There has been a huge increase in the prescription of antipsychotic medication to children and adolescents (<18 years of age).1 However, there is a lack of empirical evidence to support an ever widening pattern of prescribing in this age group. In the USA, between 1999 and 2002 there was a sixfold increase in the prescription of antipsychotics to this population – 92% were second-generation antipsychotics (SGAs), and about a third (32%) were prescribed for mood disorders (Olfson 2006). Despite the lack of formal indications, one study revealed that 12% of all SGA prescriptions were for children under age 9 years (Doey 2007), mostly for disruptive behavioural disorders.

This article assumes a thorough initial assessment of the patient, family and social circumstances. In only a few conditions such as psychosis is antipsychotic medication a first-line treatment. Antipsychotics, however, can be used in combination with other treatments such as cognitive–behavioural therapy (CBT), and always as part of a comprehensive treatment plan. Psycho-education about the disorder, the effects and side-effects of the medication is important, and may help with medication adherence.

An important issue is the licensing of SGAs in the UK. Risperidone and amisulpride are licensed for patients aged 15 or over, and clozapine for over-16s. A UK application for a licence for the use of risperidone for the management of severe aggression in autism was withdrawn by the drug company (Morgan 2007). With the adoption in 2007 of the European Union Regulation on Paediatric Medicines (Medicines and Healthcare products Regulatory Agency 2007), one hopes that clearer guidance will become available.

Schizophrenia

The evidence base demonstrating the efficacy of antipsychotic medication in the treatment of early-onset schizophrenia is relatively limited, but growing. A Cochrane review (Kennedy 2007) for childhood-onset schizophrenia (age at onset <13 years) found six studies (Table 1) with a total of 256 children and adolescents. The SGAs used were clozapine, risperidone and olanzapine. Although noting improvements with antipsychotic treatment, there was little to support the use of one antipsychotic over another, with the exception of clozapine over haloperidol. No superiority of SGAs over FGAs was found. A further systematic review and meta-analysis of 15 studies of antipsychotics in children and adolescents (up to the year 2003) showed a 55.7% average response to SGAs compared with 72.3% for FGAs. The effect size of 0.36 in favour of the FGAs was not significant (Armenteros 2006). The review was limited by the methodological quality of the studies which included only two randomised controlled trials (RCTs) of FGAs – loxapine (Pool 1976) and haloperidol (Spencer 1992).

The recent US multicentre RCT, Treatment of Early-Onset Schizophrenia Spectrum Disorders (TEOSS; Sikich 2008), was designed to test whether SGAs are superior to FGAs in treating schizophrenia and schizoaffective disorder (Table 1). It was one of the largest studies involving 119 young people (aged 8–19 years). Results showed...
# TABLE 1  Randomised controlled trials of antipsychotic medication for the treatment of schizophrenia

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Treatment</th>
<th>Duration</th>
<th>Effectiveness</th>
<th>Adverse effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faretra 1970</td>
<td>n=60, 87% childhood-onset schizophrenia Age 5–12 years</td>
<td>Fluphenazine: up to 1.25 mg three times a day, n=30 Haloperidol: up to 1.25 mg three times a day, n=30</td>
<td>8 weeks</td>
<td>CGI: no differences fluphenazine v. haloperidol</td>
<td>EPS, fluphenazine v. haloperidol Relative risk 0.6 (95% CI 0.21–2.13)</td>
</tr>
<tr>
<td>Engelhardt 1973</td>
<td>n=30 Age 6–12 years</td>
<td>Fluphenazine: mean 10.4 mg/day, n=15 Haloperidol: mean 10.4 mg/day, n=15</td>
<td>12 weeks</td>
<td>Clinical Global Improvement CPRS: no differences fluphenazine v. haloperidol</td>
<td>EPS, fluphenazine v. haloperidol Relative risk 2.0 (95% CI 0.5–2.46)</td>
</tr>
<tr>
<td>Pool 1976</td>
<td>n=75 Mean age –15.5 years</td>
<td>Loxapine 87.5 mg/day, n=15 Haloperidol 8.9 mg/day, n=15 Placebo</td>
<td>4 weeks</td>
<td>Both treatments significantly reduced BPRS total ratings compared with placebo No significant differences observed between active treatment groups</td>
<td>EPS (e.g. muscle rigidity) noted in 19 (73%) of 26 receiving loxapine and 18 (72%) of 25 patients receiving haloperidol Sedation also problematic</td>
</tr>
<tr>
<td>Realmuto 1984</td>
<td>n=21 Mean age –15.5 years</td>
<td>Thiothixene 16.2 mg, n=15 Thioridazine 178 mg, n=15</td>
<td>6 weeks</td>
<td>Both treatments significantly reduced BPRS total scores</td>
<td>Marked sedation</td>
</tr>
<tr>
<td>Spencer 1992</td>
<td>n=16 Mean (s.d.) age: –8.9 years</td>
<td>Crossover design: haloperidol 1.8 mg/day, n=15 placebo</td>
<td>6 weeks</td>
<td>CGI–I much/very much improved: 12 (75%) patients of 16; marked reduction in severity of persecutory ideation and hallucinations</td>
<td>Sedation</td>
</tr>
<tr>
<td>Kumra 1996</td>
<td>n=21 Mean (s.d.) age: 14.0 (2.3) years</td>
<td>Clozapine 176 (149) mg/day, n=15 Haloperidol 16 (8) mg/day, n=15</td>
<td>6 weeks</td>
<td>Clozapine &gt; haloperidol in terms of positive (SAPS total) and negative symptoms (SANS total)</td>
<td>Clozapine: high rates of neutropenia and seizures</td>
</tr>
<tr>
<td>Sikich 2004</td>
<td>n=50, broad psychotic disorders Mean (s.d.) age: 14.7 (2.7) years</td>
<td>Risperidone 4.1 (2.1) mg/day, n=30 Olanzapine 12.3 (3.5) mg/day, n=30 Haloperidol 5.0 (2.0) mg/day, n=30</td>
<td>8 weeks</td>
<td>BPRS–C reduction &gt;20%: risperidone 74%, olanzapine 89%, haloperidol 54% All CGI–I much/very much improved</td>
<td>EPS and weight gain more than reported in adult studies</td>
</tr>
<tr>
<td>Yao 2003</td>
<td>n=42 childhood-onset schizophrenia Mean age –11 years</td>
<td>Risperidone 0.25–3 mg/day, n=21 Haloperidol 0.5–12 mg/day, n=21</td>
<td>6 weeks</td>
<td>BPRS</td>
<td>Risperidone fewer EPS than haloperidol Relative risk 0.10 (95% CI 0.03–0.36, NNT = 2 (95% CI 2–3)</td>
</tr>
<tr>
<td>Xiong 2004</td>
<td>n=60 Age 7–16 years Length of illness 9–9.5 years</td>
<td>Risperidone 0.5–5 mg/day, n=30 Chlorpromazine 50–400 mg/day, n=30</td>
<td>8 weeks</td>
<td>BPRS: no improvement No difference between risperidone and chlorpromazine</td>
<td>Restless Relative risk 1.5 (95% CI 0.27–8.34)</td>
</tr>
<tr>
<td>Shaw 2006</td>
<td>n=25 Mean age –12 years</td>
<td>Clozapine 327 (113) mg/day, n=15 Olanzapine 18.1 (4.3) mg/day, n=15</td>
<td>8 weeks</td>
<td>Clozapine &gt; olanzapine improvement in negative symptoms (SANS)</td>
<td>Marked weight gain at 4 kg during the 8-week trial noted in both groups. At 2-year follow-up, 6 (40%) of 15 patients were observed to have dyslipidaemia</td>
</tr>
<tr>
<td>Kumra 2008</td>
<td>n=39 Mean (s.d.) age: 15.6 (2.1) years</td>
<td>Clozapine 403.1 (201.8) mg/day, n=15 Olanzapine 26.2 (6.5) mg/day, n=15</td>
<td>12 weeks</td>
<td>&gt; 30% BPRS reduction: 66% clozapine, 33% olanzapine Clozapine &gt; ‘high-dose’ olanzapine negative symptoms (SANS) CGI much/very much improved</td>
<td>Weight gain High incidence of dyslipidaemia</td>
</tr>
<tr>
<td>Kryzhanovskaya 2009</td>
<td>n=107 Mean (s.d.) age: 16.2 (1.3) years</td>
<td>Olanzapine 11.1 (4.0) mg/day v. placebo</td>
<td>6 weeks</td>
<td>Olanzapine &gt; placebo in terms of improvement from baseline to end-point on the BPRS–C (P&lt;0.003) and CGI–S (P&lt;0.004) respectively Treatment response rate was not significantly different between olanzapine (37.5%) and placebo (25.7%)</td>
<td>Mean weight gain 4.3 (3.3) kg with olanzapine</td>
</tr>
</tbody>
</table>

