

ASHP Therapeutic Position Statement on the Use of Second-Generation Antipsychotic Medications in the Treatment of Adults with Psychotic Disorders

Position

The American Society of Health-System Pharmacists (ASHP) recognizes that schizophrenia, schizoaffective disorder, and other psychotic disorders are serious mental illnesses that can significantly affect an individual's perceptual, behavioral, affective, and cognitive functions. These conditions are usually chronic and recurrent, necessitating continuous treatment over the patient's lifetime. Individuals with these disorders frequently require lengthy and expensive hospitalizations, as well as a variety of ongoing rehabilitative and supportive services that can impose a significant burden on society. In addition, high rates of suicidal behavior and completed suicides have been observed in patients with psychotic disorders. The management of these disorders typically requires long-term treatment with antipsychotic medications, the use of adjunctive pharmacologic treatments, and ongoing psychosocial and supportive interventions to reduce morbidity and mortality.

ASHP encourages health professionals to consider the use of second-generation ("atypical" or "novel") antipsychotics as first-line drug treatments for individuals with psychotic disorders. Second-generation antipsychotics share the common pharmacologic action of dual serotonin-dopamine antagonism. While the acquisition costs of these agents are greater than those of older drugs, randomized controlled trials and naturalistic studies have demonstrated that second-generation antipsychotics effectively treat the symptoms of psychotic disorders while providing a tolerability profile that improves treatment adherence and reduces the severity of short- and long-term adverse motor effects. Second-generation antipsychotics have also been found to have improved profiles for cognitive impairments in schizophrenia, relative to older agents, allowing for opportunities toward psychosocial rehabilitation. There is also evidence that the use of these agents improves outcomes in patients with chronic psychotic disorders compared with older antipsychotics, specifically reducing the rates of symptom relapse and inpatient rehospitalization. However, it should be noted that second-generation antipsychotics are associated with significant treatment risks, such as adverse cardiovascular and metabolic effects, that should be carefully considered during treatment initiation and throughout the course of therapy.

Individuals with schizophrenia generally exhibit a mixture of positive, negative, and cognitive symptoms with varying intensity throughout the course of their illness (Table 1). Schizoaffective disorder differs from schizophrenia in that recurrent mood episodes (mania or depression) occur over a substantial period of time over the course of the illness in addition to chronic psychotic symptoms. These two disorders have been studied together in many clinical trials and will be considered together for the purpose of this document.

It has been estimated that the worldwide lifetime frequency of psychotic disorders is about 1%.^{2,3} Onset of the first severe psychotic symptoms in a patient with schizophrenia usually occurs between the late teens and mid-30s, with onset in males peaking between ages 15 and 30 and females exhibiting a later onset, between ages 20 and 35.^{4,5} Late-onset schizophrenia, occurring after 40 years of age, may have an otherwise similar course to typical adult-onset schizophrenia. Prodromal symptoms of psychosis occurring in children and adolescents (e.g., apathy, social withdrawal) may be present before the first psychotic break, but the full symptoms of these disorders are rare in this population. Because these illnesses frequently have their symptom onset in early adulthood and are characterized by a wide range of symptoms, they usually cause significant, progressive impairment in the social, occupational, and academic functioning of affected individuals.

Pharmacologic Characteristics of Antipsychotic Drugs

The effectiveness of first-generation antipsychotic agents, whose primary mechanism of action was blockade of post-synaptic dopamine type 2 (D₂) receptors in the brain, led to the initial hypothesis regarding dopamine's role in schizophrenia. While it is apparent that increased dopamine in the mesolimbic pathway is responsible for the positive symptoms of schizophrenia, it is now understood that psychotic disorders frequently involve numerous neurochemical abnormalities. Psychosis has been observed in individuals with idiopathic⁶ and drug-induced⁷ hypofunction of the glutamate

Table 1.
Positive, Negative, and Cognitive Symptoms of Schizophrenia

Positive Symptoms	Negative Symptoms	Cognitive Symptoms
Hostility	Emotional withdrawal	Impaired attention
Excitement	Uncooperativeness	Impaired short-term memory
Hallucinations	Blunted affect	Impaired executive functioning
Delusions	Inappropriate affect	Impaired verbal fluency
Suspiciousness	Poverty of thought	
Grandiosity	Social withdrawal	
Conceptual disorganization	Lack of spontaneity	
	Poor abstract thinking	

Background

Schizophrenia and schizoaffective disorder are serious, chronic mental illnesses that affect perceptual, behavioral, and cognitive functioning. The *DSM-IV-TR* established criteria for five main subtypes of schizophrenia and for schizoaffective disorder.¹

system. In addition, the high rate of nicotine dependence in individuals with psychotic disorders—up to 88% in one study⁸—has led to the identification and study of acetylcholine-receptor abnormalities in the pathophysiology of schizophrenia.⁹

The ideal drug for the treatment of psychotic disorders would have several important characteristics. It would provide effective relief and prevention of acute positive symptoms of schizophrenia. Other ideal characteristics would include effective relief of affective, cognitive, and negative symptoms; minimal short- and long-term adverse effects; few drug interactions; and low acquisition cost. Although no antipsychotic agent currently available completely fits all these criteria, second-generation antipsychotics offer many benefits not achieved with traditional antipsychotics.

First-generation antipsychotic agents primarily exert their therapeutic effects through the blockade of postsynaptic D₂ receptors in the mesolimbic pathway, thereby reducing positive symptoms over time. However, these drugs are not selective in their activity. Blockade of dopamine in other areas of the brain often leads to acute extrapyramidal motor effects (e.g., dystonias, parkinsonism), tardive dyskinesia, increased levels of serum prolactin, and exacerbation of negative symptoms. Although occurring infrequently at standard doses, an array of adverse neurologic, cardiovascular, and dermatologic effects are associated with these agents.

