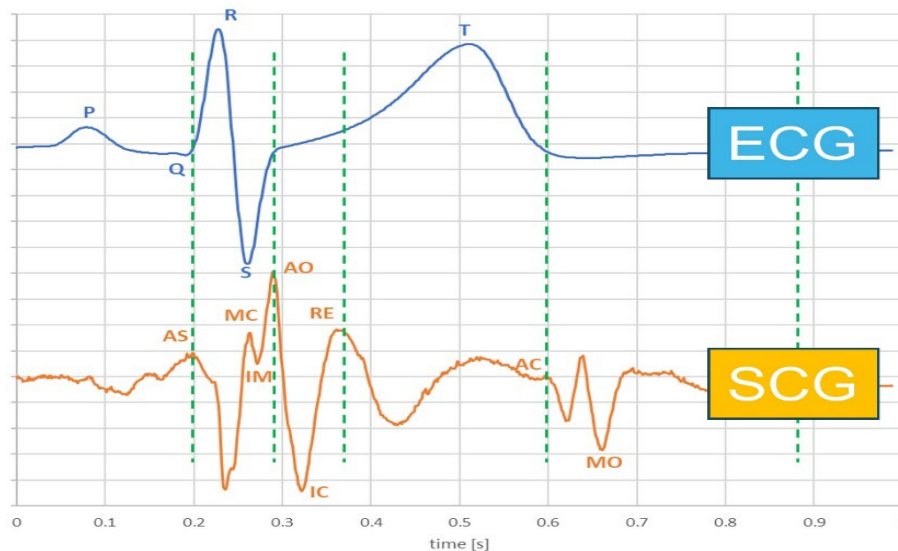
realizing the advantages of the accelerated learning enabled by semiconductor development cycles and high-volume production. One way of thinking about this: “high volume markets enable low volume applications.” This approach is starting to accelerate in the healthcare industry.

To further illustrate this point, consider the diagnosis of an illness or disease where key health indicators are taken, usually known as vital sign monitoring or biomarker monitoring. As an example, in diagnosing and treating hypertension, measurement of blood pressure (BP) is key. High accuracy BP measurement is a central part of the initial diagnosis requiring several measurements in the clinic or physician’s office, sometimes with other potential indicators such as an Electrocardiogram (ECG). From a treatment perspective, having the ability to continuously monitor BP provides considerable insight into the efficacy while monitoring impacts of lifestyle like exercise, diet, and stress. As continuous data is acquired over a longer time horizon, the physician can now monitor the onset of chronic diseases and therefore be more responsive. In this way, wearables provide a path to offer a more integrative approach to healthcare in a personalized way where the patient has better control of their health and appropriate lifestyle changes. Imagine now we can measure multiple vital signs and biomarkers, giving a fuller and more personalized health and wellness profile, both initially and over time. These advancements will revolutionize the delivery of healthcare and promote wellness. By their very nature, wearables can be implemented faster than medical devices, making them easier for semiconductor investment. While ST works with and sells to many medical device companies, ST is not really known as a key player in the medical market – internally or externally. We spent a good deal of time in the last year gathering information across the company and pulling together examples of ST’s current and future engagements in health and wellness. During CES 2025, we had a private ballroom showing ST’s latest and greatest technologies.



As part of this, we showcased 15 active and passive demos showing some of the products that ST has enabled with our partners. This approach has started to improve both internal and external perceptions of ST in the healthcare space.

Semiconductor companies can have different approaches to healthcare and wellness. However, ST's broad portfolio is ideally positioned to address the emerging healthcare market. Our core technologies in sensing, computing, connectivity and power management are fundamental to wearable products. We are using these strengths to create new and interesting solutions. For example, we can leverage an existing product family, by adding a simple analog line into a MEMS sensor. The resultant product provides two unique



signals out of the same device. In our ECG patch reference design with the ST1VAFE3BX accelerometer, we can measure the ECG signal going to the heart and the seismocardiography (SCG) signal coming from the

heart. The SCG measures the chest vibrations, showing each heart valve opening and closing. In one simple component, we have a closed loop measurement – the signal coming in and the resultant operation going out. In a different example, we are building a continuous blood pressure monitor utilizing a pair of accelerometers measuring the pulse wave propagation through the artery. By applying sophisticated AI algorithms to extract blood pressure we create a low-cost measurement solution. We apply our technology and algorithm expertise while partnering with application experts to address this challenge. Our goal is to help change ST's approach in addressing emerging markets – we currently sell components, but we need to offer solutions. Our broad portfolio has historically been developed and marketed as independent components. In the healthcare and wellness space, we must bring a whole system or subsystem design to deliver a solution. By integrating the catalog of individual parts into a cohesive, functional, and interoperable system, we can offer compelling ideas to this new and growing market space.

Healthcare and wellness are rapidly emerging markets for semiconductor companies. There has been relatively slow semiconductor adoption due to

the divergent medical and semiconductor product lifecycles. Wearables provide an opportunity to measure vital signs as well as a range of biomarkers on the body. Atrial Fibrillation and continuous glucose monitoring are just some recent market examples of this. In fact, Dexcom, one maker of a continuous glucose monitor, and Oura, a wearable smart ring that tracks a variety of health metrics, announced a partnership in late 2024 to synchronize data across a human group of devices, instead of just a single wearable device (Dexcom Investor Relations, 2024). As the range of biomarkers that are measured increases, as the volume of these data increases, and with the advent of powerful AI algorithms, personalized healthcare and wellness will be realized. Moreover, with the projected shortfall of healthcare workers worldwide (WHO 2019), wearables will be a critical part of remote healthcare delivery. Earlier we noted the adage that an ounce of prevention is worth a pound of cure. This is absolutely true for the individual. And if ST can help enable wearables, an ounce of prevention is worth a pound of revenue for the company.



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