(continued)
that risperidone and olanzapine (SGAs) were not superior to the FGA molindone. Given the side-effect profile of SGAs, particularly weight gain and metabolic problems, the authors questioned the current, almost exclusive, use of SGAs to treat early-onset schizophrenia and schizoaffective disorder. Indeed, given the similar findings of a lack of superiority of SGAs over FGAs in two large pragmatic trials for adults with schizophrenia (CATIE and CUTLAS; Lewis 2008), there are questions about the National Institute for Health and Clinical Excellence (NICE) guidelines (National Collaborating Centre for Mental Health 2002) recommending SGAs as first-line treatment.

**Mixed dopamine agonists and antagonists**

According to the dopamine hypothesis of schizophrenia, it is an excess of dopamine in the mesolimbic system which is responsible for increased salience being given to insignificant events and thoughts (Kapur 2003), and which ultimately leads to the development of psychotic symptoms. Alongside this dopamine excess in the mesolimbic system there is a relative dopamine deficiency in the frontal lobes. The finding of a hypo- and hyperdopaminergic state has led to the development of mixed dopamine agonists and antagonists such as aripiprazole. Aripiprazole was designed to reduce dopamine overactivity in the mesolimbic system while purportedly increasing dopamine underactivity in frontal lobe projections. Preliminary evidence for its efficacy in adolescents comes from a short-term RCT (6 weeks) (Sanford 2007) of aripiprazole v. placebo.

**Cognition**

Despite the claims of cognitive enhancement with SGAs, the evidence is weak. For example, methodological problems of earlier studies include the lack of a control group. Recent work suggests that some of the improvements in cognition in the first-episode schizophrenia group may have been due to practice effects (i.e. exposure, familiarity, and/or procedural learning) (Goldberg 2007). Differential medication effects on cognition appear small.

**Clozapine**

Various RCTs have shown clozapine to be more effective than haloperidol (Kumra 1996), olanzapine (Shaw 2006) and high-dose olanzapine (Kumra 2008) (Box 1). Clozapine is effective against both positive and negative symptoms of schizophrenia. (Kumra 2008). Improvement with clozapine is seen within the first 6 weeks of treatment and is related to the plasma concentrations of n-desmethyloclozapine (NDMC)/clozapine ratio (Sporn 2007). Unfortunately, as with nearly all antipsychotics, the rate of side-effects in children and adolescents is higher than that typically found in the adult population. Interestingly, the side-effects do not appear to be related to clozapine dose, clozapine or NDMC plasma concentrations, or NDMC/clozapine ratio. Overall, clozapine appears