Second-generation antipsychotic drugs share the common pharmacologic action of dual serotonin–dopamine antagonism (Table 2). Aripiprazole differs slightly in that it functions as a partial agonist at dopamine receptors, reducing dopamine activity in the mesolimbic pathway.^{10,11} Antagonism of serotonin type 2 (5-HT₂) receptors increases the release of endogenous dopamine.¹² This increase in dopamine decreases the likelihood of extrapyramidal motor symptoms and elevated prolactin levels without significantly reducing the beneficial effects against positive symptoms of psychosis. Theoretically, this property of the newer drugs may also help to improve the negative symptoms of schizophrenia.

Efficacy for Psychotic Symptoms

Second-generation antipsychotic agents have been demonstrated to be at least as effective as the traditional antipsychotic agents in the treatment of positive symptoms of schizophrenia when used in appropriate therapeutic doses. The newer antipsychotics also demonstrate benefits for affective symptoms, cognition, and psychosocial functioning not seen with the older agents.

Table 2.
Second-Generation Antipsychotics Currently Available in the United States

Drug (Trade Name)	Manufacturer	Year Approved
Clozapine (Clozaril)	Novartis	1989
Risperidone (Risperdal)	Janssen Pharmaceutica	1993
Olanzapine (Zyprexa)	Eli Lilly	1996
Quetiapine (Seroquel)	AstraZeneca	1997
Ziprasidone (Geodon)	Pfizer	2001
Aripiprazole (Abilify)	Bristol-Myers Squibb	2002
Paliperidone (Invega)	Janssen Pharmaceutica	2006

Clozapine, the first second-generation antipsychotic introduced in the United States, has an established level of efficacy for use in individuals with psychotic disorders resistant to treatment with other antipsychotics. Kane et al.¹³ conducted the landmark trial that demonstrated the superior efficacy of clozapine in individuals with treatment-resistant psychosis. This trial enrolled only patients whose psychosis was treatment resistant, defined as not responding to at least three periods of treatment in the preceding five years with antipsychotic agents from two different chemical classes at dosages equivalent to 1000 mg/day of chlorpromazine for six weeks. The previous antipsychotic trials must have failed to provide periods of good functioning or significant symptomatic relief. A six-week trial of haloperidol (mean dosage, 61 mg/day) and benztropine followed to confirm lack of drug response. Participants whose psychosis did not respond to haloperidol were randomized to receive clozapine (up to 900 mg/day) or chlorpromazine (up to 1800 mg/day) with benztropine. Using a priori criteria, response rates were 30% for patients treated with clozapine versus 4% for the chlorpromazine group. The authors found that improvements in the Brief Psychiatric Rating Scale total scores and clinical global impression (CGI) were three times greater in patients treated with clozapine.

The landmark clinical studies used in the evaluation of second-generation antipsychotics are summarized in Table 3. In general, these trials lasted four to six weeks and assessed the efficacy of these agents in the treatment of acute psychotic disorders. Because of the study designs employed, no assumptions can be made regarding the efficacy of these agents for long-term prevention of psychotic relapse, for comorbid substance abuse or mood disorders, or in other complex clinical situations. The medical literature suggests that all currently available second-generation antipsychotic agents are superior to placebo and at least as effective as the traditional antipsychotics in the reduction of positive symptoms of schizophrenia. With long-term therapy, second-generation antipsychotics may also have beneficial effects on negative symptoms; however, these benefits have not been consistently demonstrated in the four- to six-week clinical trials.

The Clinical Antipsychotic Trials of Intervention Effectiveness (CATIE) was a multicenter clinical study sponsored by the National Institute of Mental Health.²⁵ The first phase of this study, conducted between January 2001 and December 2004, involved 1460 patients with chronic schizophrenia age 18–65 years. Patients were randomized to treatment for up to 18 months with one of four available second-generation antipsychotics (olanzapine, quetiapine, risperidone, or ziprasidone) or perphenazine, a traditional antipsychotic. The primary outcome measured was time to discontinuation of treatment for any cause, including lack of efficacy, intolerable adverse effects, or patient's decision to end treatment. Treatment with olanzapine at a mean modal dosage (MMD) of 20.1 mg/day was associated with a significantly longer median duration of treatment (9.2 months) compared with quetiapine (4.6 months; MMD, 543.4 mg/day), risperidone

