Coffey CE, Cummings JL. (eds.). Textbook of Geriatric Neuropsychiatry (2nd Edition). Washington D.C: American Psychiatric Press, Inc. 2000.

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# Electroconvulsive Therapy

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If major depression were not a serious public health problem in the elderly population, there would be no need to discuss electroconvulsive therapy (ECT) in this book. Yet, major depression is one of the most common and serious illnesses in the elderly (see Chapter 13). In addition to death from suicide, depressive illness is associated with substantial mortality from medical illness (Avery and Winokur 1976). ECT remains the "gold standard" treatment for serious depression and, as such, requires careful consideration as a therapeutic modality. Such consideration is particularly relevant because there is evidence that ECT is especially safe and effective in elderly patients (Consensus Conference 1985) and because of the sensitivity to the side effects of antidepressant medication experienced by the geriatric population. With the burgeoning of psychopharmacological treatments for depression over the past 35 years, many may have believed that ECT was well on its way to extinction; however, we are now no longer sanguine about the efficacy of antidepressant medications for all patients. Even with the most sophisticated psychopharmacological treatment combinations, a substantial proportion of patients remains severely ill. For these patients, it is fortunate that ECT is still available.

The case for ECT is strengthened by its remarkable record of safety. ECT compares favorably with any procedure in all of medicine for its low morbidity and mortality. With recent advances in ECT technique, the safety profile of the treatment continues to be refined, and ECT has enjoyed a resurgence as a more mainstream treatment in the psychiatric armamentarium. Furthermore, it has a predictably rapid onset of effect and can be performed in both inpatient and outpatient settings.

It is widely known that ECT is most commonly used for the treatment of severe depression. We will discuss its use for this indication in depth here, but because this is a textbook of neuropsychiatry, we will also evaluate ECT as a treatment for mood disorders due to a general medical condition such as poststroke depression, as well as for neurological disorders such as Parkinson's disease. As the mind-body dualism separating the fields of psychiatry and neurology dissolves, investigators and clinicians will have further opportunities to explore the potent effects of ECT on functions of the brain as well as of the mind.

## ECT in Geriatric Practice

Considerable evidence exists to demonstrate that a large proportion of patients receiving ECT is elderly. Kramer (1985) reviewed patterns of ECT use in California between 1977 and 1983 and found that the probability of receiving ECT increased with age of the patient. Patients 65 years and older were given ECT at a rate of 3.86/10,000 population, compared with 0.85/10,000 in those 25–44 years old. In an analysis of the data on ECT use in California between 1984 and 1994, Kramer (1999) found similar patterns. Lambourn and Barrington (1986) surveyed the use of ECT from 1972 to 1983 in a British population of 3 million and found that ECT was more common in patients (especially female patients) 60 years or older. In a study of 5,729 psychiatric admissions over 3 years, Malla (1988) found that patients who received ECT in general hospitals were significantly older than patients who did not receive ECT. Babigian and Guttmacher (1984) reviewed a massive data set from the Monroe County (New York) Psychiatric Case Register over three 5-year periods. They found that among patients who were being hospitalized for the first time, those who received ECT were older than those who did not. Thompson et al. (1994) analyzed data from the National Institute of Mental Health Sample Survey Program for 1980 and 1986, which included representative samples of psychiatric inpatients in the United States. These researchers found that approximately one-third of ECT recipients were 65 years or older, a figure far out of proportion to the representation of that age group in the sample (8.2%). In contrast, Hermann et al. (1995) reported that age was not related to ECT use as estimated from the American Psychiatric Association's 1988–1989 Professional Activities Survey.

Several features of the natural history of major depressive illness help to explain the frequent use of ECT in elderly patients. Post (1992) reviewed data suggesting that major affective disorders increase in both severity and cycle frequency with increasing age. In a review of the course of illness of late-onset depression, Alexopoulos (1990) cited evidence for an association between high relapse rates and later onset of illness (Zis and Goodwin 1979). Thus in the geriatric population, the frequency and severity of depressive illness, its impact on quality of life, and the increased sensitivity of the elderly to adverse effects of antidepressant medications, combine to make ECT an attractive and often-used treatment option (Benbow 1987, 1989; McCall et al. 1999; Weiner 1982).

## Medical Physiology of ECT in Elderly Patients

The data on the physiology of ECT have been compiled largely from mixed-age samples, and to our knowledge, few data focus specifically on the physiology of ECT in elderly patients. Clearly, the myriad physiological changes that accompany an ECT seizure take on particular importance in elderly individuals, in whom medical illnesses involving multiple organ systems are so common. In a study of 33 elderly patients (mean age, 74 years) receiving ECT, Gaspar and Samarasinghe (1982) found the incidence of major or minor medical risk factors for ECT to be 75%. Of greatest importance are the physiological effects of ECT on the brain and the cardiovascular system. As described later in this chapter, modifications in ECT technique may be required in patients with brain or cardiovascular disease.

### Cerebral Physiology

With ECT, an electrical stimulus is used to depolarize cerebral neurons and thereby produce a generalized cerebral seizure. The mechanism by which ECT seizures are propagated is not well understood. Bilateral ECT appears to lead to seizure generalization through direct stimulation of the diencephalon, whereas seizures induced with unilateral stimulation may begin focally in the stimulated cortex and then generalize via corticothalamic pathways (Staton 1981).

During the initial phase of the induced seizure, electroencephalographic activity is variable, consisting of patterns of low-voltage fast activity and polyspike rhythms. These patterns correlate with tonic or irregular clonic motor movements. With seizure progression, electroencephalographic activity evolves into a pattern of hypersynchronous polyspikes and waves that characterize the clonic motor phase. These regular patterns begin to slow and eventually disintegrate as the seizure ends, sometimes terminating abruptly in a flat electroencephalogram (EEG) (Weiner and Krystal 1993). The ictal EEG has been the focus of much research, by our group and others, aimed at identifying markers of therapeutic response (discussed in a later section). These studies indicate that age has a major impact on a number of ictal EEG measures and is associated with shorter seizure duration, shorter slow-wave–phase duration, weaker overall strength and patterning, and lower early ictal, midictal, and postictal amplitudes (Krystal et al. 1995, 1998; Nobler et al. 1993).

Transient cumulative changes are also evident on the interictal EEG during a course of ECT. Increased predominance of delta activity on the interictal EEG is seen as a function of the number of ECT treatments given in a course of ECT and their rate of administration (Fink 1979). Asymmetric (left greater than right) decreases in average EEG frequency after a course of ECT have been correlated with increasing age of the patient (Turek 1972; Volavka et al. 1972). (No such relation was reported by Bergman et al. [1953].) Strömgren and Juul-Jensen (1975) found an association between age and postictal slowing with bilateral ECT but not with unilateral nondominant ECT. By 30 days after the ECT course, EEGs resemble baseline EEGs in most patients (Abrams 1997a). The effects of aging on the severity and persistence of interictal electroencephalographic changes have not been extensively studied.

The ECT-induced seizure is also associated with a variety of transient and benign changes in cerebral physiology, including increases in cerebral blood flow, cerebral blood volume (resulting in a transient increase in intracranial pressure), and cerebral metabolism of oxygen and glucose (Bolwig et al. 1977; Brodersen et al. 1973; Prohovnik et al. 1986). The brief increase in intracranial pressure is rarely of clinical consequence, but it is the reason for the well-known proscription against ECT in patients with space-occupying mass lesions. Postictally, cerebral blood flow and metabolism are decreased globally and regionally for at least several hours, and then they return to normal values (Nobler et al. 1994; Rosenberg et al. 1988; Scott et al. 1994; Volkow et al. 1988). Conflicting data exist regarding the interictal effects of ECT, with both reduced (Nobler et al. 1994) and increased (Bonne et al. 1996) cerebral blood flow reported approximately 1 week after a course of ECT. The effects of age on these changes have not been described.

Transient disruptions in blood-brain barrier permeability also occur during the seizure (Bolwig et al. 1977) and may account for the short-lived increase in $T_1$ relaxation times demonstrated by brain magnetic resonance (MR) imaging after ECT (Mander et al. 1987; Scott et al. 1990). The effects of age and associated brain changes on these blood-brain barrier alterations have not been described in humans, but in animals age is associated with more pronounced blood-brain barrier changes after 10 electroconvulsive seizures (Oztas et al. 1990).

