



Review article

Antipsychotic drugs and sudden cardiac death: A literature review of the challenges in the prediction, management, and future steps



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ABSTRACT

Sudden cardiac death (SCD) is relatively uncommon, yet it is a deadly consequence of some antipsychotic medications in patients with psychiatric disorders. The widespread concerns about the adverse cardiac effects associated with antipsychotics and their unpredictable nature have led to a restriction on the use of some antipsychotic medications. Recent progress has been made in the identification of important genetic factors that may contribute to the adverse complication of antipsychotic drugs, suggesting that high-risk individuals can be identified prior to initiating therapy. In addition, some high-tech smart wearable medical devices have recently been developed, allowing users to record and analyze the electrocardiogram (ECG) in couple with artificial intelligence (AI) technologies, and notifying of irregular heart rhythms or arrhythmias, a medical condition well documented in most SCD cases. In this literature review, we summarize recent advances in understanding the link between SCD and antipsychotic drug usage, as well as in utilizing wearable medical devices for monitoring of cardiac arrhythmias. New strategies for improving the care of patients receiving antipsychotic medications are proposed. As it is now possible to evaluate the risk of SCD in patients on antipsychotic medications, preventative measures and close monitoring may be used to detect the early signs of adverse cardiac events and SCD.

1. Introduction

Antipsychotics are highly effective drugs used for the treatment of schizophrenia and other severe psychiatric disorders. However, the use of antipsychotics has been linked to some adverse cardiac effects, including life-threatening arrhythmias and sudden cardiac death (SCD). Sudden cardiac death (SCD) is defined as death from a sudden and pulseless condition termed as sudden cardiac arrest (SCA), presumably due to a ventricular tachyarrhythmia (Ray et al., 2009; Chen et al., 2013; Ray et al., 2001). Unlike other forms of sudden death, SCD

represents an unexpected event of sudden death in the absence of a non-cardiac-related causes (e.g., pneumonia), extrinsic causes (e.g., drug overdose), or cardiac causes unrelated to ventricular tachyarrhythmia (e.g., heart failure) (Ray et al., 2009, 2001; Chen et al., 2013; Albert et al., 1998; Siscovick et al., 1994). In some cases, the drugs have been limited to specific patients, discontinued in clinical practice, or permanently withdrawn from the market due to their serious adverse cardiac effects. Despite SCD being an uncommon consequence of antipsychotics, many typical and atypical antipsychotic medications have been reported to significantly increase the risk of SCD in patients with

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psychiatric disorders (Mehtonen et al., 1991; Ray et al., 2009; Sicouri and Antzelevitch, 2018).

Despite decades of intense research on the topic, the connection between antipsychotic drugs and SCD remains to be elucidated. Recent progress has been made in identifying a significant heritable component involved in antipsychotic drug-induced SCD (Itoh et al., 2016; Mahida et al., 2013; Strauss et al., 2017) using next-generation gene sequencing technologies. These findings have suggested that individuals with specific genetic variants may be at a higher risk of developing SCD. These studies have also highlighted an opportunity for the utilization of genetic screening in the assessment of disease risk and therapeutic benefit before prescribing antipsychotic medications. Furthermore, novel approaches have been employed to better care for patients receiving antipsychotics, such as wearable devices that can monitor cardiac symptoms. Using these types of preventative strategies, patients can monitor themselves for the early signs of heart disease, which could be of value in reducing the risk of SCD. Particularly, high-tech wearable devices capable of electrocardiograms (ECG) have become available to monitor and notify users of irregular heart rhythms and other warning signals of SCD anytime and anywhere, which is accomplished through an integrated artificial intelligence (AI) analysis of ECG.

In this review, we were trying to summarize the current literature about the association between antipsychotics and SCD. Moreover, we proposed new steps toward the better care of patients receiving antipsychotics, which will likely provide further guidance in the management of patients at high-risk of antipsychotic drug-induced SCD. For this review, we have focused on the most recent studies on the molecular mechanisms underlying the link between antipsychotic medications and SCD and proposed new steps towards better management of patients undergoing antipsychotic therapy with high-tech wearable devices for monitoring ECG.