Table 3.
Major Efficacy Trials of Second-Generation Antipsychotics^{13–24}

Ref.	Patient Population	Treatment	Duration (wk)	Results ^a
13	268 inpatients with schizophrenia refractory to treatment with adequate trials with at least three agents from two different chemical classes, after nonresponse to 6-wk trial of haloperidol	Clozapine 500–900 mg/day vs. chlorpromazine 1000–1800 mg/day + benzotropine (up to 6 mg/day)	6	BPRS total, CGI: Improvement with clozapine 3 times greater than with chlorpromazine ($p < 0.001$). Patient improvement (20% reduction in BPRS and either CGI of ≤ 3 or BPRS total of ≤ 35 : Clozapine, 30%; chlorpromazine, 4% ($p < 0.001$).
14	39 outpatients with schizophrenia with history of residual symptoms after at least two 6-wk trials of neuroleptics from different classes, after nonresponse to 6-wk trial of fluphenazine	Clozapine 200–600 mg/day vs. haloperidol 10–30 mg/day + benzotropine (up to 4 mg/day)	10	BPRS positive symptoms: Improvement with clozapine greater than with haloperidol ($p = 0.05$). SANS: Improvement with clozapine, worsening with haloperidol ($p = 0.04$). Clinical response rate: Clozapine, 44.4%; haloperidol, 5.5% ($p = 0.017$).
15	388 inpatients with schizophrenia	Risperidone 2, 6, 10, and 16 mg/day; haloperidol 20 mg/day; placebo	8	Clinical improvement (20% reduction in PANSS): Greater improvement in patients receiving risperidone 6 and 16 mg vs. haloperidol. Clinical improvement (Kane et al. criteria): Risperidone 6, 10, and 16 mg superior to placebo ($p < 0.05$).
16	135 patients with schizophrenia	Risperidone 2, 6, 10, and 16 mg/day; haloperidol 20 mg/day; placebo	8	Clinical improvement (20% reduction in PANSS): Greater improvement in patients receiving risperidone 2, 6, 10, and 16 mg and haloperidol recipients vs. placebo. PANSS—negative subscale: Only risperidone 6 mg superior to placebo.
17	400 patients with schizophrenia	Risperidone long-acting injection 25, 50, and 75 mg every 2 wk vs. placebo	12	Improvement in PANSS and CGI (LOCF) significant for all groups vs. placebo.
18	335 patients with schizophrenia	Olanzapine-L (2.5–7.5 mg/day), olanzapine-M (7.5–12.5 mg/day), olanzapine-H (12.5–17.5 mg/day), haloperidol 10–20 mg/day, placebo	6	CGI, BPRS: Olanzapine-M, olanzapine-H, and haloperidol groups significantly improved vs. placebo. SANS: Olanzapine-H group demonstrated significant improvement vs. haloperidol.
19	152 inpatients with schizophrenia	Olanzapine 1 and 10 mg/day vs. placebo	6	BPRS total, PANSS-negative score: Olanzapine 10-mg group superior to placebo. Olanzapine 1-mg group showed no improvement over placebo for any efficacy measure.
20	361 hospitalized patients with schizophrenia	Quetiapine 75, 150, 300, 600, and 750 mg/day; haloperidol 12 mg/day; placebo	6	BPRS total: Significant improvement from baseline vs. placebo noted in all treatment groups except quetiapine 75 mg. SANS: Significant improvement vs. placebo noted in quetiapine 300 mg and haloperidol groups.

(Continued on next page)

Table 3 (continued)

Ref.	Patient Population	Treatment	Duration (wk)	Results ^a
21	286 hospitalized patients with schizophrenia	Quetiapine-H (up to 750 mg/day), quetiapine-L (up to 250 mg/day), placebo	6	BPRS total, CGI, SANS: Quetiapine-H demonstrated significant improvement over placebo. Quetiapine-L group did not show superiority to placebo for any efficacy measure.
22	302 patients with schizophrenia or schizoaffective disorder	Ziprasidone 80 mg/day (40 mg b.i.d.) and 160 mg/day (80 mg b.i.d.), placebo	6	BPRS, PANSS, CGI: Both active treatment groups demonstrated significant improvement over placebo. MADRS: Subset of ziprasidone 160-mg group with depressive symptomatology demonstrated improvement vs. placebo.
23	139 patients with schizophrenia or schizoaffective disorder	Ziprasidone 40 and 120 mg/day, placebo	4	BPRS total, CGI: Ziprasidone 120-mg group demonstrated significant improvement.
24	414 patients with schizophrenia or schizoaffective disorder	Aripiprazole 15 and 30 mg/day, haloperidol 10 mg/day, placebo	4	PANSS total: Significant improvement with all active treatment groups at 2 wk. CGI: Scores in LOCF analysis superior to placebo for all active treatment groups.

^aBPRS = Brief Psychiatric Rating Scale, CGI = clinical global impression, SANS = Schedule for the Assessment of Negative Symptoms, PANSS = Positive and Negative Syndrome Scale, MADRS = Montgomery-Asberg Depression Rating Scale, LOCF = last observation carried forward.

(4.8 months; MMD, 3.9 mg/day), perphenazine (5.6 months; MMD, 20.8 mg/day), and ziprasidone (3.5 months; MMD, 112.8 mg/day). For patients remaining on the assigned treatment over the course of the study, overall psychopathology as assessed by the Positive and Negative Syndrome Scale and the CGI showed improvement over time. Notably, the traditional antipsychotic perphenazine demonstrated comparable efficacy to the second-generation comparators across all measures.

There are several concerns that need to be considered regarding CATIE. First, within the 18-month study period, 74% of the patients discontinued their initial assigned drug therapy. Second, patients with preexisting tardive dyskinesia were not assigned to perphenazine and may have been less likely to exhibit adverse motor effects during the study. Finally, 30% of the patients receiving olanzapine experienced weight gain and adverse metabolic effects, including elevated blood glucose, cholesterol, triglyceride, and glycosylated hemoglobin levels. CATIE compared a single traditional antipsychotic, perphenazine, given at a low dosage to several second-generation antipsychotics. While the data generated from this study are helpful for determining differences in effectiveness between the assigned regimens and comparing important adverse effect issues, they support the widely held notion that the selection of antipsychotic drugs should be an individualized process.

Neurocognitive Effects

Impaired cognitive functioning has long been observed as a core feature of psychotic disorders. These impairments are relatively stable over the natural course of the illness, regardless of the frequency of acute exacerbations of psychotic symptoms.²⁶ Furthermore, cognitive impairment may have a greater impact on psychosocial functioning than any other feature of schizophrenia.^{27,28}

Many domains of cognition, including attention, short-term memory, and executive function, are affected by schizophrenia.²⁶ Treatment with traditional antipsychotic drugs, while relieving positive symptoms of psychosis, do little to improve cognitive functioning. The concomitant use of anticholinergic drugs intended to prevent or treat extrapyramidal symptoms that accompany antipsychotic therapy may actually worsen some cognitive functions.²⁹

Second-generation antipsychotics can play an important role in facilitating the psychosocial rehabilitation of individuals with psychotic disorders by improving cognition. These agents have been shown to improve scores on assessments representing a broad range of cognitive functions. A lower degree of binding to dopamine-D₂ receptors, as well as 5-HT₂ antagonism, in the mesocortical pathway may contribute to the beneficial effects on cognition. The individualized receptor-binding properties of second-generation antipsychotics may contribute to differential improvements in various cognitive domains in individuals with psychotic disorders.

