The impact of obstructive sleep apnoea monitoring functionality on smartwatches: a new frontier for ophthalmologists

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Dawn of a new era in wearable technology?

Smartwatches have really stepped up their game and have evolved from telling time to keeping an eye on our health. In February 2024, the United States Food and Drug Administration (FDA) gave a 'thumbs up' to a cool feature in the Samsung Health Monitor App, compatible with the Galaxy Watch [1]. This software is set to roll out in the third quarter of 2024 and is all about spotting signs of obstructive sleep apnoea (OSA).

Obstructive sleep apnoea is a global health concern. It affects up to 1 billion people all over the world and is linked to serious health issues like heart disease, hypertension, diabetes, and consequently increased morbidity and mortality [2,3]. It is approximated that around 80–90% of OSA cases are undiagnosed [4]. While obesity is by far the largest risk factor for OSA, it can also occur in patients with normal and even low body mass indices, secondary to upper airway pathology such as redundant soft palates and elongated uvula [5].

Given OSA's significant health impact, this new smartwatch feature is pretty big news. At present, the standard diagnostic study used for detection of OSA is polysomnography, in which one would have to spend the night at a sleep centre, hooked up to a bunch of devices tracking oxygen, brain activity, and breathing, just to understand sleep patterns and detect periods of breathing cessation [6]. This new smartwatch technology piggybacks on another FDA-approved OSA diagnostic modality that has been gaining traction in recent years – Home Sleep Apnoea Testing [7]. This test uses specific wearable devices that detect blood oxygen level concentrations during sleep. With the new smartwatch technology, no extra specific wearable devices are required apart from the patient's own smartwatch. It is now possible to identify moderate to severe OSA by monitoring your sleep on two separate occasions, each for more than four hours within a 10-day window, using a smartwatch. During this time, the Galaxy Watch's BioActive Sensor tracks blood oxygen levels and the software estimates an apnoea-hypopnoea index (AHI) based on the number of times blood oxygen levels drop due to partially or fully blocked breathing [8].

It is important to note that the new Galaxy Watch feature is not the only smartwatch technology which has potential value in OSA diagnostics. Apple is also working on its own OSA detection system for its next smartwatch, with older models able to track relevant data such as heart rate changes, sleep disturbances and loud snoring. However, it is currently also trying to navigate a patent lawsuit over its blood oxygen monitoring feature [9]. Other commonly available smartwatches such as Garmin and Fitbit watches also have sleep health tracking abilities [10]. Like the Apple Watch, these are not yet FDA-approved, with Samsung's Galaxy Watch software being the only FDA-approved one to date. Therefore, data collected by these other devices could only at best indicate whether further sleep testing is required. Of note, at present none of these devices are approved for OSA-detection in the EU or UK, including the Samsung Galaxy Watch.

The advent of smartwatch technology enables early detection of OSA, democratising access to diagnostics and identifying patients for potential intervention. Apart from reducing the health burden from untreated OSA, this technological advancement is also anticipated to increase awareness of this condition, consequently leading to heightened concerns among patients regarding the potential ophthalmic manifestations of OSA – a few of which can be sight-threatening.

In response to these implications, we as eye professionals must adopt a comprehensive approach. Firstly, it is essential to stay informed about the latest evidence and research around the ocular manifestations of OSA. Only then would we be able to provide accurate information and appropriate reassurance to concerned patients. Secondly, we need to be part of a collaborative model and multidisciplinary team which involves otolaryngologists, pulmonologists, sleep medicine specialists, dentists, and bariatric surgery specialists. Since a number of treatment options are available, treatment of OSA can be quite complex. Examples include continuous positive airway pressure (CPAP), oral appliance therapy, bariatric surgery, and novel approaches such as hypoglossal nerve stimulation implants.

Ophthalmic manifestations of OSA

There is a broad spectrum of OSA-related ocular comorbidities.