2. Methods

We conducted a literature search in PubMed and Wanfang Med Online as core databases, and in other sources, including Google Scholar and Baidu Scholar. During the literature search and review, the following keywords were used: antipsychotic drug, sudden cardiac death, adverse cardiac effect, adverse drug reaction, cardiac arrhythmia, long QT syndrome, electrocardiogram, heart rate, wearable device, schizophrenia, psychiatric disorders, bipolar disorder, and depression. We subsequently included the most relevant original research articles but excluded those lacking relevance from the full articles identified by the literature search. A flow diagram of the articles selected for this review was summarized in Fig. 1.

3. Results and discussion

3.1. SCD in patients on antipsychotic drugs

3.1.1. Epidemiological studies on SCD among patients taking antipsychotic drugs

Epidemiological studies have revealed a clear link between the use of antipsychotic drugs and increased incidence and mortality of SCD among individuals with psychiatric disorders. Recently, Ray and colleagues evaluated the relationship between antipsychotic drug usage and SCD risk. This vital study recruited a large group of patients receiving antipsychotic medications, including 44,218 users of typical antipsychotic drugs (e.g., haloperidol and thioridazine) and 46,089 users of atypical antipsychotic drugs (e.g., clozapine, olanzapine, quetiapine, and risperidone) (Ray et al., 2009). The users of antipsychotic medications exhibited higher rates of SCD compared with patients not receiving antipsychotic medications (Ray et al., 2009). After the antipsychotic medications were stratified into typical or atypical antipsychotic drugs, both groups showed a similar increase in the risk of

SCD, suggesting that both typical and atypical antipsychotics place users at a substantially increased risk of SCD (Ray et al., 2009). The same study found that the risk of SCD in patients using antipsychotic drugs, both typical and atypical, was increased in a dose-dependent manner (Ray et al., 2009).

Thioridazine, once an antipsychotic frequently prescribed for the treatment of schizophrenia, has been extensively reported to be associated with an increase in the risk of SCD through inducing severe cardiac arrhythmias (Purhonen et al., 2012), for which thioridazine was discontinued by Novartis in June 2005 (Purhonen et al., 2012). In addition to thioridazine, a number of other antipsychotic medications (e.g., mesoridazine, pimozide, triflupromazine, sertindole, ziprasidone, moperone, droperidol, pipamperone, and sultopride), chlorpromazine (Ban, 2007; Lopez-Munoz et al., 2005), levomepromazine (Sivaraman et al., 2010), haloperidol (Kudo and Ishizaki, 1999), droperidol (Domino et al., 1999; Lischke et al., 1994; Peroutka and Synder, 1980), pimozide (Colvin and Tankanow, 1985), flupenthixol (Robertson and Trimble, 1981; Shen et al., 2012), ziprasidone (Mattei et al., 2011), cyamemazine (Alvarez-Guerra et al., 2000; Bourin et al., 2001), sulpride (Bell et al., 2013; Pani and Gessa, 2002), pimavanserin (Friedman, 2013; Howland, 2016), zotepine (Leucht et al., 2013), (Hennessy et al., 2002; Mehtonen et al., 1991; Ray et al., 2001; Stollberger et al., 2005), have also been associated with an increase in the risk of SCD (Table 1). There have been widespread concerns about the severe cardiac effects in the psychiatric and cardiology communities, which have led to restrictions in use of these drugs in clinical practice, and in some instances, the withdrawal from the market.

3.1.2. Characteristics of antipsychotic drug-induced SCD

Although the causes of SCD vary, most cases have abnormal or irregular heart rhythms, also known as arrhythmias, resulting from a problem in the heart's electrical system. Atrial fibrillation (AF) is the most common type of arrhythmia, which is characterized by an abnormally fast heartbeat, while ventricular fibrillation (VF) is a severe form of ventricular arrhythmia that affects the lower chambers of the heart (ventricles). VF has been extensively documented as the most common cause of SCD and is the most frequently observed arrhythmia in SCD cases. AF has also been shown to be independently associated with an increased risk of SCD (Chen et al., 2013; Pedersen et al., 2006; Berton et al., 2009; Wu et al., 2015). In previous studies, AF as an independent factor increased the risk of SCD by 1.3–2.7-fold in specific patient subgroups (Pedersen et al., 2006; Berton et al., 2009). Antipsychotic drugs produce adverse cardiac effects by delaying the cardiac repolarization, a condition that is measurable on an ECG as an abnormal QT interval prolongation (Haddad and Anderson, 2002; Reilly et al., 2000; Stollberger et al., 2005; Thomas, 1994). Notably, a prolonged QT interval has been extensively documented as one of the most important mechanisms involved in cardiac ventricular arrhythmias [e.g., Torsade de Pointers (TdP)], and this abnormal condition is common in SCD patients taking antipsychotic drugs (Hennessy et al., 2002; Ray et al., 2001; Reilly et al., 2002; Straus et al., 2004).