**TABLE 1** (continued) Randomised controlled trials of antipsychotic medication for the treatment of schizophrenia

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Treatment</th>
<th>Duration</th>
<th>Effectiveness</th>
<th>Adverse effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanford 2007</td>
<td>n=302</td>
<td>Aripiprazole 10 mg/day,</td>
<td>8 weeks</td>
<td>Aripiprazole (10 mg and 30 mg doses) &gt; placebo improvement from baseline to end-point on the PANSS</td>
<td>Mild to moderate severity Extrapyramidal disorder, somnolence, akathisia</td>
</tr>
<tr>
<td></td>
<td>Mean age 15.5 years (range 13–17)</td>
<td>aripiprazole 30 mg/day v. placebo</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haas 2009b</td>
<td>n=257</td>
<td>Risperidone low dose 0.15–1.6 mg/day (n=132) v. high dose 1.5–8.0 mg/day (n=125) risperidone</td>
<td>8 weeks</td>
<td>PANSS total score improvement (mean (s.d.)) was significantly (P&lt;0.001) greater with high-high (–23.6 (22.8)) v. low-low (–12.5 (20.3)) risperidone</td>
<td>All adverse events &gt; with high-dose, e.g. hypotension 4.5% low dose v. 14.4% high dose</td>
</tr>
<tr>
<td></td>
<td>Age 13–17 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sikich 2008</td>
<td>n=119</td>
<td>Olanzapine 2.5–20 mg/day,</td>
<td>8 weeks</td>
<td>No significant differences in response rates: molindone 50%, olanzapine 34%, risperidone 46%</td>
<td>Olanzapine significant weight gain and lipid changes</td>
</tr>
<tr>
<td></td>
<td>schizophrenia 66%, schizoaffective 34%</td>
<td>risperidone 0.5–6.0 mg/day or molindone 10–140 mg/day + benztropine 1 mg/day</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**BOX 1 First- and second-generation antipsychotics**

- First-generation antipsychotics such as chlorpromazine, introduced in the 1950s, were thought to work by reducing dopamine overactivity in the mesolimbic pathways via blockade of D₂ receptors
- Second-generation antipsychotics such as risperidone and olanzapine, introduced in the 1990s, were designed to be similar to clozapine, a superior antipsychotic, but with fewer side-effects. They have lower dopamine D₂ receptor affinity and higher affinity for serotoninergic 5-HT₄ receptors

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**Notes**

**BPRS, Brief Psychiatric Rating Scale; BPRS-C, Brief Psychiatric Rating Scale for Children; CPRS, Children's Psychiatric Rating Scale; CGI-I, Clinical Global Impression scale – Improvement; CGI–S, Clinical Global Impression scale – Severity; EPS, extrapyramidal symptoms; NNT, number needed to treat; PANSS, Positive and Negative Syndrome Scale; SANS, Scale for the Assessment of Negative Symptoms; SAPS, Scale for the Assessment of Positive Symptoms.**
to be a uniquely beneficial second-line agent for treating children with refractory schizophrenia (Gogtay 2008), and some argue for its early use in first-episode psychosis (Agrid 2007).

Pharmacokinetics
For clozapine and olanzapine, the pharmacokinetic profile varies greatly between individuals. The metabolism of olanzapine and clozapine is higher in males and in those who smoke (Bigos 2008). It is thought that aromatic polycarbons produced by smoking induce liver enzymes. The serum concentrations of olanzapine and olanzapine metabolites in adolescents show high intra-individual variability (1.04- to 10.7-fold, dose-corrected) (Bachmann 2008). For olanzapine, the daily dose, number of co-medications, body mass index and age all affect the variability of dose-corrected olanzapine serum concentrations (all P < 0.001). Monitoring of plasma levels is indicated, especially if there is doubt about the therapeutic response.

Bipolar disorder
There is an increasing trend to use antipsychotics in children and adolescents with bipolar disorder, both in the acute manic phase and as mood stabilisers (Offson 2006), although the evidence base for this age group relies largely upon open trials and case reports. A small, double-blind, placebo-controlled study found that quetiapine in combination with divalproex was more effective for the treatment of adolescent bipolar mania than divalproex alone (DeiBello 2002), while separately, quetiapine appears to act faster than divalproex (DeiBello 2006) (Table 2). A short-term (3 weeks) multicentre double-blind RCT involving out-patient and in-patient adolescents aged 13–17 years with an acute manic or mixed episode (Tohen 2007) showed a significant benefit of olanzapine over placebo in reducing Young Mania Rating Scale scores (effect size 0.84). Risperidone also appears effective in the manic stage of the illness (Haas 2009a) (Table 2).

Expert guidelines on the treatment of paediatric bipolar disorder (Kowatch 2005) recommend the use of mood stabilisers and SGAs. A combination of mood stabilisers and SGAs is advocated in some cases. Indeed, polypharmacy has become more common. The choice of medication depends on the phase of the illness, presence of psychosis, presence of rapid cycling, risk of side-effects and, crucially, patient and family acceptance. Second-generation antipsychotics are recommended for treating psychotic symptoms but they also act as mood stabilisers. It is important to note that premature discontinuation of antipsychotic medication leads to a recurrence of psychotic symptoms in a large percentage of cases (Kafantaris 2001).

According to expert consensus guidelines (Kowatch 2005), both clozapine and electroconvulsive therapy are considered treatments of last resort. It is suggested that clozapine be reserved for patients with bipolar disorder who have failed to respond adequately to at least two trials of a combination treatment regimen that includes at least two of the following: lithium, an anticonvulsant, and an antipsychotic.

Depression
According to the NICE guidelines (National Institute for Health and Clinical Excellence 2005), the treatment for mild cases of juvenile depression