In a 14-week study of individuals with treatment-resistant schizophrenia, risperidone and olanzapine improved executive function, declarative memory, and attention.³⁰ Clozapine has been shown to positively affect executive function and working memory in numerous studies.³¹⁻³³ In an open-label study of 255 clinically stable patients, ar-

ipiprazole and olanzapine improved working memory from baseline after eight weeks of treatment, while aripiprazole showed a greater improvement than olanzapine in verbal learning at weeks 8 and 26.³⁴

Adverse Effects

One of the primary advantages of second-generation antipsychotics in the chronic treatment of psychotic disorders is the improved tolerability profile over older antipsychotics. Adverse effects related to dopamine blockade in the central nervous system tend to occur less frequently in individuals treated with second-generation antipsychotics compared with those receiving traditional antipsychotics. However, the newer drugs have been associated with different problems that can affect drug therapy.

Motor Symptoms. Treatment with conventional antipsychotics has long been associated with both acute and chronic adverse motor effects. Acute extrapyramidal symptoms—dystonia, pseudoparkinsonism, and akathisia (a syndrome of subjective anxiety and restlessness)—are thought to be related to drug-induced blockade of dopamine receptors in the nigrostriatal pathway in the brain. Second-generation antipsychotics, possibly through a combination of 5-HT₂-receptor antagonism and rapid dissociation from D₂ receptors,³⁵ produce antipsychotic effects with a lower likelihood of acute extrapyramidal symptoms.³⁶

Tardive dyskinesia, a potentially irreversible chronic motor disorder caused by long-term exposure to dopamine antagonists, has been another serious concern with conventional antipsychotics. Though not completely eliminating the risk, second-generation antipsychotics have been shown to have a lower risk of treatment-emergent tardive dyskinesia with maintenance treatment. Using data pooled from three controlled comparative studies, Tollefson et al.³⁷ reported that 50 (7.1%) of 707 olanzapine-treated patients manifested symptoms of tardive dyskinesia during the trials, compared with 32 (16.2%) of 197 individuals treated with haloperidol ($p < 0.001$). In a nine-month prospective study of outpatients age 45 years or older, the risk of developing tardive dyskinesia was over four times greater for patients treated with haloperidol than for those receiving risperidone ($p = 0.045$).³⁸ Similar results have been found in other controlled and noncontrolled studies of risperidone, olanzapine, and quetiapine.^{39–41}

Clozapine appears to have an especially favorable profile for the prevention and management of antipsychotic-induced movement disorders. In comparative trials, clozapine exhibited little to no evidence of inducing treatment-emergent extrapyramidal symptoms.^{13,42,43} The risk of tardive dyskinesia associated with clozapine treatment also appears to be minimal.⁴⁴ In fact, clozapine has been used to successfully treat preexisting tardive dyskinesia. Remission of symptoms has been reported in some, but not all, cases of preexisting tardive dyskinesia treated with clozapine.^{45–47} In addition, withdrawal of clozapine in patients with tardive dyskinesia has resulted in either maintenance of reduced movements⁴⁶ or worsening of dyskinesias. The inconsistent nature of tardive dyskinesia treatment makes prevention of this syndrome a very important consideration in the pharmacotherapy of psychotic disorders.⁴⁸

Prolactin Elevation. Dopamine antagonists may elevate serum prolactin levels by decreasing the prolactin inhibitory effects of dopamine in the hypothalamus. Prolactin elevation has been reported to cause an irregular or suppressed menstrual cycle,⁴⁹ galactorrhea,⁵⁰ gynecomastia, and sexual dysfunction⁵¹ in the short term. With long-term elevation of plasma prolactin levels, suppression of estrogen and testosterone may occur. These effects may lead to a decrease in bone mineral density and to osteoporosis.⁵²

The degree of prolactin elevation that an antipsychotic agent may exert appears to be related to its dopamine- and serotonin-binding properties. Significant prolactin elevation and its associated adverse effects can occur with moderate-to-high doses of the traditional antipsychotics and risperidone.⁵² Risperidone has been consistently associated with the greatest degree of prolactin elevation among the second-generation antipsychotics.^{53,54} In a prospective trial, olanzapine was found to cause a low and transient increase in prolactin levels across its dosage range, compared with the significant, persistent hyperprolactinemia associated with haloperidol.⁵⁵ The effect of quetiapine treatment across its dosage range on plasma prolactin levels was comparable to placebo, while significant elevations were associated with haloperidol.²⁰ Similarly, aripiprazole has been shown to be comparable to placebo for prolactin elevation.²⁴ Antipsychotic-associated prolactin elevation has been successfully managed by switching to an antipsychotic agent with a lower propensity toward increasing prolactin.^{56,57}

Weight Gain. The metabolic effects of antipsychotic drug therapy have become a source of concern for clinicians and patients. Psychotic disorders and antipsychotic drug treatment have long been associated with comorbid obesity⁵⁸ and its related conditions: type 2 diabetes mellitus^{59,60} and cardiovascular disease.⁶¹ In addition, drug treatments⁶² and lifestyle changes^{63,64} aimed at weight reduction may be ineffective or difficult to implement in this population.