## Cardiovascular Physiology

ECT results in a marked activation of the autonomic nervous system, and the relative balance of parasympathetic and sympathetic nervous system activity determines the observed cardiovascular effects (Applegate 1997). Vagal (parasympathetic) tone is increased during and immediately after administration of the electrical stimulus, and this may be manifested by bradycardia or even a brief period of asystole. With development of the seizure, activation of the sympathetic nervous system occurs, resulting in a marked increase in heart rate, blood pressure, and cardiac workload. Peripheral stigmata of sympathetic activation may also be observed and include piloerection and gooseflesh. The tachycardia and hypertension continue through the ictus and generally end along with the seizure. Shortly after the seizure, there may be a second period of increased vagal tone that may be manifested by bradycardia and various dysrhythmias, including ectopic beats. As the patient awakens from anesthesia, there may be an additional period of increased heart rate and blood pressure as a result of arousal and further sympathetic outflow (Welch and Drop 1989).

The cardiovascular responses during ECT combine to produce an increase in myocardial oxygen demand and a decrease in coronary artery diastolic filling time. Transient electrocardiographic changes in the ST segment and T waves are seen in some patients during the procedure, but it is unclear whether these findings are related to myocardial ischemia (Gould et al. 1983; McCall 1997; Wesner 1986; Zvara et al. 1997). A direct effect of central nervous system stimulation on cardiac repolarization has been proposed as an alternative mechanism (Welch and Drop 1989). No corresponding increase in levels of cardiac enzymes has been found to accompany these electrocardiographic changes (Braasch and Demaso 1980). In a study of patients receiving ECT, Messina et al. (1992) obtained echocardiograms during and after ECT treatments and found transient regional wall motion abnormalities more often in patients with ST-T changes on electrocardiograms (ECGs), suggesting a period of demand myocardial ischemia. The clinical importance of these findings remains to be evaluated.

The effects of age on the cardiovascular response to ECT have been examined in only a few modern studies. Shettar et al. (1989) randomly assigned 19 patients (mean age [± SD], 51 ± 21 years; range, 19–84 years) to ECT with pretreatment with glycopyrrolate or with placebo, the alternate pretreatment drug being used for the subsequent ECT treatment (i.e., each patient served as his or her own control). For both types of pretreatment, there was no correlation between age and length of poststimulus asystole. In two controlled studies of mixed-age samples that included elderly patients (Prudic et al. 1987; Webb et al. 1990), no relationship was found between age and ECT-induced changes in heart rate, blood pressure, or rate-pressure product. In a study of relatively younger patients (mean age, 43 years; range, 20–64 years), Huang et al. (1989) noted a significant inverse correlation between age and increases in blood pressure and rate-pressure product.

Although these results suggest that age, per se, is not associated with the extent of the cardiovascular response to ECT, these findings must be interpreted cautiously. Some of the subjects in these studies (especially those who were older) were also receiving antihypertensive drug therapy that may have attenuated their cardiovascular response to the treatments, and (as discussed later in this chapter) other clinical observations suggest that at least some elderly patients with cardiovascular disease may be at risk for marked increases in pulse and blood pressure during ECT (Applegate 1997; Bodley and Fenwick 1966; Gerring and Shields 1982; Zielinski et al. 1993).

## Diagnostic Indications and Efficacy

### Major Depression

The most common indication for ECT in the elderly population remains depression, both unipolar and bipolar. In elderly patients with depression, ECT is typically used as a second-line treatment, after patients have failed to respond to a trial of medication or have exhibited intolerance of the side effects of medication. ECT should be considered a first-line intervention, however, in certain situations: severe suicidality, inanition and malnutrition, history of previous response to ECT, or patient preference (American Psychiatric Association 2000).

Several clinical studies involving mixed-age samples and various diagnoses have found increasing age to be associated with a favorable outcome from ECT (Black et al. 1993; Carney et al. 1965; Coryell and Zimmerman 1984; Folstein et al. 1973; Gold and Chiarella 1944; Kahn et al. 1959; Mendels 1965; Roberts 1959; Strömgren 1973). Investigators in other studies involving older patients have reported a diminished response to unilateral but not bilateral ECT (Heshe et al. 1978; Pettinati et al. 1986; Strömgren 1973) or a requirement for longer courses of treatment (Ottosson 1960; Rich et al. 1984b).

The effects of ECT in elderly patients with depression have been directly examined in a small number of studies, but results are somewhat difficult to compare because of differences in patient samples (e.g., size and diagnosis), ECT technique (e.g., stimulus waveform and dosage and electrode placement), and assessment methodology (Table 35–1). Nevertheless, reported response rates range from 63% to 98%, clearly demonstrating that increasing age, per se, does not have a negative impact on the effectiveness of ECT for depressive illness. Indeed, other data (although uncontrolled) indicate that ECT is associated with reduced chronicity, decreased morbidity, and decreased mortality (Avery and Winokur 1976; Babigian and Guttmacher 1984; Wesner and Winokur 1989).

There are no controlled, prospective, randomized studies comparing the efficacy and side effects of ECT versus drug therapy for treatment of depression in elderly patients. In a retrospective chart review of 112 consecutive geriatric hospital admissions, Meyers and Mei-Tal (1985–1986) compared outcome in depressed patients who had received ECT with outcome in those who had received tricyclic antidepressants (nonrandom assignment) and found that ECT was associated with a better response rate (81% versus 62%) and a lower morbidity rate (0% versus 27%).

Because major depression in elderly patients appears to respond well to ECT, there may be little need to correlate specific clinical features with ECT response. However, in the case of data derived largely from mixed-age samples, a particularly good response to ECT has been associated with the presence of psychosis, catatonia, pseudodementia, pathological guilt, anhedonia, agitation, and neurovegetative signs (Greenberg and Fink 1992; Hickie et al. 1996; Salzman 1982; Zorumski et al. 1988). In a prospective study involving 29 elderly patients (Fraser and Glass 1980), guilt, anhedonia, and agitation were identified as positive prognostic signs. In multiple studies, response to ECT has been particularly good in patients with delusional depression, compared with a nonpsychotic group (Hickie et al. 1996; Mulsant et al. 1991; Pande et al. 1990; Wilkinson et al. 1993), although other studies have found no difference (O'Leary et al. 1995; Rich et al. 1984a, 1986; Sobin et al. 1995; Solan et al. 1988). The use of ECT in agitated or psychotic elderly patients may spare them exposure to neuroleptic agents. This consideration is important, given the high risk of tardive dyskinesia and drug-induced parkinsonism in elderly patients (Jenike 1985; see also Chapter 25).

Several authors have also attempted to identify predictors of nonresponse to ECT. In a retrospective study, Magni et al. (1988) compared elderly patients who responded to ECT and those who did not respond and found that physical illness during the index episode, fewer negative life events preceding the onset of the index episode, and prior depressive episodes of long duration were predictive of nonresponse to ECT. Other investigators have found that longer duration of the index episode predicts poorer outcome (Fraser and Glass 1980; Karlinsky and