Aside from VF in most SCD cases, AF has also been shown to be independently associated with an increase in the risk of SCD (Chen et al., 2013; Pedersen et al., 2006; Berton et al., 2009). In several previous studies, AF as an independent factor increased the risk of SCD by 1.3–2.7-fold in specific patient subgroups (Pedersen et al., 2006; Berton et al., 2009). In a recent nested case-control study in Taiwan, Chou et al. assessed 34,053 AF cases and found that patients using antipsychotic drugs, both typical and atypical antipsychotics, had significantly higher risk of developing AF than the matched control individuals not receiving antipsychotics, suggesting a direct link between antipsychotic medications and AF (Chou et al., 2017). The same study also demonstrated that the risk of AF was dose-dependent with higher dosages of antipsychotics being linked with a higher AF incidence

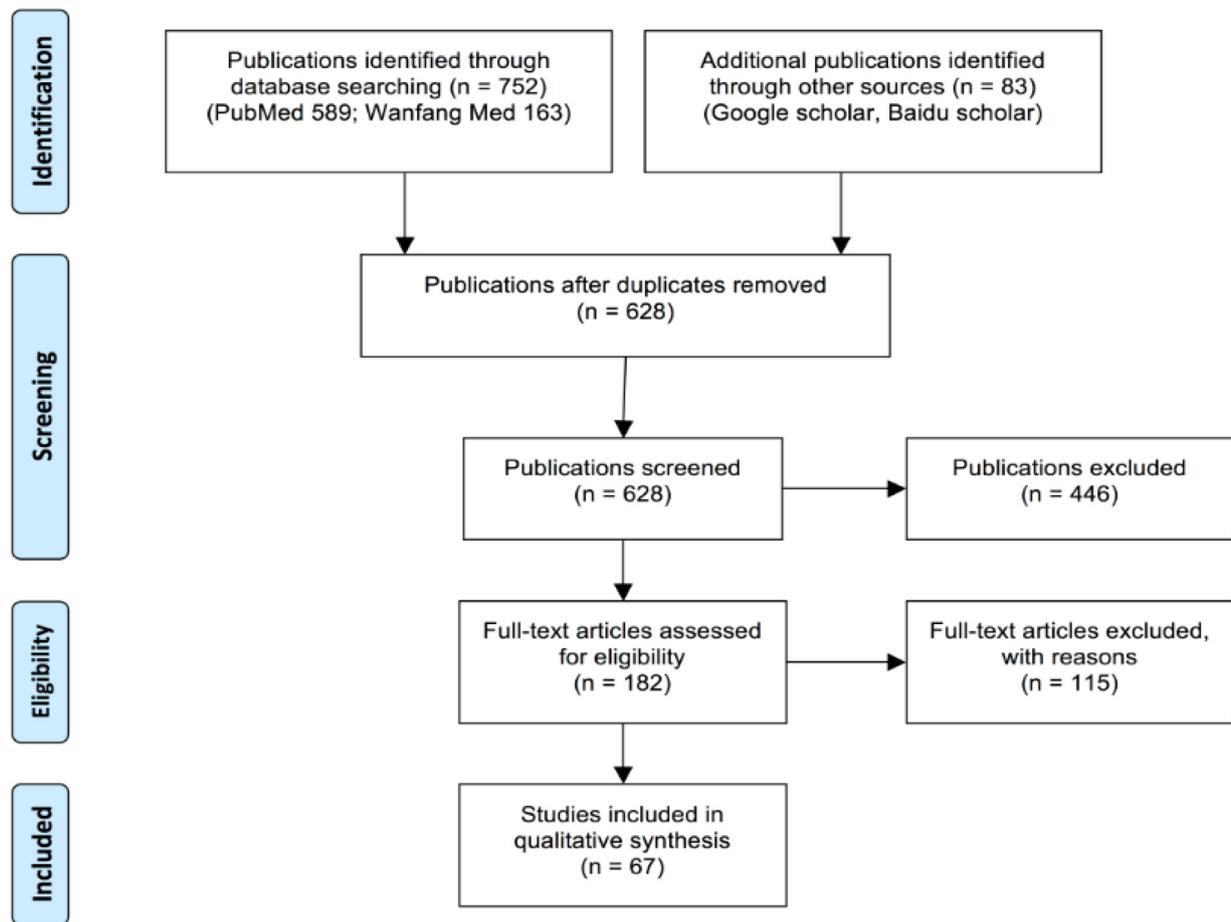


Fig. 1. Flow diagram of literature selection process for this review. A literature search was performed in core databases (PubMed, Wanfang Med Online), and in other sources (Google Scholar, Baidu Scholar). We removed duplicates to avoid reviewing duplicate articles. Of 628 publications, 446 publications (abstracts presented in conferences, annual meetings, and workshops; not in English; book chapters; studies in vitro) were excluded. In the final step of literature selection, 115 full articles were excluded mainly as they were less relevant to the topic and research questions than those studies included in the qualitative synthesis, as compared and determined by two senior authors (CZ and WH).

(Chou et al., 2017).

In addition to cardiac ventricular arrhythmias, olanzapine, clozapine, and paliperidone have been shown to induce AF, which is one of the most common form of atrial arrhythmias that is associated with a 5-fold increase in the risk of stroke and a 2-fold increase in the risk of long-term mortality (Michelsen and Meyer, 2007). Clozapine has been the cornerstone therapy for schizophrenia over the past two decades, and its long-term effects on the cardiovascular system were recently evaluated in a cohort of schizophrenia patients receiving maintenance clozapine therapy (Khan et al., 2017). From the 503 patients evaluated during the six-year study period, 10 (2%) patients experienced SCD, while 14 (3%) patients developed myocarditis (Khan et al., 2017), suggesting that myocarditis and SCD are two complications caused by clozapine in patients with schizophrenia (Khan et al., 2017). The study also showed that myocarditis occurred for 15 days after discontinuing clozapine, which is in support of the need for more intensive monitoring of patients receiving clozapine (Khan et al., 2017).