Varying degrees of weight gain have been reported with chronic use of traditional and second-generation antipsychotics. Among the traditional antipsychotics, loxapine⁶⁵ and molindone^{66,67} are notable for weight-loss or weight-neutral profiles. Of the second-generation antipsychotics, ziprasidone and aripiprazole have been associated with the lowest likelihood for causing weight gain. A large meta-analysis by Allison et al.⁶⁸ was conducted to compare the weight gain associated with the use of various antipsychotic drugs that were approved or under investigation in the United States. Table 4 lists estimated weight gain after 10 weeks of treatment on drugs for which sufficient data are available. Clozapine and olanzapine were associated with more weight gain than all other agents included in this review. The small weight loss associated with placebo may have been due to discontinuation of antipsychotic therapy as the subjects entered the studies.

The antipsychotic agents also appear to differ in the duration and rate of weight changes. In one study, weight increases with continuous clozapine treatment occurred until about 46 months of treatment, with the greatest amount of weight being gained during the first 12 months.⁶⁹ Weight gain with olanzapine may plateau after 4–5 months.⁷⁰

Table 4.
**Estimated Body Weight
 Changes at 10 Weeks in Patients
 Receiving Antipsychotics⁶⁸**

Treatment	Weight Gain (kg)
Placebo	-0.74
Molindone	-0.39
Ziprasidone	0.04
Fluphenazine	0.43
Haloperidol	1.08
Risperidone	2.10
Chlorpromazine	2.58
Thioridazine- mesoridazine	3.19
Olanzapine	4.15
Clozapine	4.45

Diabetes Mellitus. New-onset hyperglycemia and diabetes mellitus have also been observed with antipsychotic treatment. In some instances, the initial presentation consists of life-threatening diabetic ketoacidosis or hyperosmolar coma.⁷¹ Frequently, clinically significant weight gain does not occur before the diagnosis of diabetes.⁷² Koller et al.⁷³ reviewed cases of hyperglycemic episodes associated with risperidone and haloperidol reported to the Food and Drug Administration's (FDA's) MedWatch surveillance program. Of the 131 cases of hyperglycemia associated with antipsychotic monotherapy with risperidone, 78 were clearly identified as newly diagnosed hyperglycemia. In the cases for which adequate data were available, 71% of cases with preexisting hyperglycemia and 48% of cases of new-onset hyperglycemia occurred within the first three months of risperidone monotherapy.

Sernyak et al.⁷⁴ conducted a large analysis of a national sample of patients treated for schizophrenia in Veterans Affairs medical centers to investigate a possible association between the use of antipsychotic medications and development of diabetes mellitus. Patients were identified as being treated with clozapine, olanzapine, quetiapine, risperidone, or traditional antipsychotics. When the patients were stratified by age, significantly higher rates of comorbid diabetes were found in patients treated with second-generation antipsychotics. Overall, clozapine, olanzapine, and quetiapine were most frequently implicated. The strongest relationships were found in individuals less than 40 years of age.

Plasma glucose regulation in individuals receiving antipsychotics and in healthy controls was assessed using oral glucose tolerance tests.⁷⁵ Olanzapine-treated patients demonstrated significantly elevated plasma glucose levels while fasting and at 15, 45, and 75 minutes postload compared with controls and patients treated with traditional antipsychotics. Clozapine-treated patients had significant elevations while fasting and at 75 minutes postload compared with controls and patients receiving traditional antipsychotics. With risperidone, the elevations in plasma glucose were seen in the fasting state and at 45 and 75 minutes postload and were significantly higher compared with healthy controls.

Dyslipidemias. Hyperlipidemia is another significant cardiac risk associated with second-generation antipsychotic treatment. Increases in serum triglycerides and low-density

lipoproteins with second-generation antipsychotics have not always correlated with significant weight gain.⁷⁶

A retrospective analysis of long-term inpatients treated with risperidone and olanzapine was conducted to determine trends of various metabolic values.⁷⁷ The investigator reported that the average increase in triglyceride concentrations was 104.8 mg/dL with olanzapine versus 31.7 mg/dL with risperidone after one year. Total cholesterol increased by 30.7 mg/dL with olanzapine and 7.2 mg/dL with risperidone. A naturalistic study of clozapine treatment revealed a significant increase in serum triglyceride level over five years of treatment.⁶⁹ In CATIE, olanzapine was associated with the greatest exposure-adjusted increases in serum cholesterol and triglycerides.²⁵

In November 2003, a consensus panel that included experts from the American Diabetes Association, American Psychiatric Association, American Association of Clinical Endocrinologists, and the North American Association for the Study of Obesity was convened. Using data collected during a comprehensive literature review and presentations from representatives from the pharmaceutical industry and FDA, the consensus panel developed a statement outlining the metabolic risks of treatment with second-generation antipsychotics.⁷⁸ The panel recommended careful consideration of metabolic risks whenever second-generation antipsychotics are initiated, especially in high-risk patients. The panel also recommended considering switching antipsychotics in patients who gain 5% or more of their initial weight, experience worsening hyperglycemia, or develop worsening hyperlipidemia.

Cardiac Toxicity. Certain traditional and second-generation antipsychotics have been associated with clinically significant prolongation of the corrected Q-T (Q-Tc) interval, which may lead to torsades de pointes, a fatal ventricular arrhythmia. The risk of cardiac mortality associated with psychotropic drug treatment is particularly troublesome because of its spontaneous and unpredictable nature.

The traditional antipsychotics thioridazine, mesoridazine, pimozide, and droperidol have been implicated in numerous cases of sudden unexpected death.⁷⁹ Electrocardiographic data have revealed that patients receiving droperidol and thioridazine are more likely to have an abnormally long Q-Tc interval.⁸⁰ Numerous reports of patient fatalities and the availability of safer alternatives have prompted FDA to recommend that thioridazine, mesoridazine, pimozide, and droperidol only be used as alternative agents with extreme caution.