**TABLE 35–1. Studies of electroconvulsive therapy (ECT) as a treatment for geriatric depression**

| Study | Subjects | Methods | Findings |
|---|---|---|---|
| Fraser and Glass 1980 | 29 patients (8 men, 21 women)<br>Age 64–86 years<br>Depressive illness by Feighner criteria[a] | Prospective<br>ECT two times/week; chopped sine wave; randomized assignment to bilateral (*n* = 16) or right unilateral (*n* = 13) electrode placement<br>Blinded outcome rating | Both groups had significant reductions in HRSD scores 3 weeks after last treatment, at which point 28 patients (97%) showed "satisfactory" clinical outcome. No group differences in therapeutic response.<br>Average time to reorientation after fifth ECT treatment was 32.8 minutes for bilateral ECT and 9.5 minutes for right unilateral ECT.<br>WMS scores improved during ECT, and 3 weeks after ECT all scores were normal. No group differences. |
| Gaspar and Samarasinghe 1982 | 33 patients (9 men, 24 women)<br>Age 66–88 years (mean ± SD, 73.9 ± 5.7 years)<br>Depression in 28 (85%) of 33 patients; diagnostic criteria unspecified | Prospective<br>ECT two times/week for 3–4 weeks, then one time/week; mean number of ECT treatments, 8.7 (range, 2–29); bilateral<br>Outcome rated as good, intermediate, poor | Good outcome in 26 patients (79%), intermediate outcome in 3 (9%), poor outcome in 4 (12%). |
| Karlinsky and Shulman 1984 | 33 inpatients (11 men, 22 women)<br>Age 62–85 years (mean ± SD, 73.2 ± 5.0 years)<br>DSM-III major depression, single episode, in 12 patients (36.4%); major depression, recurrent, in 18 (54.5%); bipolar disorder in 3 (9.1%) | Retrospective<br>ECT two or three times/week; sine wave; unilateral (*n* = 23, 69.7%), bilateral (*n* = 3, 9.1%), or both (*n* = 7, 21.2%)<br>Nonblinded outcome rating by author consensus from clinical progress notes<br>Follow-up at 3 and 6 months | Immediate "good" response in 14 patients (42.4%), "moderate" response in 12 (36.4%), "poor" response in 7 (21.2%).<br>During 6-month follow-up, 23 patients (69.7%) remained out of hospital and 6 (18.2%) received more ECT.<br>Only one complication (pneumonia), and even this patient was able to complete ECT course. |
| Burke et al. 1985 | 30 patients (7 men, 23 women)<br>Age 60–82 years (mean, 72 years)<br>DSM-III major depression in 24 patients, bipolar disorder in 5 | Retrospective<br>Average number of ECT treatments, 9 (range, 1–25); brief pulse; bilateral in 70%<br>Outcome rating (four-point scale) determined by review of medical records | 92% of patients with major depression improved, and 69% showed complete symptom resolution. |
| Burke et al. 1987 | 136 patients (39 men, 97 women)<br>Mean age of total sample, 48 years; 96 subjects < 60 years (mean ± SD, 39 ± 12.19 years), 40 subjects > 60 years (mean ± SD, 69 ± 6.43 years)<br>81% of total sample had a major affective disorder; diagnoses of elderly subgroup unspecified | Sine wave; bilateral in 87%, unilateral in 73%; mean number (± SD) of ECT treatments, 9 ± 3.6 | 70% of total sample had complete resolution of affective symptoms (61% < 60 years, 75% > 60 years).<br>Complication rates increased with age (35% in older group, 18% in younger group). |
| Kramer 1987 | 50 inpatients (9 men, 41 women)<br>Age 61–88 years (mean, 74.1 years)<br>DSM-III major depression in 49 patients, schizophrenia in 1 | Retrospective<br>ECT three times/week; brief pulse; bilateral all patients<br>Nonblinded assessment by author's chart review | 46 patients (92%) "much improved" after ECT.<br>No serious medical complications. |
| Godber et al. 1987 | 163 patients (43 men, 120 women)<br>Mean age, 86 years; all > 65 years<br>Primary depression by Feighner criteria[a] in 153 patients (94%), psychotic symptoms in 80 (49%) | ECT two times/week for most patients, three times/week for those slow to respond; sine wave; right unilateral in 155 patients (95%); mean number of ECT treatments, 11.2 | 83 patients (51%) "fully recovered," 37 (23%) "much improved," 34 (21%) poor response. |
| Magni et al. 1988 | 30 patients (14 men, 16 women)<br>Mean age, 73.9 years<br>DSM-III major depression | Retrospective<br>ECT two or three times/week initially, then once weekly; bilateral in all patients; minimum of 7 ECT treatments (range, 7–12)<br>Independent clinical rating by two psychiatrists | 19 patients (63%) responded to ECT. |

*(continued)*

**TABLE 35–1. Studies of electroconvulsive therapy (ECT) as a treatment for geriatric depression *(continued)***

| Study | Subjects | Methods | Findings |
|---|---|---|---|
| Coffey et al. 1988 | 44 inpatients (18 men, 26 women) with leukoencephalopathy<br>Age 60–86 years (mean, 73 years)<br>DSM-III major depression in all patients | Retrospective<br>ECT three times/week; brief-pulse, "moderately suprathreshold" stimulus; average number of ECT treatments, 9 (range, 6–14)<br>Nonblinded global ratings of clinical response | "Excellent" response in 54%, "good" response in 44%. |
| Coffey et al. 1989 | 51 inpatients (15 men, 36 women)<br>Age 60–90 years (mean, 71.3 years)<br>DSM-III major or bipolar depression in 49 patients, organic affective disorder in 2 | Prospective<br>ECT three times/week; brief pulse; unilateral ($n$ = 38), bilateral ($n$ = 3), or both ($n$ = 10); mean number of ECT treatments, 9 (range, 5–18)<br>Nonblinded observer and patient self-rating | 42 patients (82%) met criteria for full therapeutic response.<br>No association between ECT response and brain white matter abnormalities on magnetic resonance images. |
| Mulsant et al. 1991 | 42 inpatients (7 men, 35 women)<br>Age 60–89 years (mean ± SD, 73.5 ± 7.3 years)<br>DSM-III major depression | Prospective<br>ECT three times/week; brief pulse; unilateral ($n$ = 29, 69%), bilateral ($n$ = 3, 7%), or unilateral and then bilateral ($n$ = 10, 24%); mean number of ECT treatments, 8.3 (range, 4–13)<br>HRSD, BPRS, and MMSE scores, used for outcome rating, obtained by research nurses | 28 patients (67%) had excellent response to ECT (50% decrease in HRSD score).<br>38 patients had decrease in BPRS score.<br>No significant change in mean MMSE scores for group. |
| Rubin et al. 1991 | 101 inpatients (19 men, 82 women)<br>Mean age (± SD), 76.0 ± 6.4 years<br>DSM-III unipolar depression | Retrospective<br>46 patients (46%) received ECT (technique not described), some in combination with antidepressant drug therapy; 65 (64%) received antidepressant drug therapy only; nonrandomized<br>Nonblinded retrospective outcome rating by unit director | Relative to patients treated with drug therapy, those who received ECT had significantly lower final BDI scores, greater reduction in BDI scores, and higher frequency of ratings of "major improvement" (78% vs. 42% for non-ECT group). |
| Kellner et al. 1992 | 15 patients (11 men, 4 women)<br>Age 53–87 (mean, 69.9 years)<br>DSM-III major depression | Prospective<br>Blinded rating of outcome measures including cognitive assessment and antidepressant response<br>Randomized assignment to ECT one time/week or three times/week for 3 weeks; brief pulse; bilateral | All patients improved. Mean HRSD scores decreased from 27 to 12 in three times/week group and from 29 to 20 in one time/week group.<br>No difference in cognitive effects between groups. |
| Wilkinson et al. 1993 | 78 patients (23 men, 55 women)<br>Four age groups (18–39, 40–64, 65–74, and 75–88 years)<br>43 patients > 65 years (mean, 68.96 years in age 65–74 group and 79.50 years in age 75–88 group)<br>DSM-III major depression with melancholia or psychosis | Prospective<br>ECT two times/week; right unilateral in 5 patients (6%), bilateral in rem ainder; mean number of ECT treatments, 7.9<br>Nonblinded cognitive and affective ratings<br>Positive response to ECT defined as ≥ 50% reduction in Montgomery Asberg Depression Rating Scale | Positive response to ECT in 73% of patients ≥ 65 years and 54% of patients < 65 years.<br>Age associated with response to ECT, and with more improvement in cognition on MMSE with ECT. |
| Casey and Davis 1996 | 19 patients (8 men, 16 women)<br>Mean age 79.5 years<br>DSM-III major depression in 18 patients; bipolar disorder depressed in 1 | Retrospective<br>Brief-pulse ECT (22 courses); nonrandomized electrode placement (bilateral, $n$ = 13; unilateral, $n$ = 1; both, $n$ = 8)<br>Nonblinded assessment of "complication," "confusion,"and clinical response (4-point scale) | Clinical response (rating of ≥ 3) achieved in 19 (86.3%) courses. Response associated with younger age, lower ASA rating, and absence of neurological disorder.<br>Complications in 5 patients: dental (1), cardiovascular (2), urinary retention (1), and confusion (1). |

*(continued)*

**TABLE 35–1. Studies of electroconvulsive therapy (ECT) as a treatment for geriatric depression *(continued)***

| Study | Subjects | Methods | Findings |
|---|---|---|---|
| Tomac et al. 1997 | 34 patients > 85 years old (79% female)<br>Mean age 81 years (range 85–96)<br>DSM-III-R major depression (85%), bipolar disorder (9%), depressive disorder NOS (3%), delusional disorder (3%), and dementia NOS (59%) | Retrospective<br>Brief-pulse ECT three times/week (mean, 7 ECTs); nonrandomized electrode placement (unilateral, 65%; bilateral, 18%; and both 17%); stimulus dosage at 150%–200% initial seizure threshold<br>Nonblinded assessment of therapeutic response and treatment complications | Significant increase in GAF (mean, 8.2 points, $n = 30$) and significant decrease in HRSD (mean, 5.7 points, $n = 16$) and BPRS (mean, 47.2 points, $n = 18$).<br>Significant increase in MMSE scores (mean, 2.6 points, $n = 20$)<br>Treatment complications in 27 (79%): most common included confusion or delirium (32%), transient hypertension (67%), and arrhythmia (24%) |
| Gormley et al. 1998 | 67 patients > 75 years old (73% female)<br>Mean age 79.4 years (range 75–91)<br>ICD-10 recurrent depression (78%), bipolar disorder (15%), or depressive disorder (7%) | Retrospective<br>Brief-pulse ECT twice weekly (mean, 6.7 ECTs); nonrandomized electrode placement (bilateral, 95%; unilateral, 2%; both, 3%)<br>Nonblinded assessment of therapeutic response (4-point scale), "complications,""confusion," and "memory impairment" | Marked improvement in 53% and moderate improvement in 32%<br>Complications in 11% (prolonged confusion, 6.5%; hypomania, 4%; hypertension, 2%; headache, 2%) |
| Tew et al. 1999 | 268 women<br>Adults (< age 60 years), 133 patients; young-old (age 60–74 years), 63 patients; old-old (≥ age 75 years ), 72 patients<br>DSM-III-R major depression | Prospective<br>Brief-pulse ECT three times/week; nonrandomized electrode placement (bilateral, $n = 22$; unilateral, $n = 136$; both, $n = 87$); stimulus dosage at 2.5 times initial seizure threshold<br>Nonblinded assessment of therapeutic response (HRSD score ≤ 10 at 3 days post last ECT) and of MMSE scores | Adult group had lower response rate (54%) than young-old group (73%), whereas old-old group had an intermediate rate of response (67%); no relation of response to burden of medical illness.<br>Only adult group showed significant decline in MMSE scores at 3 days post ECT. |