3.1.3. Potential mechanisms of antipsychotic drug-associated SCD

Although recent decades have witnessed the rapid advances in the development of atypical antipsychotic medications for the treatment of schizophrenia, the mechanisms by which these medications cause SCD remain unclear (Sicouri and Antzelevitch, 2018). The mechanisms are thought to be multifaceted, and several of the potential mechanisms may explain, at least in part, the actions by which some antipsychotic drugs cause SCD (Sicouri and Antzelevitch, 2018; Albert et al., 1998;

Lischke et al., 1994). Cardiac ion channels contribute to the formation of action potentials, which plays a critical role in maintaining normal cardiac rhythms in a healthy heart (Bohnen et al., 2017; Sipido et al., 2000; Epstein and Katz, 1993; Steffensen et al., 2015; Giudicessi and Ackerman, 2013; Miller et al., 2014; Sanguinetti and Tristanifirouzi, 2006; Schmitt et al., 2014). Mutations in the genes encoding cardiac ion channel proteins have been directly associated with an increased risk of arrhythmias in patients with specific inherited and acquired diseases like inherited arrhythmic disorders (Clancy, 2005; Bohnen et al., 2017).

Antipsychotic drugs have been reported to block ion channels in the ventricles. For example, some antipsychotic medications (e.g., chlorpromazine, clozapine, and thioridazine) suppress the rapidly activating delayed rectifier current (I_{Kr}), and the QT prolongation most commonly occurs secondary to the I_{Kr} block. Blocking I_{Kr} with antipsychotic medications has been directly associated with QT interval prolongation in ECGs, along with other serious cardiac arrhythmias, such as TdP (Redfern et al., 2003; Sicouri and Antzelevitch, 2018). The IC_{50} values for blocking I_{Kr} with some antipsychotic medications, including chlorpromazine, clozapine, haloperidol, thioridazine, and serindole, have been determined in previous studies (Tamargo, 2000; Tie et al., 2001, 2000). These drugs cause QT interval prolongation in the ventricles (Tamargo, 2000; Tie et al., 2001, 2000). Therefore, a 30-fold difference between the IC_{50} for inhibition of I_{Kr} and the plasma concentration as a margin of cardiac safety should be used in the clinical practice to avoid life-threatening cardiac effects (Redfern et al., 2003; Sicouri and

Table 1
Typical and atypical antipsychotic drugs associated with sudden cardiac death.