### Table 2: Randomised controlled trials of antipsychotic medication for the treatment of bipolar disorder

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Treatment</th>
<th>Duration</th>
<th>Effectiveness</th>
<th>Adverse effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>DeiBello 2002</td>
<td>n=30, bipolar I disorder, mixed or manic YMRS score &gt;20 Mean age 14.3 years</td>
<td>Divalproex 20 mg/kg + quetiapine 450 mg/day or placebo</td>
<td>6 weeks</td>
<td>More patients showed greater YMRS improvements with addition of quetiapine (87%) than placebo (53%) (P &lt; 0.05)</td>
<td>No EPS Sedation: quetiapine 80% v. placebo 33%</td>
</tr>
<tr>
<td>DeiBello 2006</td>
<td>n=50, bipolar I disorder, manic, mixed</td>
<td>Quetiapine 400–600 mg/day v. divalproex</td>
<td>4 weeks</td>
<td>No differences in YMRS improvement Quetiapine faster onset of action</td>
<td>Sedation, dizziness and gastrointestinal upset 30–60%</td>
</tr>
<tr>
<td>Tohen 2007</td>
<td>n=160, 107 placebo Mean age 15.1 years (s.d. = 1.3)</td>
<td>Olanzapine 2.5–20 mg/day v. placebo</td>
<td>3 weeks</td>
<td>The mean baseline to LOCF end-point change in the YMRS total olanzapine &gt; placebo −7.85 v. −9.99, P &lt; 0.001; effect size 0.84</td>
<td>Weight gain; rise in hepatic enzymes and prolactin in olanzapine group</td>
</tr>
<tr>
<td>Haas 2009a</td>
<td>n=169 Age 10–17 years</td>
<td>Risperidone low dose 0.5–2.5 mg/day (n=50) v. high dose 3–6 mg/day (n=61) v. placebo (n=58)</td>
<td>3 weeks</td>
<td>Mean (s.d.) improvement in YMRS total score was greater in both risperidone groups (0.5–2.5 mg: −18.5 (9.7); 3–6 mg: −16.5 (10.3)) v. placebo (−9.1 (11.0)) (P &lt; 0.001)</td>
<td>Somnolence: 19% placebo v. 42% low dose and 52% high dose</td>
</tr>
</tbody>
</table>

EPS, extrapyramidal symptoms; LOCF, last observation carried forward; YMRS, Young Mania Rating Scale.
consists of brief psychosocial interventions followed by a trial of CBT and then antidepressant medication, if required. The ADAPT study (Goodyer 2007), however, points to the earlier use of selective serotonin reuptake inhibitors (SSRIs) for moderate to severe depression, with little benefit seemingly conferred by the addition of CBT.

The effects of SGAs on serotonin (5-HT) receptors – as 5-HT2A and 5-HT2C antagonists, and as a partial 5-HT2A agonist in the case of aripiprazole – suggest that this class of drugs may be useful in treating depression. Available evidence from randomised placebo-controlled trials involving adults supports the partial effectiveness of olanzapine and quetiapine as augmenters of SSRIs in treatment-resistant depression (defined as a failure to respond to at least one adequate trial of an antidepressant) (Shelton 2008). For children and adolescents, however, such evidence is at present lacking.

**Pervasive developmental disorder**

It is generally held that there are no indications for the use of antipsychotics in treating the core symptoms of autism or pervasive developmental disorder. However, the Research on Pediatric Psychopharmacology Autism Network (McDougle 2005) showed improvements in the areas of sensory motor behaviours, affectual reactions and sensory responses in children with autism given risperidone (Table 3). Small-scale RCTs point to a significantly greater reduction in sensory motor and language subscale scores on the Ritvo–Freeman Real Life Rating Scale with risperidone v. haloperidol (Miral 2008), and an improvement in divided attention in young children with autism prescribed risperidone (Troost 2005) (Table 3). However, the main indication for the use of antipsychotics appears to be to control temper tantrums, irritability, aggression and rapid mood changes. Six RCTs support the use of risperidone in reducing these behaviours (Chavez 2007). An RCT of olanzapine (Hollander 2006) found an overall improvement on the Clinicians Global Impressions–Improvement (CGI–I) scale, but no changes in aggression or irritability. There is less evidence supporting the use of other SGAs such as ziprasidone and aripiprazole (Chavez 2007). A small RCT by Luby et al (2006) pointed to the relative safety of risperidone in the pre-school population (children under 5 years old), which is important as this is an age group likely to be targeted for this developmental disorder.

**Conduct disorder**

Conduct disorder is often associated with psychosocial stressors and adversity. Environmental, social and psychological interventions are therefore the first line of treatment. Treatment of comorbid conditions such as attention-deficit hyperactivity disorder, which may require medication, is important; however, antipsychotic medication for ‘pure’ conduct disorder is not often used in routine clinical practice in the UK.

For children admitted to hospital with severe aggression and conduct disorder, both lithium and haloperidol (dose 1–6 mg/day) reduce aggression (Campbell 1984); however, there are notable side-effects with both drugs. Double-blind controlled studies show that risperidone is effective in reducing symptoms (Table 4), with effect sizes ranging from 0.6 (medium) to 1.5 (very large) (Jensen 2007). However, the RCTs share methodological problems of small trial numbers, high drop-out rates, and selection issues, with most children having low IQs. Nevertheless, when an improvement occurs, it does so in the first 2 weeks of treatment. An important question is the length of treatment, as withdrawal may lead to a recurrence of symptoms. Long-term maintenance therapy with risperidone appears effective, with few reported adverse effects (Jensen 2007).

There are no NICE guidelines for pharmacological treatments of conduct disorder; instead, parent training is advocated (National Institute for Health and Clinical Excellence 2006). Overall, with children and adolescents medication should be reserved for those whom psychosocial treatments have failed or for whom they have proved inadequate. For severe aggression, a trial of medication may then be appropriate.

**Tourette syndrome and tics**

As a treatment rationale for Tourette syndrome and tics, antipsychotics are thought to act primarily by blocking dopamine receptors, thus decreasing dopaminergic input from the substantia nigra and ventral tegmentum to the basal ganglia. Pimozide and haloperidol are effective (Sallee 1997); however, both have serious side-effects – haloperidol producing extrapyramidal symptoms, and pimozide prolonging the QT interval with associated risk of a fatal ventricular arrhythmia. Randomised controlled trials have shown risperidone to be superior to placebo (Schallit 2003), equally effective as clonidine – an alpha adrenergic agonist (Gaffney 2002) – and superior to pimozide (Gilbert 2004). Doses ranging from 1.0 to 2.5 mg/day are effective and neurological side-effects rare. Ziprasidone is also effective (Sallee 2000), although cardiac side-effects with QT prolongation are concerning. These trials are limited by small numbers and short duration (Table 3).
Randomised controlled trials of antipsychotic medication for the treatment of pervasive developmental disorder and Tourette syndrome/tics