*Note.* BDI = Beck Depression Inventory; BPRS = Brief Psychiatric Rating Scale; DSM-III = Diagnostic and Statistical Manual of Mental Disorders, 3rd Edition (American Psychiatric Association 1980); HRSD = Hamilton Rating Scale for Depression; MMSE = Mini-Mental State Exam; WMS = Wechsler Memory Scale.
[a]See Feighner et al. 1972.

Shulman 1984). Previous courses of ECT and increased age at the time of first treatment with ECT have been linked with a slower response rate to ECT, with no effect on eventual positive outcome (Rich et al. 1984b; Salzman 1982; Shapira and Lerer 1999). These limited data should not discourage the clinician from initiating a trial of ECT in patients with any of the aforementioned predictors of nonresponse. Clinical experience suggests that many elderly patients with these putative predictors of nonresponse often will improve with ECT.

Efforts at using biological markers to predict ECT response in elderly patients have met with equivocal success. A variety of probes have been investigated in mixed-age samples, including the dexamethasone suppression test (DST), the thyrotropin-releasing hormone (TRH) test, and other neuroendocrine tests (Decina et al. 1987; Kamil and Joffe 1991; Kirkegaard et al. 1975; Krog-Meyer et al. 1984; Papakostas et al. 1981; Swartz 1993), as well as polysomnographic studies (Coffey et al. 1988; Grunhaus et al. 1996). None of these laboratory studies appear to be strong "state-specific" markers for major depressive illness, and data are conflicting on whether they can be used serially to follow the course of ECT, predict outcome, or predict early relapse. Nevertheless, a report by Devanand et al. (1991) suggests that consideration of complex technical factors in neuroendocrine testing may enhance the clinical utility of such assessments in ECT.

## Mania

Although extensive clinical experience indicates that ECT is effective for treating both the manic and depressed phases of bipolar illness in elderly patients, formal data for this population are lacking. A small number of controlled studies involving relatively young mixed-age samples have found ECT to be superior to drug therapy (Mukherjee 1988; Mukherjee et al. 1994; Small et al. 1988, 1991). ECT appeared to be particularly effective in mixed bipolar states and agitated mania, conditions that tend to become more prevalent as the illness becomes more chronic and refractory (Calabrese et al. 1993). Many elderly patients with bipolar disorder have reached this more severe phase of the illness and thus may be expected to have a particularly good response to ECT. Anticonvulsant medications are often effective in mixed bipolar disorder (Calabrese et al. 1993), although we are not aware of efficacy studies testing this use of anticonvulsants in elderly patients. ECT itself also has powerful anticonvulsant properties (Coffey et al. 1995b; Sackeim et al. 1983). Whether bilateral ECT is more effective than nondominant unilateral ECT in the treatment of mania remains controversial (Small et al. 1991).

## Schizophrenia and Other Psychotic Disorders

No controlled data exist on the use of ECT in elderly patients with schizophrenia. ECT has been used in relatively younger patients with this illness, and in these patients the presence of affective or catatonic features, an acute onset of illness with relatively brief duration of illness, or a history of response to ECT, correlate with good outcome (American Psychiatric Association 2000). ECT is not very effective for treating the chronic, residual phase of the illness with predominant negative features (Weiner and Coffey 1988). These "deficit" states become more common as the illness progresses (Kaplan and Sadock 1988) and thus should be highly represented in elderly schizophrenic populations, although controlled data on this issue are lacking.

ECT has also been used in elderly patients with other psychotic disorders. Botteron et al. (1991) reported the cases of three elderly patients with late-onset psychosis treated with ECT. None of the patients had major depression or dementia. Two patients with substantial structural brain changes as shown by MR imaging (lateral ventricular enlargement and deep white matter hyperintensities) did not respond to ECT. A third patient with bilateral caudate hyperintensities and normal subcortical white matter did respond to ECT. As will be discussed later, we have noted an excellent response to ECT for major depression in patients with subcortical hyperintensities on magnetic resonance images, including patients with psychotic symptoms and late-age onset (Coffey et al. 1989). To the best of our knowledge, there are no data on the efficacy of ECT in patients with late-onset functional psychoses, such as paraphrenia.

## Concomitant Neurological Disease

There is increasing clinical evidence that ECT may be effective for affective disorders in patients with brain disease (Dubovsky 1986; Hsiao et al. 1987; Krystal and Coffey 1997; Weiner et al., in press; Zwil et al. 1992). In some cases, advantage has been taken of the neurobiological effects of ECT in order to treat the neurological disorder. Issues related to modifications of ECT technique in patients with cerebral disease are discussed later in this chapter.

**Affective disorder in dementia.** Twenty percent to 30% of patients with dementia have marked concomitant depression, and 10%–15% of patients with a diagnosis of dementia actually have the pseudodementia of depression (Price and McAllister 1989; Rummans et al. 1999). Depression may be difficult to diagnose in demented patients. Some dementia patients may be too ill to generate depressive complaints, with affective disorder manifesting itself chiefly as agitated, screaming behavior with neurovegetative signs. Determining whether there is a personal or family history of affective disorder may be helpful in diagnosing depression in these patients (Fogel 1988). Thorough treatment of depression in patients with dementia often does much to enhance quality of life and functional status. (The effectiveness of drug therapy for depression in patients with dementia is discussed in Chapter 34.)

Fisman (1988) reported the case of a man with major depression and profound pseudodementia whose condition was diagnosed incorrectly for 14 years as Alzheimer's disease before his affective disorder was successfully treated with ECT. In a literature review of the cases of 56 patients with dementia and depression treated with ECT, Price and McAllister (1989) found the rate of response of depression to be 73%. ECT effectively treated depression in several subtypes of dementia, including senile dementia of the Alzheimer's type, multi-infarct dementia, and normal-pressure hydrocephalus, as well as the dementias of Parkinson's disease and Huntington's disease (Price and McAllister 1989). Locations of electrodes were not specified in the majority of cases reviewed. Nearly one-third of patients with dementia also had an improvement in cognition after ECT. Delirium was a relatively infrequent complication of ECT in these patients (overall occurrence, 21%), clearing by the time of discharge in all but one patient.

Dementia does not appear to be worsened by ECT. Still, to minimize cognitive side effects of ECT, physicians of patients with dementia may need to pay special attention to issues of concomitant medications, electrode placement, and frequency of treatments (discussed below). Prospective studies are needed to address the efficacy and side effects of ECT in depressed patients with dementia.

**Parkinson's disease.** As discussed in Chapter 26, depression is common in patients with Parkinson's disease, and treatment of depression with medication may be complicated. Pharmacological treatment of the parkinsonism is also limited. Levodopa therapy for Parkinson's disease often has serious side effects and does little to retard the progression of the illness. Increasing doses of the medication are required to maintain motor function but in turn cause more and more debilitating side effects such as hallucinations, dyskinesias, and the on-off phenomenon. Neuroleptics may improve the psychoses and dyskinesia but increase parkinsonism. This situation has led to recent attempts to graft fetal mesencephalic tissue into the brains of patients with Parkinson's disease (Krauss and Jankovic 1996). Despite some encouraging results, these experiments remain fraught with difficulty at multiple levels (Fahn 1992). Pallidotomy and deep brain stimulation are other neurosurgical procedures that have recently been gaining wider acceptance (Arle and Alterman 1999).