Although regulatory scrutiny for cardiac assessment heightened during the development of second-generation antipsychotics, these agents are generally associated with a low risk of electrocardiographic abnormalities. Ziprasidone was found to be associated with modest Q-Tc prolongation during its premarketing studies. A comparative study that sought to determine the extent of Q-Tc prolongation seen with the target therapeutic dosages of haloperidol, risperidone, olanzapine, quetiapine, and ziprasidone was later presented to FDA.⁸¹ Thioridazine was also assessed in this study at half its maximum recommended dosage. Thioridazine was associated with an average Q-Tc-interval increase of 35.6 milliseconds. Of the second-generation agents included in this study, ziprasidone was associated with the greatest mean increase in the Q-Tc interval—20.3

milliseconds. Haloperidol-treated subjects had an average Q-Tc-interval increase of 4.7 seconds, the smallest change observed in this study. Coadministration of other interacting drugs (e.g., cytochrome P-450 isoenzyme inhibitors) did not lead to significant changes in Q-Tc measurement. Ziprasidone's labeling warned of its greater potential of Q-Tc-interval prolongation and discouraged use in patients with electrolyte abnormalities, cardiac comorbidity, or concomitant use of metabolic inhibitors.⁸²

Clozapine has been associated with treatment-emergent myocarditis and cardiomyopathy. Myocarditis associated with clozapine treatment presents as an acute inflammation of the myocardium, which may lead to congestive heart failure.⁸³ With over 180,000 patient exposures to clozapine during the first 10 years of its clinical use in the United States, FDA received 28 reports of myocarditis, including 18 deaths.⁸⁴ The greatest risk of fatal events appears to exist during the first month of therapy. Cardiomyopathy associated with clozapine is an insidious process characterized by ventricular dilatation, impaired contraction, and symptoms of congestive heart failure.⁸³ A total of 41 cases of cardiomyopathy, including 10 deaths, were reported to FDA between 1989 and 1999.⁸⁴

Cerebrovascular Events. The use of second-generation antipsychotics for the treatment of dementia-related agitation and psychosis in elderly patients is an unlabeled use that is generally supported by efficacy data in published controlled clinical trials.⁸⁵ However, post hoc analyses of the safety data for these trials revealed an elevated risk of cerebrovascular adverse events (CVAEs), including stroke and transient ischemic attacks, among patients treated with second-generation antipsychotics. These data led FDA to issue a public health advisory warning of the potential for fatal CVAEs in patients with dementia being treated with second-generation antipsychotics. The manufacturers of second-generation antipsychotic agents were also requested to place a black-box warning describing this treatment risk on the labeling of these products.

A closer look at the applicable safety data reveals that the patients in the dementia trials were often at elevated risk for CVAEs because of advanced age, poor control of chronic cardiovascular disease, and the underlying etiology of the dementia.⁸⁶ Cases of CVAEs included nonspecific events, such as hypotensive episodes, periods of unresponsiveness, and slurred speech. For example, the pooled results of six placebo-controlled randomized studies of risperidone for the treatment of behavioral disturbances in patients with dementia revealed 33 CVAEs (3.3%) in 1009 subjects receiving the drug. The frequency of CVAEs was 1.1% (8 of 712) among placebo-treated patients ($p = 0.004$). However, serious CVAEs (fatal events, life-threatening events, or CVAEs associated with hospitalization or disability) occurred in 15 (1.5%) of 1009 patients treated with risperidone and 4 (0.6%) of 712 patients treated with placebo, a difference that failed to reach statistical significance. Furthermore, most patients experiencing stroke had risk factors, including hypertension, atrial fibrillation, and previous strokes.⁸⁶

The nature of this type of safety data makes it difficult to determine causality. It has been postulated that the adverse effects of sedation, hypotension, pseudoparkinsonism, and enhanced platelet aggregation may contribute to the observed increase in CVAEs.⁸⁶ In addition, these findings have

not been widely observed among patients with psychotic disorders. It would therefore be advisable to consider stroke prophylaxis in all elderly patients receiving antipsychotic drugs, particularly high-risk patients.

Hematologic Toxicity, Respiratory Depression, and Seizures.

Despite its superior efficacy for treatment-resistant psychotic disorders, the use of clozapine has remained restricted due to the potential of severe adverse effects not commonly seen with other antipsychotics. Agranulocytosis has been estimated to occur in 1–2% of patients treated with clozapine.⁸⁷ Episodes tend to occur between two and six months after initiation of treatment.⁸⁸ Fatal infectious complications may occur as a result of reduced white blood cell count. Clozapine-induced agranulocytosis can be reversed with the prompt discontinuation of treatment.

In the United States, clozapine is available only under the surveillance of one of the national manufacturer-operated registries that monitor weekly complete blood counts from individuals taking this agent. Consistent monitoring has resulted in a markedly reduced rate of agranulocytosis and mortality associated with clozapine-induced agranulocytosis.⁸⁹ Furthermore, the continual monitoring mandated by the clozapine registry programs likely allows for improved treatment adherence and outcomes.⁹⁰

Other toxicities that are more common with clozapine than with other second-generation antipsychotics are respiratory depression and seizures. Respiratory collapse has been associated with rapid dosage adjustment and concomitant benzodiazepine use. It is therefore recommended that clozapine dosage be gradually adjusted from the starting dose if the patient is new to clozapine treatment or if two or more days have elapsed since the last dose. A dose-related reduction of the seizure threshold has been observed with clozapine.⁹¹ Precautions should be taken for patients with seizure disorders receiving clozapine treatment.