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Treatment</th>
<th>Duration</th>
<th>Effectiveness</th>
<th>Adverse effects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pervasive developmental disorder</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>McCracken 2002</td>
<td>n=101 with autism</td>
<td>Risperidone 1.8 (0.7)mg/day (n=49) v. placebo (n=52)</td>
<td>8 weeks</td>
<td>Mean (s.d.) ABC–I score: 56.9% decrease with risperidone from 26.2 (7.9) at baseline to 11.3 (7.4) at 8 weeks v. 14.1% decrease with placebo [from 25.5 (6.6) to 21.9 (9.5)] (P&lt;0.001) Effect size –1.2</td>
<td>Tiredness during the day (P&lt;0.0001), excessive appetite (P&lt;0.05), difficulty waking (P&lt;0.04), excessive saliva or drooling (P=0.04), and dizziness or loss of balance (P=0.04), increased appetite (73%), fatigue (59%), drowsiness (49%). Weight gain 2.7 kg risperidone v. 0.8 kg placebo</td>
</tr>
<tr>
<td>Shea 2004</td>
<td>n=79: PDD n=41, controls n=39</td>
<td>Risperidone 1.17 (0.7)mg/day</td>
<td>8 weeks</td>
<td>Mean ABC–I score: with risperidone decrease from 18.9 at baseline to 6.8 at end-point; placebo 21.2 to 14.7 (P&lt;0.001) Effect size –0.8</td>
<td>Somnolence: 72.5% risperidone v. 7.7% placebo Mean weight gain 2.7 kg v. 1.0 kg EPS: tremor, hypokinesia, increased systolic blood pressure, tachycardia</td>
</tr>
<tr>
<td>Nagaraj 2006</td>
<td>n=39 with autism</td>
<td>Risperidone 0.5mg/day for 2 weeks then 1mg/day</td>
<td>6 months</td>
<td>&gt; 20% improvement on the CARS: risperidone 12/19 v. placebo 0/20, P&lt;0.001</td>
<td>Sedation</td>
</tr>
<tr>
<td>Troost 2005</td>
<td>n=24 with PDD</td>
<td>Risperidone discontinuation</td>
<td>8 weeks</td>
<td>8/12 risperidone relapsed v. 3/12 placebo, P=0.04</td>
<td>Weight gain 5.7 kg with risperidone</td>
</tr>
<tr>
<td>Hollander 2006</td>
<td>n=11 with PPD</td>
<td>Olanzapine mean (s.d.) dose: 10 (2)mg/day</td>
<td>8 weeks</td>
<td>CGI–I: 50% on olanzapine v. 20% on placebo were responders</td>
<td>Weight gain 3.3kg on olanzapine v. 0.9kg placebo</td>
</tr>
<tr>
<td>Luby 2006</td>
<td>n=23 with ASD</td>
<td>Risperidone 0.5–1.5mg/day (n=11) v. placebo (n=12)</td>
<td>6 months</td>
<td>No significant differences in autism severity scores</td>
<td>Weight gain and hyperprolactinaemia</td>
</tr>
<tr>
<td>Miral 2008</td>
<td>n=26 with autism</td>
<td>Risperidone mean (s.d.) dose: 2.6 (1.3)mg/day (n=13) v. haloperidol 2.6 (0.8)mg/day (n=15)</td>
<td>10 weeks</td>
<td>Reduction from baseline in Ritvo–Freeman Real Life Rating Scale, sensory motor (subscale I) and language (subscale V) scores, risperidone &gt; haloperidol (P&lt;0.05) ABC and Turgay DSM–IV PDD reduction in scale scores, risperidone &gt; haloperidol (P&lt;0.05 and P&lt;0.01 respectively)</td>
<td>Few EPS</td>
</tr>
<tr>
<td><strong>Tourette syndrome/tics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sallee 1997</td>
<td>n=22</td>
<td>Pimozide 3.4 (1.6)mg/day v. haloperidol 3.5 (2.2)mg/day v. placebo</td>
<td>24 weeks crossover trial</td>
<td>Pimozide &gt; placebo: P&lt;0.05 Tourette syndrome/tic subscale score 26 Effect size 0.5 Haloperidol v. placebo: P not significant Effect size 0.3</td>
<td>41% of those on haloperidol experienced side-effects, mainly EPS</td>
</tr>
<tr>
<td>Sallee 2000</td>
<td>n=28</td>
<td>Ziprasidone 28.2mg/day (n=16) v. haloperidol (n=12)</td>
<td>8 weeks</td>
<td>Tic severity: –39% ziprasidone v. –16% placebo (P=0.02) Effect size –0.8</td>
<td>Weight gain 0.7kg ziprasidone v. 0.8kg placebo</td>
</tr>
<tr>
<td>Gaffney 2002</td>
<td>n=21</td>
<td>Risperidone 1.5mg/day (n=9) v. clonidine 0.18mg/day (n=12)</td>
<td>8 weeks</td>
<td>Response similar in both groups: Tics reduced: 21% risperidone v. 26% clonidine</td>
<td>Weight gain 2.1kg risperidone v. 0.1kg clonidine Sedation: clonidine &gt; risperidone</td>
</tr>
<tr>
<td>Scahill 2003</td>
<td>n=26</td>
<td>Risperidone 2.5mg/day (n=12) v. placebo (n=14)</td>
<td>8 weeks</td>
<td>Tic severity reduced: 36% risperidone v. 9% placebo (P&lt;0.01); Effect size 1.0</td>
<td>No EPS Weight gain 2.8kg risperidone v. 0kg placebo</td>
</tr>
<tr>
<td>Gilbert 2004</td>
<td>n=9</td>
<td>Crossover: risperidone 2.5mg/day and pimozide 2.4mg/day</td>
<td>4 weeks</td>
<td>Greater reduction in tic severity with risperidone (42%) v. pimozide (21%), P&lt;0.05</td>
<td>Weight gain 1.9kg risperidone v. 1.0kg pimozide</td>
</tr>
</tbody>
</table>