Antipsychotic drugs	Clinical use	Potential mechanisms	References
Typical antipsychotics	Psychotic disorders	Blocking the rapidly activating delayed rectifier current (I_{Kr}): QT interval prolongation; ventricular arrhythmias; atrial fibrillation	(Ban, 2007; Lopez-Munoz et al., 2005)
Chlorpromazine			
Cyamemazine	Schizophrenia, anxiety	QT interval prolongation; ventricular arrhythmias including torsades de pointes	(Alvarez-Guerra et al., 2000; Bourin et al., 2001)
Droperidol	Psychotic disorders, nausea, vomiting	QT interval prolongation; ventricular arrhythmias including torsades de pointes	(Domino et al., 1999; Lischke et al., 1994; Peroutka and Synder, 1980)
Flupentixol	Schizophrenia, depression	Blocking cardiac potassium channel, QT prolongation; ventricular arrhythmias including torsades de pointes	(Robertson and Trimble, 1981; Shen et al., 2012)
Haloperidol	Schizophrenia, psychosis, bipolar disorder	QT interval prolongation and ventricular arrhythmias including torsades de pointes	(Kudo and Ishizaki, 1999)
Levomepromazine	Schizophrenia, bipolar disorder	Blocking I_{Kr} : QT interval prolongation; ventricular arrhythmias	(Sivaraman et al., 2010)
Pimozide	Schizophrenia, psychosis, Tourette syndrome	Inhibiting I_{Kr} : QT interval prolongation; ventricular arrhythmias	(Colvin and Tankanow, 1985)
Thioridazine	Schizophrenia	Blocking I_{Kr} : QT interval prolongation; ventricular arrhythmias; atrial fibrillation	(Purhonen et al., 2012)
Atypical antipsychotics	Schizophrenia	Blocking cardiac potassium channel, delay in cardiac repolarization, QT interval prolongation; ventricular arrhythmias; atrial fibrillation	(Sicouri and Antzelevitch, 2018; Khan et al., 2017)
Clozapine			
Quetiapine	Schizophrenia	QT prolongation and ventricular arrhythmias via potassium channel	(Sicouri and Antzelevitch, 2018; Ray et al., 2009)
Olanzapine	Schizophrenia	QT interval prolongation, delay in cardiac repolarization, ventricular arrhythmias	(Sicouri and Antzelevitch, 2018; Ray et al., 2009)
Pimavanserin	Psychosis, Parkinson's disease	QT interval prolongation and ventricular arrhythmias	(Friedman, 2013; Howland, 2016)
Risperidone	Schizophrenia	Inhibiting cardiac potassium channel, QT interval prolongation	(Sicouri and Antzelevitch, 2018; Ray et al., 2009)
Sulpiride	Schizophrenia, depression	QT interval prolongation via cardiac potassium channels	(Bell et al., 2013; Pani and Gessa, 2002)
Ziprasidone	Schizophrenia, bipolar disorder	QT prolongation and ventricular arrhythmias through blocking potassium	(Mattei et al., 2011)
Zotepine	Schizophrenia	QT interval prolongation via suppressing cardiac potassium channels	(Hennessy et al., 2002; Mehtonen et al., 1991; Ray et al., 2001; Stollberger et al., 2005; Leucht et al., 2013)

Antzelevitch, 2018).

Recent studies have provided increasing evidence suggesting a genetic mechanism of predisposition to drug-associated SCD, although the degree to which the genetic predisposition contributes to SCD as a clinical consequence remains largely unknown. Until now, a large number of genetic variants have been associated with the QT interval prolongation induced by specific medications (Sicouri and Antzelevitch, 2018). For example, genetic polymorphisms (variations) of the cytochrome P450 CYP2D6 have been shown to affect the metabolism of thioridazine, a drug known to cause QT-prolongation (Sicouri and Antzelevitch, 2018). Carriers of unfavorable variants lack a functional CYP2D6, and in turn, could be susceptible to antipsychotic drug-associated SCD. As such, care should be taken in these patients with unfavorable genetic variants in CYP2D6 when antipsychotic medications are prescribed. The identification of these important genetic variants associated with the adverse complications of antipsychotic drugs may allow physicians to assess the risk prior to initiating therapy.