Drug Selection and Dosing Considerations

With the notable exception of clozapine, the principal differences among the available second-generation antipsychotics lie in their adverse-effect profiles and dosage forms. Selection of an initial treatment for a patient whose psychosis is not considered to be treatment resistant should be individualized based on the patient's specific tolerability and compliance concerns.⁹² Individuals with a sensitivity to extrapyramidal symptoms may benefit from quetiapine or aripiprazole. Patients with preexisting obesity or diabetes mellitus may benefit from an initial trial with ziprasidone or aripiprazole. The availability of orally disintegrating formulations of olanzapine, risperidone, and aripiprazole; liquid formulations of risperidone and aripiprazole; and a long-acting injectable formulation of risperidone provides options for patients with a history of poor treatment adherence or who have difficulty taking standard oral tablets or capsules. The traditional antipsychotics may be an initial choice for those who are at low risk for movement disorders²⁵ or for whom the newer drugs may be cost-prohibitive.

The importance of appropriate dosing of second-generation antipsychotics was highlighted in an analysis conducted by Love et al.⁹³ Results of the premarketing studies

for risperidone suggested that the dose–efficacy curve peaked at 6 mg/day, leading to the recommendation on the product labeling that risperidone be adjusted to this dosage over the first three days of treatment. After the introduction of risperidone to the mass market, numerous reports^{94–96} demonstrated that the optimal dosage of risperidone for efficacy was between 4 and 6 mg/day, a dosage range not assessed in the original large efficacy studies. Aggregate computerized pharmacy records from state inpatient psychiatry facilities in Maryland revealed significantly higher discharge rates for patients receiving 2–4 mg/day than for those receiving 6 mg/day. It is now recommended that clinicians attempt to stabilize patients on risperidone 2–4 mg/day before initiating a trial at higher dosages.⁹³

In general, clinical studies suggest that for most of the other second-generation antipsychotics indicated for first-line treatment, a more linear dose–response curve is applicable. Patients may require dosage adjustment to 10–20 mg/day of olanzapine, 300–800 mg/day of quetiapine, 80–160 mg/day of ziprasidone, or 10–30 mg/day of aripiprazole for control of acute psychotic symptoms.^{13–24} Maintenance therapy can frequently be achieved with lower dosages, thereby reducing toxicity. Special populations, such as the elderly or individuals with hepatic impairment, may require lower doses due to increased sensitivity to adverse effects. In some individuals with a history of suboptimal response to antipsychotic treatment, additional benefit has been gained using second-generation antipsychotics with doses higher than the maximum recommended in the product labeling.⁹⁷

In the event of nonresponse to an initial trial of antipsychotic medication, most treatment guidelines recommend sequential trials of second-generation antipsychotics with a minimum of three weeks duration at therapeutic doses.^{98–100} A trial of clozapine is generally warranted for patients who demonstrate a suboptimal response to two or more trials with first-line antipsychotic agents. Traditional antipsychotics may also have a role for patients who fail treatment with second-generation antipsychotics. In addition, the adjunctive use of antidepressants, mood stabilizers, or anxiolytics may be beneficial in selected patients. The combined use of more than one antipsychotic drug is a controversial and costly practice.¹⁰¹ Very little published evidence supports the use of multiple oral antipsychotics, except when attempting to transition a patient from one agent to another.¹⁰²

Patient Monitoring

Frequent and continuous monitoring is necessary for individuals treated with antipsychotics in order to assess for therapeutic response and adverse effects. For the second-generation antipsychotics intended for first-line use, the recommended minimum trial duration is three weeks after adjustment to a recommended therapeutic dose. A longer trial is generally warranted for clozapine. Gradual reductions in the severity of psychotic

symptoms (e.g., suspiciousness, hallucinations) are expected with adequate treatment.

Monitoring for metabolic adverse effects of second-generation antipsychotic therapy should consist of regular assessments of body weight, glucose levels, and lipid values (Table 5).¹⁰³ Treatment with clozapine requires weekly assessments of complete blood count and absolute neutrophil count for the first six months. If no evidence of neutropenia or granulocytopenia is found, the monitoring frequency can be reduced to every two weeks for the next six months and then every four weeks thereafter.

Despite the lower propensity for causing adverse motor effects, all patients receiving second-generation antipsychotics should be monitored for symptoms of dystonia, parkinsonism, akathisia, and tardive dyskinesia.¹⁰³ Patients should be evaluated for acute extrapyramidal symptoms weekly until two weeks after dose stabilization when antipsychotics are initiated or adjusted. Assessments for tardive dyskinesia should be conducted at least once yearly for individuals receiving continuous treatment with antipsychotics.¹⁰³

Measurement of antipsychotic plasma levels is not clinically indicated, except to assess for treatment adherence or suspected drug interactions. However, a minimum plasma clozapine concentration of 350 ng/mL has been correlated with treatment response among patients whose psychosis has been identified as treatment resistant.^{104,105} In a study of the use of therapeutic drug monitoring in long-term treatment with clozapine, relapse was more frequently associated with a decrease from a stable drug level than maintenance of a threshold minimum concentration.¹⁰⁶

Treatment Outcomes

Schizophrenia and related disorders are characterized by chronic courses and periodic exacerbations. Exacerbations in the positive symptoms of schizophrenia may precipitate costly hospitalizations and may result in encounters with the legal system, while the negative and cognitive symptoms affect independent functioning, employment, and quality of life. Hospitalizations in specialty psychiatric facilities may

Table 5.
Monitoring Guidelines for Patients Treated with Second-Generation Antipsychotics

Assessment	Monitoring Frequency
Fasting blood glucose	All drugs: Baseline, then monthly for the first 3 mo and every 6 mo thereafter. More frequent assessments are indicated for individuals noted to be gaining weight.
Weight assessment	All drugs: Baseline and monthly thereafter. (Self-monitoring of weight should be encouraged.)
Electrocardiogram	Clozapine and ziprasidone: Baseline and annually thereafter. More frequent assessments may be indicated in patients over age 50 yr and in patients with a history of cardiac arrhythmias.
Complete blood count with differential	Clozapine: Weekly for the first 6 mo. Every other wk for the next 6 mo, and every 4 wk thereafter if no abnormalities are noted.
Fasting total cholesterol, low- and high-density lipoproteins, and triglycerides	All drugs: Baseline and every 2 yr thereafter if no abnormalities are noted. Every 6 mo for individuals noted to have hyperlipidemia or receiving lipid-lowering therapy.

result in lengths of stay measured in months or years. Thus, the single greatest component of the cost of schizophrenia is the cost of hospital stay. In contrast, drugs are thought to account for less than 10% of the direct costs of treating these illnesses.