Prescribing antipsychotics for children and adolescents

### TABLE 4
Randomised controlled trials of antipsychotic medication for the treatment of disruptive behaviour disorders

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Treatment</th>
<th>Duration</th>
<th>Effectiveness</th>
<th>Adverse effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Findling 2000</td>
<td>n=20: conduct disorder n=10, controls n=10 Mean 9.2 years</td>
<td>Risperidone 0.03 mg/kg</td>
<td>10 weeks</td>
<td>RAAPP score: –1.7 risperidone v. –0.2 placebo (P&lt;0.05) CGI: –2.6 risperidone v. –0.1 placebo (P&lt;0.01) Effect size –1.0</td>
<td>No EPS Weight gain: 4.2 kg risperidone v. 0.7 kg placebo (P&lt;0.01)</td>
</tr>
<tr>
<td>Buitelaar 2001</td>
<td>n=38: DBD/ADHD n=19, controls n=19 Mean age 14 years IQ 60–90</td>
<td>Risperidone 2.9 (0.04) mg/day v. placebo</td>
<td>6 weeks</td>
<td>CGI score: –1.6 risperidone v. +0.2 placebo (P&lt;0.001) Effect size –1.5 ABC significantly improved with risperidone (P&lt;0.05)</td>
<td>Risperidone: no or mild EPS Weight gain: 2.3 kg risperidone v. 0.6 kg placebo (P&lt;0.05)</td>
</tr>
<tr>
<td>Van Bellinghen 2001</td>
<td>n=14: DBD n=7, controls n=7 Age 6–14 years IQ 45–85</td>
<td>Risperidone 1.2 (0.05) mg/day v. placebo</td>
<td>4 weeks</td>
<td>ABC score improvement in 65% risperidone v. 7% placebo EPS similar with risperidone and placebo Weight gain: 1.8 kg risperidone v. 0.6 kg placebo (P=0.319)</td>
<td></td>
</tr>
<tr>
<td>Snyder 2002</td>
<td>n=110: DBD n=53, controls n=57 Mean age 8.7 years IQ 36–84</td>
<td>Risperidone 0.98 (0.03) mg/day v. placebo</td>
<td>6 weeks</td>
<td>N–CBRF conduct scale score: –15.8 risperidone v. –6.8 placebo (P&lt;0.001) Effect size –0.8</td>
<td>Hypertonia: 8% risperidone v. 2% placebo Somnolence: 42% v. 14% Weight gain: 2.2 kg v. 0.2 kg</td>
</tr>
<tr>
<td>Aman 2002</td>
<td>n=118: DBD n=55, controls n=63 Age 5–2 years IQ 36–84</td>
<td>Risperidone 1.2 (0.04) mg/day v. placebo</td>
<td>6 weeks</td>
<td>N–CBRF conduct scale score: –15.2 risperidone v. –6.2 placebo (P&lt;0.01) Effect size –0.8 BPI aggressive scale: –6.8 risperidone v. –2.4 placebo (P&lt;0.01)</td>
<td>Low EPS: risperidone = placebo Weight gain: 15% (2.2 kg v. 2% (0.9 kg)</td>
</tr>
<tr>
<td>Hollander 2006</td>
<td>n=11 Age 6–14 years</td>
<td>Olanzapine mean (s.d.) dose: 10 (2) mg/day</td>
<td>8 weeks</td>
<td>CGI–I: 50% on olanzapine v. 20% on placebo were responders</td>
<td>Weight gain: 3.3 kg on olanzapine v. 0.9 kg placebo</td>
</tr>
<tr>
<td>Reyes 2006</td>
<td>n=335: DBD n=172, controls n=163 Mean age 11 years IQ ≥55</td>
<td>Risperidone 0.02 mg/kg v. placebo</td>
<td>6 months</td>
<td>DBD with N–CBRF conduct scale scores Symptom recurrence rate: 42.3% placebo v. 27.3% risperidone Hazard ratio 2.24 (95% CI 1.54–3.28)</td>
<td>Weight gain (3.2 kg) and somnolence (11.6%) with risperidone Infrequent EPS and prolactin-related adverse events</td>
</tr>
</tbody>
</table>

ABC, Aberrant Behaviour Checklist; ADHD, attention-deficit hyperactivity disorder; BPI, Behaviour Problems Inventory; CGI, Clinical Global Impression scale; CGI–I, Clinical Global Impression scale – Improvement; DBD, disruptive behavioural disorder; EPS, extrapyramidal symptoms; N–CBRF, Nisonger–Child Behaviour Rating Form; RAAPP, Rating of Aggression Against People and/or Property scale.

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### Obsessive–compulsive disorder

The Pediatric OCD Treatment Study (POTS) Team (2004) found CBT to be an important component of treatment; however, further improvement was gained with the addition of an SSRI, sertraline. A recent review and meta-analysis (Watson 2008) demonstrated positive effects for CBT and medication in treating obsessive–compulsive disorder (OCD); however, there are no reported RCTs of antipsychotic augmentation with SSRIs in children and adolescents. A meta-analysis of nine studies of adults with treatment-resistant OCD (Bloch 2006) showed a significant absolute risk difference (ARD) of 0.22 (95% CI 0.13–0.31) in favour of antipsychotic augmentation; those with comorbid tics had a particularly beneficial response (ARD=0.43, 95% CI 0.19–0.68).

### Anorexia nervosa

Psychological interventions are the mainstay of treatment for eating disorders, and according to the NICE guidelines (National Collaborating Centre for Mental Health 2004) medication is not advocated for anorexia in any age group. There is some evidence for the use of olanzapine in adults with anorexia nervosa, but only 16 case reports have been published on its use in children and adolescents (Mehler-Wex 2008). The results of an RCT in adolescent females are awaited (Spettigue 2008). Case reports reveal positive psychopathological effects and good tolerability of quetiapine in children and adolescents with severe anorexia (Mehler-Wex 2008). In a small subset of patients with severe treatment-resistant anorexia, extreme weight phobia, delusional body image disturbances or severe hyperactivity, a trial of an SGA may be justified. Clearly, controlled studies are needed.