3.2. Challenges in the prediction of SCD caused by antipsychotic drugs

Currently, implantable cardioverter defibrillators (ICDs) are considered as the most effective treatment for patients at high risk of SCD, along with survivors of SCD. Unfortunately, it is difficult to predict and diagnose SCD among patients using antipsychotic medications due to the lack of physical symptoms. The majority of patients with SCD remain asymptomatic.

The prediction and management of SCD in patients taking antipsychotic drugs in clinical practice are incredibly challenging, which has been attributed to several factors. First, there is no reliable risk algorithms or predictive models for assessing SCD among patients exposed to antipsychotic medications. The primary contemporary guidelines recommend that the SCD risk should be assessed through an

evaluation of clinical parameters capable of reflecting the severity of myocardial diseases, and the resulting assessment is subsequently used for the decision-making process when considering prophylactic ICDs (Gersh et al., 2011; Maron et al., 2003; O'Mahony et al., 2014). For example, SCD risk stratification and treatment algorithms have been developed and validated in patients with hypertrophic cardiomyopathy (O'Mahony et al., 2013).

While SCD risk assessment has been beneficial in patients at high risk of SCD; however, the overestimation of SCD risk has led to inappropriate or unnecessary implantation of prophylactic ICDs in a large number of patients (Maron et al., 2003; O'Mahony et al., 2014, 2013). Besides this limitation, the current SCD risk prediction algorithms offer crude estimates of SCD risk without accounting for the distinct effect of individual risk factors, such as exposure to antipsychotic drugs. Thus far, the SCD risk prediction model and stratification for SCD risk are unavailable to the users of antipsychotic medications, which has posed difficulties in the prediction of antipsychotic drug-associated SCD. In addition, our limited knowledge of the mechanism of action whereby a specific antipsychotic drug could be a bottleneck in the development of more reliable models for the prediction of SCD in patients using antipsychotic medications. Thus, further in-depth studies are required to better decipher the mechanisms underlying SCD in this patient population to speed up the development of preventive measures. The presence of multiple conditions, such as diabetes mellitus, smoking, alcohol consumption, substance abuse, and obesity, have been associated with SCD of schizophrenia patients taking antipsychotic medications (Khan et al., 2017) and may serve as confounding factors. Future prospective studies are needed to assess the appropriate management of these conditions in the prevention of SCD in patients receiving antipsychotic medications.

3.3. Steps toward better prediction and management of SCD in patients taking antipsychotic drugs

The ICD can effectively prevent the occurrence of SCD regardless of the etiology of the disease. In recent years, significant advances have been witnessed in the emerging and expanding market of individual wrist-worn medical devices with capability of monitoring several biometrics, such as heart rate (HR) and blood pressure (BP), as well as ECG (Cadmus-Bertram et al., 2017; Koshy et al., 2018; Rumsfeld et al., 2016; Wallen et al., 2016; Wang et al., 2017; Pevnick et al., 2017). Although the efficacy of these wearable medical devices in the management of SCD still requires further investigation in patients using antipsychotic medications, they hold promise as new steps toward better prediction and management of SCD in patients receiving antipsychotic therapy. Notably, the recently developed high-tech wrist-worn device with a new ECG feature and the other upcoming wearable medical devices can monitor and notify users of irregular heart rhythm (arrhythmias) and other warning signs of SCD anytime and anywhere. These emerging wearable medical devices are expected to bring new hope in the management of patients at high-risk of antipsychotic drug-associated SCD. The wrist-worn devices that allow for the continuous monitoring of pulse and ECG can provide physicians with the data to assess long-term trends in HR and ECG, similar to an implanted in-built loop recorder or a Holter monitoring system (Koshy et al., 2018). In addition, these devices can notify both users and physicians of urgent medical crises, while they also provide global positioning system (GPS) data when needed (Koshy et al., 2018). However, no data have been obtained from clinical trials to support the accuracy and efficacy of these wrist-worn devices in saving lives. Previous studies have primarily evaluated the accuracy of these devices in detecting abnormal sinus rhythms (SR) (Cadmus-Bertram et al., 2017; Koshy et al., 2018; Wallen et al., 2016; Wang et al., 2017). Koshy and colleagues first evaluated the utility of these wearable devices for HR assessment in patients with AF (Koshy et al., 2018). The study consisted of 102 patients with normal SR ($n = 50$), AF ($n = 32$), or atrial flutter ($n = 20$). The arrhythmia analysis showed excellent agreement with the ECG in patients with atrial flutter and SR, but it was more likely to underestimate the effect of HR in AF, which may pose a limitation in the utilization of these wearable devices at this time.