In this setting of limited treatment options, reports of the efficacy of ECT in Parkinson's disease offer the hope of a safe and effective treatment (Table 35–2). Case reports document that ECT is an effective treatment for both the motor manifestations of Parkinson's disease and the commonly associated depression (for a review, see Kellner and Bernstein 1993). Interestingly, some patients experience improvement in motor symptoms but not improvement in mood, or vice versa (Kellner and Bernstein 1993; Young et al. 1985).

A group of Swedish investigators (Andersen et al. 1987) performed the most methodologically rigorous trial of ECT in Parkinson's disease. In this double-blind, controlled, crossover-design comparison of real ECT and sham ECT, 9 (82%) of 11 nondepressed elderly patients with the on-off phenomenon experienced substantial improvement in parkinsonian symptoms with ECT, with the improvement lasting 2–6 weeks. Sham ECT was ineffective. Nine patients received bilateral ECT (8 responded, 1 did not respond) and 2 patients received right unilateral ECT (1 responded, 1 did not respond). A total of five to six treatments was given during the active phase of the trial. The stimulus-dosing strategy was not fully detailed in the report.

In a prospective naturalistic study, Douyon et al. (1989) studied seven patients with both Parkinson's disease and major depression. Major improvement in motor function was noted after only two bilateral treatments. Following an average of seven bilateral ECT treatments with "just above threshold" stimulus dosing, mean New York University Parkinson's Disease Rating Scale scores decreased from 65 to 32 (51% improvement). Patients remained well, without further ECT, for 4 weeks to 6 months. Although initial Hamilton Depression Scale scores were determined for all patients (all scores were greater than 20), follow-up scores were determined for only four. Depression scores decreased by a mean of 50% in these patients. In the report of another prospective naturalistic study, Zervas and Fink (1991) described the successful ECT treatment of four nondepressed elderly patients with severe refractory Parkinson's disease. Three of the four patients received bilateral ECT. Stimulus-dosing strategies were not specified. Improvement in parkinsonism rating scores of 20%–40% was observed. Two patients were successfully treated with ongoing maintenance ECT, but once it was discontinued, both patients relapsed within 4–6 weeks. Finally, ECT has also been found to be effective for neuroleptic-induced

**TABLE 35–2. Electroconvulsive therapy (ECT) for the treatment of Parkinson's disease**

| Study | Number of subjects | Diagnosis | ECT course | Treatment response |
|---|---|---|---|---|
| Fromm 1959 | 8 | Parkinson's disease | 5–6 bilateral ECT treatments | Improvement: 5 patients<br>Mild improvement: 2 patients<br>No improvement: 1 patient |
| Brown 1973 | 7 | Parkinson's disease and major depression | Average of 8 ECT treatments (electrode placement unknown) | No improvement in Parkinson's symptoms<br>No improvement in depression |
| Lebensohn and Jenkins 1975 | 2 | Parkinson's disease and depression: 1 patient<br>Parkinson's disease and bipolar disorder, depressed: 1 patient | 4–6 ECT treatments (electrode placement unknown) | Improvement in Parkinson's symptoms: 2 patients<br>Improvement in depressive symptoms: 2 patients |
| Lipper and Bermanzohn 1975 | 1 | Parkinson's disease and psychotic depression | 7 ECT treatments (electrode placement unknown) | Marked improvement in depression<br>Improvement in Parkinson's symptoms |
| Dysken et al. 1976 | 1 | Parkinson's disease and depression | 12 bilateral ECT treatments | Improvement in Parkinson's symptoms<br>Improvement in depressive symptoms |
| Asnis 1977 | 1 | Parkinson's disease and psychotic depression | 6 bilateral ECT treatments | Improvement in Parkinson's symptoms<br>Improvement in depressive symptoms |
| Yudofsky 1979 | 1 | Parkinson's disease and psychotic depression | 10 ECT treatments (electrode placement unknown) | Improvement in Parkinson's symptoms<br>Improvement in depressive symptoms |
| Balldin et al. 1980 | 5 | Parkinson's disease: 5 patients<br>Parkinson's disease and depression: 3 patients | 4–8 bilateral ECT treatments | Improvement in Parkinson's symptoms: 5 patients<br>Improvement in depressive symptoms: 3 patients |
| Balldin et al. 1981 | 9 | Parkinson's disease | 3–8 bilateral ECT treatments | Marked improvement: 5 patients<br>Slight improvement: 2 patients<br>No improvement: 2 patients |
| Ward et al. 1980 | 5 | Parkinson's disease | 6 bilateral ECT treatments | No improvement: 5 patients |
| Holcomb et al. 1983 | 1 | Parkinson's disease and depression | 14 ECT treatments (electrode placement unknown) | Improvement in Parkinson's symptoms<br>Improvement in depressed mood |
| Levy et al. 1983 | 1 | Parkinson's disease and major depression | 10 ECT treatments (electrode placement unknown) | Improvement in Parkinson's symptoms<br>Resolution of depressive symptoms |
| Young et al. 1985 | 1 | Parkinson's disease, major depression, and dementia | 7 right unilateral ECT treatments | Improvement in Parkinson's symptoms<br>No improvement in depressed mood or cognitive function |
| Jaeckle and Dilsaver 1986 | 1 | Parkinson's disease and bipolar disorder, depressed | 9 bilateral ECT treatments | Improvement in Parkinson's symptoms<br>Improvement in depressed mood |

| | | | | |
|---|---|---|---|---|
| Andersen et al. 1987 | 11 | Parkinson's disease | Sham control<br>Bilateral: 9 patients<br>Right unilateral: 2 patients | Improvement: 9 patients |
| Burke et al. 1988 | 3 | Parkinson's disease and depression | 5–8 right unilateral ECT treatments | Improvement in Parkinson's symptoms: 2 patients<br>Improvement in depressed mood: 3 patients |
| Atre-Vaidya and Jampala 1988 | 1 | Parkinson's disease and mania | 12 bilateral ECT treatments | Improvement in Parkinson's symptoms<br>Resolution of manic symptoms |
| Roth et al. 1988 | 1 | Parkinson's disease and bipolar disorder, manic | 10 right unilateral ECT treatments | Improvement in Parkinson's symptoms<br>Resolution of manic symptoms |
| Birkett 1988 | 5 | Parkinson's disease and major depression | Right unilateral ECT (number of treatments unknown) | Improvement in Parkinson's symptoms: 4 patients<br>Improvement in depressive symptoms: 4 patients |
| Douyon et al. 1989 | 7 | Parkinson's disease and major depression | Average of 7 bilateral ECT treatments | Improvement in depressed mood: 7 patients<br>Improvement in Parkinson's symptoms: 7 patients |
| Lauterbach and Moore 1990 | 1 | Parkinson's disease and major depression | 9 ECT treatments (electrode placement unknown) | Improvement in Parkinson's symptoms<br>Improvement in depression |
| Zervas and Fink 1991 | 4 | Parkinson's disease | 8–12 ECT treatments<br>Bilateral: 3 patients<br>Right unilateral: 1 patient | Improvement in Parkinson's symptoms: 4 patients |
| Friedman and Gordon 1992 | 5 | Parkinson's disease and major depression | 7–12 ECT treatments<br>Bilateral: 1 patient<br>Right unilateral: 3 patients<br>Electrode placement unknown: 1 patient | Improvement in depressed mood: 4 patients<br>Improvement in Parkinson's symptoms: 3 patients |
| Holzer et al. 1992 | 1 | Parkinson's disease and major depression | 8 right unilateral ECT treatments | Improvement in Parkinson's symptoms<br>Improvement in depressed mood |
| Oh et al. 1992 | 11 | Parkinson's disease and major depression (10 patients) or mania (1 patient) | 3–9 ECT treatments<br>Bilateral: 1 patient<br>Right unilateral: 9 patients<br>Unilateral then bilateral: 1 patient | Minor improvement in Parkinson's symptoms: 2 patients<br>Improvement in psychiatric symptoms: 6 patients<br>Post-ECT delirium: 7 patients |

parkinsonism (Hermesh et al. 1992).

Rasmussen and Abrams (1991) suggested that the primary indication for ECT in Parkinson's disease be refractoriness to, or intolerance of, antiparkinsonian medication in patients with severe disability from the disease. They recommended that ECT for Parkinson's disease be initiated with right unilateral placement at substantially suprathreshold electrical dosage, with a switch to bilateral ECT if no response is seen after three right unilateral treatments. However, some patients with Parkinson's disease may be at increased risk of developing delirium during ECT (Figiel et al. 1991), a complication that could be worsened by use of bilateral electrode placement. For patients who have clearly benefited from ECT, Rasmussen and Abrams (1991) recommended maintenance ECT administered just frequently enough to maintain improvement. Recently, Aarsland et al. (1997) reported on two additional patients whose Parkinson's disease was successfully treated with maintenance ECT.