Studies addressing the effect of second-generation antipsychotics on hospitalization have repeatedly found that these agents reduce the length of stay and readmission rate compared with conventional antipsychotics. Rabinowitz et al.¹⁰⁷ calculated a two-year rehospitalization rate of 31–33% for patients discharged from inpatient psychiatric hospitalization receiving olanzapine or risperidone, compared with a 48% rate for patients discharged on conventional antipsychotics ($p = 0.02$). In a landmark double-blind trial of risperidone versus haloperidol, Csernansky et al.¹⁰⁸ measured relapse by examining rehospitalization, signs of clinical decompensation, and increasing requirements for supervision. They found significantly lower relapse rates at one year and longer times to relapse with risperidone treatment. FDA accepted this trial as sufficient evidence to allow the manufacturer to indicate in the product labeling the drug's efficacy in delaying relapse.

A variety of studies have focused on the cost of second-generation antipsychotics in comparison with each other^{109,110} and conventional agents.¹¹¹ In general, the generically available first-generation antipsychotics are less expensive than the newer second-generation agents. However, when overall costs of care are calculated, second-generation antipsychotics often demonstrate lower hospital utilization, improved symptomatic control, and fewer adverse effects, resulting in lower or equal total costs for the second-generation agents versus first-generation antipsychotics.¹¹²

While most studies examining outcomes with second-generation antipsychotics have focused on cost, hospitalization, and relapse, fewer have examined issues related to quality of life. Chouinard and Albright¹¹³ addressed these issues by conducting a cost–utility analysis of risperidone versus haloperidol in association with a randomized clinical trial. Patients taking risperidone gained almost three quality-adjusted life years over those who received haloperidol. Franz et al.¹¹⁴ conducted quality-of-life interviews with patients receiving conventional antipsychotics, clozapine, risperidone, or zotepine (not available in the United States). Patients receiving second-generation antipsychotics had a significantly higher total quality of life than those receiving conventional agents. They also demonstrated significantly superior ratings in the domains of physical well-being, social life, and everyday life.

Secondary depression is also a major problem in schizophrenia, and suicide is a leading cause of death in this population.¹¹⁵ It has been estimated that about 10% of patients with psychotic disorders die by suicide.^{116,117} In addition to having favorable effects on mood symptoms, there are indications that second-generation antipsychotics may also reduce suicide rates in some populations, with clozapine demonstrating a particular benefit in this regard.¹¹⁸ In a study of 980 patients with schizophrenia or schizoaffective disorder at high risk for suicide, treatment with clozapine was associated with a significantly lower rate of suicide attempts and hospitalizations to prevent suicide compared with olanzapine (20.8% versus 28.8%, $p < 0.005$).¹¹⁹

Second-generation antipsychotics likely produce beneficial outcomes through a variety of effects. Compared with

conventional antipsychotics and placebo, second-generation antipsychotics demonstrate improved efficacy for psychotic and cognitive symptoms. In controlled trials, these agents produce fewer disabling extrapyramidal adverse effects, such as akathisia and parkinsonism. These effects result in improved adherence to prescribed regimens, less interference with socialization and occupational function, and a feeling of improved well-being compared with the effects of conventional antipsychotics.

Summary

Psychotic disorders are chronic illnesses that impart a considerable burden on patients, families, and society. Although no known drug therapies can cure these illnesses, antipsychotic agents are a mainstay for the management of acute illness and prevention of relapse. The second-generation antipsychotics—risperidone, olanzapine, quetiapine, ziprasidone, aripiprazole, and paliperidone—offer numerous advantages over the older agents, including a lower risk of extrapyramidal motor symptoms and elevated serum prolactin levels, as well as improvements in cognitive symptoms. These advantages have led to improved long-term outcomes and cost-effectiveness, despite the higher acquisition costs of these drugs. Clozapine has demonstrated a unique level of efficacy for individuals with treatment-resistant psychotic disorders and for individuals at high risk for suicide and is very valuable in these subgroups, despite the additional adverse hematologic and cardiovascular effects. Metabolic adverse effects, including weight gain, glucose abnormalities, and hyperlipidemias, cause significant concern for patients receiving second-generation antipsychotics and must be managed proactively by clinicians. Health care professionals in all settings should play an active role in assisting in the selection of an appropriate antipsychotic agent, ensuring appropriate monitoring, and providing counseling to ensure that patients remain compliant with treatment. Additional readings and resources are listed in the appendix.

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Developed through the ASHP Council on Therapeutics and approved by the ASHP Board of Directors on June 24, 2006.

Jason M. Noel, Pharm.D., BCPP, is gratefully acknowledged for drafting this therapeutic position statement. At the time of publication, Dr. Noel was Assistant Professor, University of Maryland School of Pharmacy, Baltimore, and Director of Clinical Pharmacy Services, Rosewood Center, Owings Mills, MD.

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The bibliographic citation for this document is as follows: Noel JM. ASHP therapeutic position statement on the use of second-generation antipsychotic medications in the treatment of adults with psychotic disorders. *Am J Health-Syst Pharm*. 2007; 64:863–76.

Appendix—Additional Readings and Resources

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