### Antipsychotics and pre-school children

There is a growing literature, mainly from the USA, on the use of SGAs in the very young (under 5 years of age) for the treatment of bipolar disorder.
and aggression in autism. There is only limited evidence for such usage and the side-effect profile is even greater in this age group (Gleason 2007). If a decision is made to use this medication, it should be prescribed very cautiously and with careful monitoring alongside psychosocial interventions (see guidelines, Gleason 2007). Such practice is not licensed in the UK and is not recommended.

**Side-effects**

The side-effect profile of antipsychotics differs according to their receptor blockade potential (Correll 2006, 2008). There are important differences between SGAs and FGAs in terms of weight gain and metabolic syndrome, with perhaps more similarities than originally thought with respect to extrapyramidal side-effects and hyperprolactinaemia. The major side-effects (Table 5) are discussed below.

**Weight gain**

Weight gain with SGAs is greater in children and adolescents than in adults (Correll 2006). Excessive weight gain is associated with significant medical morbidity and mortality, including dyslipidaemia, diabetes mellitus, polycystic ovary syndrome, hypertension and sleep apnoea. The potential for weight gain, both in terms of the proportion of patients affected and amount of weight gained, is greatest with olanzapine and lower with quetiapine (Correll 2006). Weight gain is also low with aripiprazole (Findling et al, 2008) and ziprasidone.

There is some evidence from a recent meta-analysis that non-pharmacological interventions are effective in reducing weight gain in those prescribed antipsychotics (Álvarez-Jiménez 2008). A Cochrane review on the usefulness of switching antipsychotics is awaited (protocol: Mukundan 2007). Two RCTs (Klein 2006; Wu 2008), one in adolescents, point to the benefit of metformin as an adjunctive treatment. This is a cheap, easily administered drug and, apart from a risk of lactic acidosis in renal failure and chronic alcoholism, a safe treatment. Metformin leads to stabilisation of weight.

**Metabolic syndrome**

As a potential result of significant weight gain, SGAs have been associated with lipid abnormalities such as elevated triglyceride, total cholesterol and low-density lipoprotein (LDL) cholesterol levels, and/or decreased high-density lipoprotein (HDL) cholesterol levels in children and adolescents (Correll 2008). It is not clear how frequently metabolic syndrome – dyslipidaemia, glucose intolerance, hypertension and abdominal obesity – occurs in children and adolescents. The syndrome appears to result from insulin resistance secondary to weight gain.

The US Food and Drug Administration (FDA) has issued a ‘black box’ warning concerning the development of diabetes mellitus in patients receiving any SGAs. There have been case reports of new-onset diabetes in antipsychotic-treated

<table>
<thead>
<tr>
<th>Table 5</th>
<th>Side-effect profile of second-generation antipsychotics and haloperidol (first-generation antipsychotic)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adverse effect</td>
<td>Aripiprazole</td>
</tr>
<tr>
<td>Anticholinergic</td>
<td>0</td>
</tr>
<tr>
<td>Parkinsonian</td>
<td>0/+</td>
</tr>
<tr>
<td>Akathisia</td>
<td>++</td>
</tr>
<tr>
<td>Diabetes</td>
<td>0/+</td>
</tr>
<tr>
<td>Raised lipids</td>
<td>0/+</td>
</tr>
<tr>
<td>Weight gain</td>
<td>0/+</td>
</tr>
<tr>
<td>Neutropenia</td>
<td>0/+</td>
</tr>
<tr>
<td>Orthostasis</td>
<td>0</td>
</tr>
<tr>
<td>Raised prolactin</td>
<td>0</td>
</tr>
<tr>
<td>Lowered prolactin</td>
<td>++</td>
</tr>
<tr>
<td>Increased QTc</td>
<td>0</td>
</tr>
<tr>
<td>Sedation</td>
<td>0</td>
</tr>
<tr>
<td>Seizure</td>
<td>0/+</td>
</tr>
<tr>
<td>Tardive dyskinesia</td>
<td>0</td>
</tr>
<tr>
<td>Withdrawal dyskinesia</td>
<td>0/+</td>
</tr>
</tbody>
</table>

0, no side-effects; +, minor side-effects; ++, moderate side-effects; +++ severe side-effects.

a. Includes some data from adult studies.
children and adolescents. In an epidemiological study in New Zealand, the estimated incidence of diabetes mellitus was 4 cases per 1000 patient-years of treatment (95% CI 0.5–15) (Harrison-Woolrych 2007). Risk factors for the development of diabetes include obesity, rapid weight gain, family history of diabetes and hyperlipidaemia (Correll 2008).

Hyperprolactinaemia
Secretion of prolactin from the pituitary is regulated by tonic dopaminergic inhibition. Consequently, the majority of FGAs and SGAs elevate prolactin levels. Hyperprolactinaemia can result in several side-effects: amenorrhoea and oligomenorrhoea, erectile dysfunction, decreased libido, hirsutism, and breast symptoms including galactorrhoea. Prolactin levels are not closely correlated with these symptoms. Hyperprolactinaemia appears dose dependent, tends to normalise over time, and resolves after antipsychotic discontinuation (Findling 2003). The relative potency of antipsychotic drugs to induce hyperprolactinaemia is greatest with risperidone and least with aripiprazole. If the patient develops persistently high prolactin levels, switching to a medication with a lower risk is often helpful. Aripiprazole may actually lower prolactin levels.

Extrapyramidal side-effects
Children and adolescents appear more sensitive than adults to extrapyramidal side-effects such as Parkinsonian side-effects and dystonia (Correll 2008). Although one study showed that the extrapyramidal side-effect rate was similar between FGAs and SGAs (Sikich 2004), the severity of extrapyramidal symptoms was greater with haloperidol. A review of extrapyramidal side-effects with risperidone in paediatric patients indicates a rate ranging from 8 to 26% (Correll 2008). Clozapine (Kumra 1996; Shaw 2006) and quetiapine (DelBello 2002) appear to be associated with relatively low rates, as is the case in adults. Dose reduction or switching medication are the first lines of treatment, although oral or intramuscular anticholinergic medications can also be used.