The mechanism by which ECT benefits patients with Parkinson's disease is unclear. Rudorfer et al. (1988) found significant increases in cerebrospinal fluid homovanillic acid, the primary metabolite of dopamine in the central nervous system, after a course of ECT. In addition to these presumed presynaptic effects, Fochtmann (1988) found increased dopamine, subtype 1 ($D_1$), receptor binding in the substantia nigra of rats who had electrically induced seizures. She hypothesized that these changes may be associated with other changes in the dopamine system, including upregulation of postsynaptic dopamine, subtype 2 ($D_2$), receptors in the striatum. Another potential dopamine-enhancing mechanism may be the temporary disruption of the blood-brain barrier seen with ECT (Bolwig et al. 1977), allowing an increase in brain concentrations of levodopa. Whatever the mechanism by which dopamine potentiation may occur, levodopa doses may need to be decreased during a course of ECT to avoid dyskinesia and delirium presumably related to dopamine overactivity.

**Poststroke depression.** As discussed in Chapter 27, approximately one-third of patients develop marked depression in the 2 years after a stroke (Robinson and Price 1982; Rummans et al. 1999). In a placebo-controlled trial, Lipsey et al. (1984) found a statistically significant improvement in poststroke depression treated with nortriptyline. In other uncontrolled studies, the response rate to psychostimulants in this population was 47%–52% (Finklestein et al. 1987; Lingam et al. 1988). However, patients with stroke are often quite medically ill and debilitated and may be intolerant of pharmacotherapy. In the study by Lipsey et al. (1984), 35% of patients assigned to receive nortriptyline dropped out because of medication intolerance.

Clinical reports suggest that ECT may also be effective for treating poststroke depression. In a retrospective chart review of 14 patients with poststroke depression (mean age, 66 years) treated with ECT at Massachusetts General Hospital, Murray et al. (1986) found that 86% had marked improvement in depression after ECT. Apparently, no patient exhibited any worsening of neurological deficit, and although formal measures of cognitive status were not reported, 5 of the 6 patients with "cognitive impairment" before ECT showed lessening of this deficit after ECT.

Currier et al. (1992) published retrospective data on 20 geriatric patients with poststroke depression treated with ECT at the same hospital, with predominantly nondominant unilateral electrode placement being used. A "marked or moderate response" to ECT was observed in 95% of patients. No patient experienced any exacerbation of preexisting neurological deficits, but 3 patients exhibited "minor encephalopathic complications" (prolonged postictal confusion and amnesia) and two patients developed "severe interictal delirium requiring neuroleptics." Of note, 7 of their patients (37%) relapsed within a mean of 4 months of discontinuation of ECT, despite ongoing maintenance drug therapy.

Elderly psychiatric patients with no clinical history of stroke often have subcortical white matter hyperintensities on magnetic resonance images, which are believed to be evidence of ischemic cerebrovascular disease. Coffey et al. (1989) found a high rate (82%) of response to ECT in depressed patients with these MRI findings, many of whom had been refractory to antidepressant drug therapy. In addition, the majority of the patients tolerated the course of ECT without major systemic or cognitive side effects. This positive outcome with ECT is especially notable given other data that suggest that subcortical ischemic disease may be associated with depressive illness that is resistant to treatment with antidepressant medications (Fujikawa et al. 1996).

In summary, ECT may be effective for poststroke depression, but controlled prospective data are needed to confirm this clinical impression and to identify patients potentially at risk for the adverse cognitive effects of the treatment.

**Other neuropsychiatric illnesses.** A variety of other mental syndromes secondary to medical conditions in elderly patients may improve with ECT (Hsiao et al. 1987), including catatonia and delirium from many different causes (Fink 1996, 1997; Krystal and Coffey 1997; Strömgren 1997;

Weiner et al. 2000). Indeed, the antidelirium effect of ECT may occur even in the absence of improvement in the conditions that originally caused the delirium. A careful neuropsychiatric evaluation is required in such instances to clarify the etiology, including those conditions that might increase the risk involved in ECT (discussed later in this chapter).

## Issues of ECT Technique Relevant to Elderly Patients

### Pretreatment Evaluation

When a patient is referred for ECT, a focused evaluation of indications and risk factors for the treatment should ensue (American Psychiatric Press 2000; Coffey 1998). The patient's current mental status, neuropsychiatric history (including recent somatic therapies and history of treatment with ECT), and family psychiatric history should be reviewed. In the evaluation of medical risk factors for the treatment, the focus should be on the brain, the cardiovascular system, the musculoskeletal system, and the upper gastrointestinal tract. Any history of head trauma or surgery, seizures, focal or general neurological complaints, angina, congestive heart failure, bony fractures, osteoporosis, spinal disease or trauma, or esophageal reflux should be elicited. Any personal or family history of problems with anesthesia should be noted.

Handedness should be assessed because of its relevance to nondominant unilateral electrode placement (Kellner et al. 1997). Because the hand used for writing is a fallible indicator, patients should be asked which hand they use to throw a ball, cut with a knife, and so on (American Psychiatric Association 2000). A minority of left-handed patients and patients with mixed dominance may have language localized to the right hemisphere. For this reason, if substantial confusion is observed in a left-handed patient after the first right unilateral ECT treatment, consideration should be given to the use of left unilateral electrode placement at the next session. The time required for the patient to become fully oriented after the treatment can be measured for each type of electrode placement, and the treatment series can then be continued using the placement associated with less confusion (Pratt et al. 1971).

A careful documentation of baseline affective and cognitive status is essential in elderly patients before initiation of ECT. In our clinical experience, the Hamilton or Montgomery Asberg Depression Rating Scales and the Mini-Mental State Exam are often helpful standardized instruments that may be used at intervals throughout the ECT course.

A physical examination and basic laboratory tests (e.g., serum potassium assay) should be performed and an ECG obtained before ECT is initiated in elderly patients. Special care should be given to the neurological examination, including the funduscopic examination to rule out papilledema. Further studies, such as a hemogram, serum chemistries, spine X-rays, EEGs, brain computed tomography (CT) scans or magnetic resonance images, and cardiac functional evaluations (Applegate 1997; Coffey 1998; Rayburn 1997), should be ordered as clinically indicated. Elderly patients have an increased occurrence of clinically important incidental brain findings (e.g., aneurysm, subdural hematoma, undiagnosed primary or metastatic brain tumor, and evidence of increased intracranial pressure), and brain imaging may have predictive value as a tool to detect increased risk for some ECT side effects (discussed in a later section) (Coffey 1996). The EEG can be helpful for differentiating between pseudodementia and dementia in some cases (Leuchter 1991). A baseline EEG to determine background frequency may also be helpful for comparison in cases of prolonged encephalopathy after ECT. Roemer et al. (1990) performed quantitative analyses of pre-ECT EEGs in elderly patients with depression and found that normal anterior interhemispheric coherence in the delta frequency band was associated with more clinical improvement, whereas a poorer clinical response was seen in those patients with lower coherence values.

For patients with serious cardiovascular disease, consultation with a cardiologist is often indicated. Once the decision to proceed with ECT has been made, the cardiologist should be asked how best to maximize the patient's cardiovascular function in preparation for, and during, ECT (McCall 1997).

The patient's medications should be carefully reviewed. Typically, all psychotropics are stopped before ECT, although neuroleptics may be used if necessary (Farah et al. 1995). Lithium taken around the time of ECT has been linked to an increased incidence of delirium and seizures (Weiner et al. 1980). These effects may be related to an increase in brain lithium concentration, due to transient opening of the blood-brain barrier with ECT. Most patients should not receive lithium for several days before or after ECT (Kellner et al. 1991a), although exceptions to this rule should be considered in patients who have demonstrated early relapse when not taking the medication.

Antidepressants are usually stopped to avoid cumulative cardiac and central nervous system side effects (Kellner et al. 1991a), although this practice is now being reconsidered. Studies in the early 1960s found no added benefit with tricyclic antidepressant and ECT combination therapy (Seager and Bird 1962). However, in a retrospective chart review of 84 geriatric patients with depression, Nelson and Benjamin (1989) found improved outcome (i.e., the need for fewer treatments) with tricyclic antidepressant and ECT combination therapy. No increase in side effects occurred in the group receiving combination therapy. The study was severely limited by its retrospective design and by the fact that the ECT-only group presumably included more medically ill patients, in whom antidepressant drug therapy may have been stopped for fear of complication (Nelson and Benjamin 1989). Recently, Lauritzen et al. (1996) demonstrated the safety of ECT combined with paroxetine or imipramine, as well as the ability of both antidepressants to decrease relapse in the 6 months after index treatment (although paroxetine was more effective for relapse prevention than was imipramine).