Despite difficulties in the precise prediction of SCD among patients treated with antipsychotic medications, screening for genetic predispositions towards drug-associated SCD could benefit the carriers of unfavorable genetic mutations. In fact, increasing evidence has supported the involvement of a genetic component in drug-associated SCD, although the degree to which the identified genetic variants contribute to SCD is unclear (Sicouri and Antzelevitch, 2018). Individuals with these unfavorable genetic depositions are susceptible to the adverse cardiac caused by antipsychotic drugs. Therefore, special care should be taken when antipsychotic medications are prescribed for individuals who carry these mutations.

Additionally, there are many other risk factors associated with SCD, including older age, smoking, obesity, hypertension, diabetes, and kidney disease. In particular, hypertension, obesity, and diabetes are strongly correlated with poor lifestyles. When considering antipsychotic therapy, it is essential to start with the lowest effective dose and closely monitor for heart arrhythmia in patients with these individual risk factors. Interestingly, a recent study report that taking a daily nap can significantly lower BP by an average of 5 mmHg, which significantly reduced the risk of developing cardiovascular diseases (Kallistratos et al., 2018; Manolis et al., 2015). These new findings are incredibly important as a 2-mmHg drop in systolic blood pressure can reduce the risk of developing cardiovascular events by approximately 10%. In another study conducted by the same research team, Kallistratos and colleagues found that mid-day naps are significantly associated with lowered BP, less damage to the heart and arteries, as well as fewer antihypertensive medications needed for controlling high BP

(Kallistratos et al., 2018; Manolis et al., 2015). Based on these critical findings, individuals with hypertension and its related diseases may benefit from taking a nap during a day. Further studies are needed to assess the benefits of napping on SCD in patients using antipsychotic medications for the treatment of neuropsychiatric disorders.

Health equipment, such as automated external defibrillators (AEDs) and cardiopulmonary resuscitation (CPR) devices, have been shown to be effective for SCD regardless of its etiology. Currently, these health devices are publicly accessible in most developed countries, yet they remain limited in most of the world. In addition to the limited equipment and devices, local and national laws will need to mandate specific citizens for training on the proper use of AEDs and CPR. The installation of these health devices in international airports, stadiums, hotels, and tourist sites, along with the proper training of the staff, are urgently needed worldwide. Patients using antipsychotic medications, in addition to their family members and physicians, should be educated on the warning signs of adverse cardiac effects in the hopes that patients will recognize the symptoms and seek immediate medical attention (Kirchhof, 2017).

However, further clinical studies are warranted in the future. Research funding for antipsychotic drug-associated SCD will need to be made a priority to prevent the devastating cardiac outcomes among specific individuals using antipsychotic medications.

3.4. Conclusions

Antipsychotic drugs increase the incidence of SCD and serious arrhythmias, likely by inhibiting potassium channels and lengthening the cardiac repolarization (QT interval). Despite a growing effort in understanding the molecular mechanisms underlying SCD in relation to the use of antipsychotic drugs, substantial knowledge gaps remain. Recent studies have uncovered genetic depositions attributed to the devastating adverse cardiac complications, including SCD, caused by the use of antipsychotic medications. Due to the connection between SCD and antipsychotic medications, researchers have looked for ways to assess the risk-benefit, take preventive measures, and monitor for the early signs of adverse cardiac events. Notably, wearable smart devices can take ECGs and analyze the scans using AI technology to help detect abnormal heart rhythms, providing a defensive role in the management of SCD in patients using antipsychotic drugs. However, further clinical studies are needed to assess the efficacy of these devices in the future. In addition, funding for antipsychotic drug-associated SCD studies will need to be prioritized to prevent the devastating cardiac outcome among individuals using antipsychotic medications.

Declaration of Competing Interest

All authors declare no competing conflict of interest.

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Supplementary materials

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