Neurological adverse events

Fits
Children and adolescents taking clozapine may be at higher risk than adults for developing seizures or epileptiform discharges on an electroencephalogram (EEG) (Findling 2005). A baseline electrocardiogram (ECG) is necessary. Blood pressure and pulse checks are initially performed daily to detect orthostatic changes and tachycardia. Some cardiomyopathies may be induced by tachycardia, and they can be avoided by early detection and appropriate dose adjustments and/or addition of a beta-blocker. Clozapine should be discontinued if either myocarditis or cardiomyopathy develops.

QTc prolongation
QTc prolongation (>430 ms) has been described in children and adolescents treated with ziprasidone (mean QTc prolongation 28 ms, s.d. = 26), which is unrelated to the dose of the drug (Blair 2005). Prolonged QTc is associated with a risk of cardiac arrest and sudden death (Hobbs 2006).
Assessment and monitoring

The following tests and measurements are recommended at baseline and at regular 3–6 monthly follow-up intervals: weight, blood pressure, blood tests (full blood count at baseline only, except with clozapine, for which more regular monitoring is required), liver function tests, fasting lipids, cholesterol, blood sugar and prolactin (Correll 2008). Glucose, triglyceride and LDL cholesterol levels are strongly affected by eating, therefore fasting blood values should be used. Unfortunately, fasting glucose is a highly insensitive marker because the body compensates by increasing insulin levels before hyperglycaemia develops (Correll 2008). Ideally, measurement of insulin should be available. Haemoglobin A1c is an insensitive screening test, and therefore should only be used for monitoring in patients with diabetes. Prolactin levels should be measured while fasting in the morning, as prolactin levels vary during the day and can be elevated by food, exercise, stress, as well as medications (Correll 2008).

Conclusions

Fortunately, the evidence base for the use of antipsychotics in children and adolescents has increased with a number of RCTs now available. The quality of RCTs is variable, with problems of short duration, unclear allocation, selection bias and participant drop out. Many studies are funded by the pharmaceutical industry. In the majority, however, the statistical analyses with stated primary outcome measures and intention-to-treat analyses are an improvement. The evidence is reasonably strong for antipsychotics being effective in a number of disorders such as psychosis, pervasive developmental disorder, conduct disorder and bipolar disorder; however, the side-effect profile is concerning and requires continuous monitoring.

Advantages and disadvantages

There do not appear to be advantages of SGAs over FGAs in treating psychosis (Armenteros 2006; Kennedy 2007; Sikich 2008). Indeed, the weight gain and metabolic problems associated with SGAs raise important public health concerns given the widespread use of these medications (Sikich 2008). Caution is further heightened by the finding that, generally, side-effects in children and adolescents appear more severe than in adults (Correll 2008). The lower rate of tardive dyskinesia with SGAs (Corell 2007) is potentially an argument in favour of SGAs over FGAs. With the notable exception of clozapine, there is no evidence for greater efficacy of one antipsychotic over another in the treatment of psychosis in this age group, although a recent meta-analysis (Leucht 2009) for adult studies showed some superiority of olanzapine over aripiprazole, quetiapine, risperidone and ziprasidone. Choice may therefore be guided by the side-effect profile and the knowledge that the switching of antipsychotics is not backed by evidence (but see review by Buckley 2008).

Using higher than British National Formulary doses of antipsychotics does not appear effective (only indirect evidence for high-dose olanzapine is available: Kumra 2008) and such practice is not recommended. Indeed, a low-dose strategy is the norm in early-intervention psychosis practice. This is in line with findings from imaging studies which show a therapeutic antipsychotic response is achieved with 70% D2-receptor blockade (Kapur 2000). Importantly, dosing should be more conservative for untreated new-onset patients than for those with multiple episodes (Berger 2008).

Indications for treatment

The increasing prescription of antipsychotics in children and adolescents needs to be examined critically. Although there are recognised indications, there is a danger that these medications will be used as first-line treatments, particularly if psychological treatments are not readily available, as for example in the case of conduct disorder (Doey 2007). This would be unfortunate and a potentially serious error given the side-effect profile of antipsychotics. Several measures might help: adoption of protocols which include reference to NICE guidelines; education for service users and parents; audit of clinicians’ prescribing habits; and making psychological treatments more available and easier to implement. This does raise the question, however, of the relative effectiveness and indications for psychological and drug treatments. Unfortunately, information to help rational prescribing is not readily available. Indeed, there is a pressing need for RCTs of medication, psychological treatments and their combination. Such trials have already been very informative in cases of treating adolescent depression (March 2004; Goodyer 2007).

Current recommendations

The current recommendation is that antipsychotics should only be used as part of a comprehensive treatment plan, which involves psychoeducation and consideration of appropriate psychological and psychosocial interventions. Practising clinicians should be aware of the limited licensing for these medications. Clearly, further guidance backed by evidence is essential.
References


Prescribing antipsychotics for children and adolescents


MCQs
1 The prescription of antipsychotics in children and adolescents in the USA has:
   a remained fairly static since 1999
   b decreased alongside the use of psychosocial treatments
   c increased only marginally
   d increased over sixfold between 1999 and 2002
   e reduced dramatically following FDA warnings.

2 Weight gain as a side-effect of antipsychotic medication:
   a is more frequent in children and adolescents
   b is more frequent with FGAs
   c is of only marginal significance
   d occurs equally with all SGAs
   e is more frequent in adults.

3 Raised prolactin levels:
   a are seen with all SGAs
   b are due to a peripheral effect of antipsychotics
   c continue to rise with continued use of antipsychotic medication
   d are irreversible
   e can lead to sexual side-effects.

4 Clozapine:
   a is not recommended for children and adolescents under 18 years
   b is more effective that other antipsychotics in children and adolescents
   c is not associated with serious side-effects in children and adolescents
   d is recommended as a first-line treatment for schizophrenia
   e unlike other antipsychotics is not associated with weight gain.

5 For children and adolescents with autism, antipsychotic medication:
   a is recommended routinely to treat core deficits
   b is not associated with adverse side-effects
   c has been shown to reduce irritability
   d should be used without other psychosocial interventions
   e is not used owing to the lack of research evidence.