Benzodiazepines may impair the intensity of the therapeutic seizure, thereby decreasing treatment response (Kellner 1997b; Pettinati et al. 1986). The use of these agents in elderly patients may also theoretically increase their susceptibility to cognitive side effects from ECT. Benzodiazepine use thus should be minimized or stopped before ECT.

In patients with epilepsy, the anticonvulsant effect of ECT itself may allow for a temporary decrease in anticonvulsant dose. There are few reported data about the effects of carbamazepine and valproate on the efficacy of ECT. However, because anticonvulsant medications could interfere with the induction of adequate ECT seizures, anticonvulsants prescribed for psychiatric indications (i.e., not for epilepsy) should usually be tapered and discontinued before ECT (Kellner et al. 1997).

Several other specific pharmacological issues require attention. Theophylline levels should be monitored closely, because high blood levels during ECT have been associated with status epilepticus (Abrams 1997a). Echothiophate, an organophosphate glaucoma medication that irreversibly inhibits cholinesterase and pseudocholinesterase, may cause prolonged apnea when combined with succinylcholine and should not be given (Zorumski et al. 1988). Likewise, donepezil (Aricept) and tacrine (Cognex), reversible cholinesterase inhibitors used as cognition enhancers in patients with Alzheimer's disease, could increase the duration of succinylcholine muscle relaxation (*Physicians' Desk Reference* 1999). Otherwise, patients should take any required cardiac, antireflux, or other medications with a sip of water the morning of the ECT session.

A final and critically important component of the pre-ECT evaluation is the informed consent procedure. According to the 1999 American Psychiatric Association Task Force report on the practice of ECT, adequately informed consent should involve "1) the provision of adequate information, 2) a patient who is capable of understanding and acting intelligently upon such information, and 3) the opportunity to provide consent in the absence of coercion" (American Psychiatric Association 2000). Compared with younger patients, those over 65 appear to be less aware that they can refuse ECT (Malcolm 1989). With the increased prevalence of cognitive impairment in elderly patients, competency to consent becomes a major issue, and the education of both patient and family becomes essential. This is also a time in the patient's life cycle when children are becoming increasingly responsible for their parents, and the patient's children should be involved in the consent process whenever possible. Incompetent patients may require the judicial appointment of a legal guardian for consent. (For a pertinent sample of an informed consent document, see American Psychiatric Association 2000).

Recently, there has been a shift to performing ECT on an outpatient basis. Many centers have found this to be a viable and efficient way to offer the treatment, as long as certain precautions are taken (Association for Compulsive Therapy 1996). First, the patient's psychiatric illness must allow for safe management outside the hospital. Clearly, acute suicidality or agitated psychosis will often require inpatient hospitalization. Second, the patient's medical status should be stable enough for safe outpatient management. Additionally, strong social support is required; family members or others must transport the patient to and from the treatment facility, ensure the patient takes nothing by mouth (NPO) for at least 8 hours before a treatment session, and provide supervision between treatments (with particular attention paid to ensuring that the patient refrains from driving and making important financial or personal decisions while experiencing cognitive side effects) (Fink 1994). For some patients, it is helpful to administer the first (or several initial) ECT treatment on an inpatient basis and then switch to outpatient treatments once it has been established that outpatient treatments can be administered safely and comfortably.

## ECT Technique

In the United States, ECT is commonly given as a series of single treatments on alternate mornings. Elderly individuals typically receive ECT initially in an inpatient setting. Patients have been previously evaluated for coexisting medical conditions and indications for treatment, and the consent process has been initiated. The treatment team consists of a psychiatrist, an anesthesiologist, and specially trained nursing personnel. ECT is typically given in either a special treatment suite or the recovery area of an operating room suite. Patients should have nothing to eat or drink for at least 8 hours before treatment. Once baseline vital signs and an ECG have been obtained and pulse oximetry has been performed, the short-acting barbiturate methohexital is given at a dosage of approximately 1 mg/kg body weight iv, followed by the depolarizing neuromuscular blocker succinylcholine, given at a dosage of 0.75–1.5 mg/kg body weight iv. Adequacy of neuromuscular blockade is monitored by the use of a peripheral nerve stimulator or by clinical assessment of relaxation, including loss of reflexes and tone.

Throughout the procedure, the patient is ventilated with 100% oxygen and blood oxygen saturation is monitored using a pulse oximeter. Heart rate and blood pressure are also closely monitored. After a specially designed bite block is inserted into the patient's mouth, a predetermined electrical stimulus is delivered across electrodes placed on the patient's properly prepared scalp. Typically, a generalized seizure ensues, lasting from 20 to 90 seconds. The seizure is monitored by electroencephalography and by observation of the motor manifestations of the seizure, a blood pressure cuff having been inflated above systolic pressure on the right ankle to prevent access of the succinylcholine to the right foot. Ventilatory support is continued until the patient emerges from the anesthesia, and further recovery is provided in an environment with as little stimulation as possible. The entire procedure takes about 20 minutes, and patients are often able to have breakfast within an hour of the time of treatment.

A typical course of ECT consists of 6–12 treatments, although occasionally patients may require fewer or more treatments to achieve full response. The treatment schedule is often modified in elderly patients to lessen cognitive side effects, with treatments given once or twice per week rather than three times per week (American Psychiatric Association 2000; Freeman 1995; Lerer et al. 1995; Zervas et al. 1993). ECT is stopped when maximal clinical improvement is thought to have been achieved or when further improvement is not noted between treatments. Special attention is then given to continuation/maintenance treatment with either medication or ECT (discussed in a later section).

## Anesthesia Considerations

Brief, light general anesthesia is used during ECT to render the patient unconscious during (and thus amnesic for) the procedure. Methohexital is the agent of choice because it has rapid onset and a brief duration of action and induces minimal postanesthesia confusion. Methohexital also appears to have a lesser anticonvulsant effect than thiopental, propofol, or alfaxalone with alfadolone (Althesin) (Bergsholm and Swartz 1996). Still, because methohexital is an anticonvulsant, and because the seizure threshold is often increased in elderly patients (see the following section), the lowest effective anesthetic dose is desirable. Because methohexital dosing is based on lean body mass, the required methohexital dosage in many elderly patients may be less than 1 mg/kg total body weight (Fragen and Avram 1990). In some cases, etomidate is a reasonable alternative to methohexital, but it is more expensive and is associated with pain on infusion, longer cognitive recovery time, and short-term adrenocortical suppression.

The preferred neuromuscular blocking agent for ECT is succinylcholine, primarily because it has rapid onset and a brief duration of action. The use of succinylcholine may require special consideration in the elderly patient. Succinylcholine stimulates muscarinic cholinergic receptors in the sinus node and may cause bradycardia, especially if serial doses are required. This effect may be pronounced in patients receiving β-blockers and those with evidence of preexisting conduction delay on ECGs, both frequently the case among elderly patients. Pretreatment with anticholinergics, such as atropine or glycopyrrolate, will block this bradycardiac effect (the use of anticholinergic premedication is discussed in greater detail later in this chapter). Patients with extensive burns or trauma, or with severe spasticity or paralysis, may have an exaggerated extracellular release of potassium in response to succinylcholine (R. D. Miller and Savarese 1990). Use of a nondepolarizing muscle relaxant should be considered in these patients. Myalgia following ECT may be due to either the fasciculation caused by succinylcholine or excessive motor movement during the seizure. Fasciculation may be blocked in subsequent ECT treatments by administering a small pretreatment dose (e.g., 3 mg) of *d*-tubocurarine.

Intragastric pressure also increases with use of succinylcholine, related to abdominal skeletal muscle fasciculation; however, the risk of gastric reflux and aspiration is reduced by a concomitant increase in esophageal pressure above the lower esophageal sphincter (R. D. Miller and Savarese 1990). Certain groups of elderly patients (e.g., those with hiatal hernia, gastroparesis, or morbid obesity) are at risk for substantial gastroesophageal reflux during the procedure, with subsequent risk for aspiration pneumonitis (Zibrak et al. 1988). Smokers are particularly prone to morbidity from aspiration (Lichtor 1990). In these patients, additional strategies beyond requiring NPO status before a session may be considered to decrease gastric volume and acidity during ECT. Premedication with histamine, subtype 2 ($H_2$), receptor antagonists or sodium citrate decreases gastric acidity, and metoclopramide increases lower esophageal sphincter tone and promotes gastric emptying (Lichtor 1990).