The ocular disorder most correlated with OSA is non-arteritic ischemic optic neuropathy (NAION), with a recent metanalysis by Bulloch, et al. reporting a 3.98-fold increased risk [11]. This correlation is physiologically plausible, given that NAION typically presents as an abrupt, painless, often unilateral, vision loss, frequently upon awakening. The pathogenesis is thought to originate from microvascular infarction of the optic nerve, attributable to nocturnal hypoxaemia affecting the short posterior ciliary artery, likely exacerbated by the sleep disturbances inherent to OSA [12]. Given that there are no treatment options for NAION, it is increasingly important to counsel patients on risk factor reduction, as bilateral NAION is devastating, with up to one quarter of patients presenting with 6/60 or worse vision [13].

Patients with OSA also have a 2.71 times higher chance of developing retinal vein occlusion (RVO), and a 1.49 times higher chance of getting glaucoma [11]. For RVO, the thinking is that hypoxic insult to blood flow autoregulation leads to loss of vessel resilience and sudden vein occlusions. Meanwhile, in OSA-related glaucoma it is believed that repeated events of

hypoxaemia result in ischaemia of the optic nerve [11].

Obstructive sleep apnoea is also linked to anterior segment disorders, such as floppy eyelid syndrome (FES) and keratoconus. For FES, there is 3.68-fold increased risk in OSA patients [11]. Floppy eyelid syndrome is identified by a reduction in eyelid elasticity, leading to ease of eyelid eversion and complications related to the ocular surface. The underlying mechanism is presumed to be mechanical, with patients frequently exhibiting more pronounced symptoms on the side they prefer to sleep on [14]. Likewise, patients with OSA may adopt specific sleeping positions to mitigate their symptoms, indicating a potential overlap in mechanical factors which link the two conditions. For keratoconus, the increased risk is 1.87-fold [11]. However, the pathophysiological basis of this association is less clear-cut. Some suggest that OSA patients have increased serum levels of matrix metalloproteinase-9, a component which is also increased in keratoconus patients [15].

Another retinal condition OSA patients have an increased risk of is central serous chorioretinopathy, with the risk reported as 1.56-fold [11]. This is a condition where there is detachment of the neurosensory retina with accumulation of subretinal fluid. It can have a serious impact on the quality of life due to distortion of central vision, especially since it typically affects young patients of working age, between 30–50 years old. Obstructive sleep apnoea-detecting smartwatch technology might be especially useful in this subset of patients, who are more likely to be smartwatch users [16].

There also seems to be a marginal association between OSA and idiopathic intracranial hypertension (IIH), with an increased risk of 1.29 [11]. This link can be difficult to establish, as obesity is a major confounder. In one of our previous studies, we explored the occurrence among IIH patients within a randomised controlled trial and found that 47% of the individuals with IIH also had OSA [17]. The theory is that OSA can lead to an increase in intracranial pressure due to hypoxia, hypercapnia, and vasodilation.

Finally, although there were previous suggestions about a possible association between sleep dysfunction and age-related macular degeneration (AMD), the meta-analysis revealed no heightened risk of AMD [11]. This finding aligns with more recent studies, which indicate a limited association and suggest a two-way relationship between the two conditions [18,19].

What can we do as ophthalmologists?

The importance of patients' systemic history in our consultations cannot be understated. The STOP-BANG questionnaire can serve as an efficient instrument in the identification of OSA [20]. This well-established and validated tool employs straightforward yes or no questions focusing on various indicators and symptoms like snoring, daytime fatigue, witnessed apnoea, and body mass index. This can potentially be used synergistically with supplementary data from smartwatches for patients who are flagged at risk.

In light of World Sleep Day, the integration of smartwatch technology as an approved OSA detection feature represents a pivotal advancement in the early detection and management of OSA. The growing evidence of increased ocular risks associated with OSA highlights the evolving need for us eye health professionals to be vigilant and proactive, whilst working hand-in-hand with other health specialties.

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