## Stimulus Dosing

Seizure threshold (the amount of electricity required to elicit a seizure) increases with age (Coffey et al. 1995a; Sackeim et al. 1991). This effect is believed to be the result of a decrease in the excitability of the brain but may also be partially due to increases in skull thickness (electrical resistance) with aging. Older patients thus require higher ECT stimulus intensities (doses) than do younger patients, but the optimal stimulus dosage for ECT has yet to be determined. Data from mixed-age samples suggest that barely suprathreshold stimulus intensities may be ineffective (especially for unilateral nondominant ECT), whereas excessive stimulus dosing has been linked to more cerebral toxicity (Sackeim et al. 1993; Weiner et al. 1986). Given these data, our clinical practice is to use stimulus dosing in unilateral ECT that is at least 2.5 times the patient's seizure threshold. This method of stimulus dosing requires a determination of the patient's seizure threshold, which may be done routinely at the first ECT session by increasing stimulus intensity in fixed increments over successive stimulations until a seizure results (Coffey et al. 1995a; Kellner et al. 1997; Sackeim et al. 1987). For bilateral ECT, we use a stimulus dose that is 1.5 times the seizure threshold, because the efficacy of this modality appears to be less sensitive to dosing effects than that of unilateral ECT.

Seizure threshold increases during ECT (the well-known anticonvulsant effect), necessitating increases in stimulus dose during the course of therapy (Coffey et al. 1990, 1995b; Kellner et al. 1997; Sackeim 1991; Sackeim et al. 1991). This effect does not appear to be more pronounced in elderly patients, but because this population has a higher initial seizure threshold, some older patients may eventually require stimulus intensities during their course of treatment that exceed the maximal settings of the ECT device. In such instances, we have found administration of caffeine to be an effective and well-tolerated strategy for augmenting ECT seizures in elderly patients (Coffey et al. 1987, 1990; Lurie and Coffey 1990). Higher-powered ECT devices (available in some European countries) are also helpful. The effects of cerebral disease and age-related changes in brain structure on ECT seizure threshold have not been described but are currently under study in our laboratories.

## Electrode Placement

The choice of unilateral or bilateral ECT in the elderly patient is often a complex one. Studies in mixed-age samples suggest that right unilateral ECT has fewer cognitive side effects (Weiner et al. 1986). Most research has also found unilateral and bilateral ECT to be equally effective (American Psychiatric Association 2000); however, in those studies in which differences have been noted, bilateral ECT has consistently been found to be more effective (for a review, see Abrams 1997a).

Few studies have addressed the issue of electrode placement specifically in elderly patients. In a meta-analysis of the literature, Pettinati et al. (1986) found a trend for improved efficacy in elderly patients receiving bilateral treatment. In the only reported randomized study, 29 elderly patients with depression were assigned either to unilateral or bilateral ECT two times a week (Fraser and Glass 1980). Stimulus-dosing strategies were unclear. No group differences were observed in terms of therapeutic response or memory performance after ECT, but those subjects randomized to bilateral electrode placement required more time to become reoriented after the fifth ECT treatment (Table 35–1). Whether the effects of cerebral disease or age-related structural brain changes modify the therapeutic or adverse effects of unilateral versus bilateral ECT in elderly patients has not been studied.

Thus, limited data exist to guide the choice of ECT electrode placement in elderly patients with neuropsychiatric illness. Our approach is to begin with right unilateral ECT in elderly patients, switching to bilateral ECT if minimal or no response is seen by the fifth or sixth treatment. Because bilateral ECT may have a more rapid onset of action, it may be considered the treatment of choice in patients in urgent need of care. If intolerable cognitive side effects develop with bilateral ECT, the treatment may be changed to unilateral ECT once the affective disorder has begun to respond. Finally, atypical electrode placements (e.g., left unilateral, right frontotemporal–left frontal, or bifrontal) may be clinically useful in some elderly patients (Kellner 1997a; Letemendia et al. 1993; Manly and Swartz 1994).

## Seizure Monitoring

The seizure may be monitored indirectly by observation of the convulsive motor response of a "cuffed" extremity, but more direct monitoring with ictal electroencephalography is preferred. The ECT seizure is monitored to confirm that a seizure has occurred and to determine when it has ended (Kellner et al. 1997; Weiner and Krystal 1993). More recently, the ictal EEG has been studied using sophisticated computer analysis to determine whether various indices such as amplitude, regularity, or coherence may be predictive of treatment efficacy (Krystal et al. 1995, 1996; Weiner and Krystal 1993). These studies suggest that such measures hold promise for indicating seizure adequacy during treatment sessions.

## Continuation/Maintenance ECT

Major depression is increasingly recognized as a chronic, relapsing condition. Some studies have found 6-month relapse rates as high as 50% for patients initially responsive to antidepressant medications who are then given no form of continuation/maintenance therapy (Prien and Kupfer 1986). Similarly high rates of relapse have been noted after response to ECT if no form of continuation/maintenance therapy is given (Imlah et al. 1965; Jarvie 1954). Frank et al. (1990) found that relapse rates after response to pharmacotherapy can be substantially reduced by continuation of antidepressant medication at full dose.

ECT is one of the few treatments in modern medicine that is commonly stopped as soon as it has proven effective. Usual clinical practice involves administration of continuation/maintenance pharmacotherapy after successful ECT. Because these patients often failed to respond to medication therapy before ECT, it is not surprising that a 50% relapse rate at 1 year was found for patients receiving maintenance pharmacotherapy after response to ECT (Sackeim et al. 1990). In that study, there was a particular propensity to relapse within 4 months after successful ECT.

Results of a growing number of studies involving mixed-age samples indicate that continuation/maintenance ECT is safe and effective for the prevention of depressive relapse, and there are several promising retrospective studies involving elderly patients (for a review, see Monroe 1991). Thienhaus et al. (1990) described the cases of six elderly patients with major mood disorder treated with maintenance ECT for a period of 1–6 years. While receiving maintenance ECT, patients spent significantly fewer days in the hospital per year on average, compared with the interval prior to beginning maintenance ECT.

Dubin et al. (1992) reported the successful use of maintenance ECT for an average of 22 months in a group of eight patients over age 75. The single patient in the case series who required rehospitalization had been previously withdrawn from maintenance ECT by her attending psychiatrist and placed on fluoxetine. No major adverse events were associated with maintenance ECT in this case series.

Loo et al. (1991) described the use of maintenance ECT in seven elderly patients over an average of 3 years. Mean time in the hospital during this 3-year period decreased to 3 weeks, compared with 27 weeks for patients treated during the 3 years before the introduction of maintenance ECT. Patients had 1.4 recurrences of illness during the maintenance ECT period, compared with 4.7 recurrences for patients during the 3 years preceding maintenance ECT.

In one of the few prospective studies to date, we (Clarke et al. 1989) evaluated 27 patients (mean age, 65 years; range, 26–90 years) not taking psychotropic medications who were assigned to a continuation ECT protocol after initial response to ECT. Only 8% of patients who completed the continuation ECT protocol required rehospitalization, whereas 47% of those who did not complete the protocol relapsed (a statistically significant difference).

Studies comparing continuation/maintenance ECT with continuation/maintenance pharmacotherapy after response to ECT are lacking in the literature. As of this writing, a multisite study comparing treatment with nortriptyline, nortriptyline plus lithium, and placebo after successful ECT is nearing completion (Sackeim 1997) and a second multisite study comparing continuation ECT and treatment with nortriptyline plus lithium has been initiated (C.H. Kellner, A.J. Rush, M. Fink, T. Rummans, unpublished data, 1996). Interim results of the former indicate high relapse rates after ECT for patients (mixed-age group) receiving monotherapy (approximately 75%) compared with patients receiving nortriptyline plus lithium (approximately 40%).

Continuation/maintenance ECT typically involves single treatments given initially at weekly intervals, with the frequency gradually reduced to every 4–8 weeks, as the patient's depressive symptoms allow. The increased interval between maintenance treatments results in fewer cognitive side effects than with an index course of ECT, leading to the suggestion that bilateral treatment may be the modality of choice for continuation/maintenance ECT (Kellner et al. 1991c). Several factors determine whether the treatments can be given on an outpatient basis. Patients must reliably follow NPO orders for 6–8 hours before treatment (patients are permitted only a sip of water to take any required premedications). Patients must also have an adequate support system to assure observation and care for several hours after treatment. If these criteria cannot be met, or if the patient has complex medical or recovery needs, an overnight stay in the hospital may be required.

# Adverse Effects of ECT and Their Management

The safety of ECT compares favorably with that of any treatment requiring general anesthesia. The mortality is variously reported as approximating three deaths per 100,000 treatments (the same as for general anesthesia for minor surgery) and may actually be decreasing as medical management of underlying illnesses improves (Abrams 1997a). To put these data into perspective, Abrams (1997b) noted that ECT is 10 times safer than childbirth and that the risk of dying from being struck by lightning is 6 times higher than the risk of dying from ECT.

Kroessler and Fogel (1993) compared the mortality during long-term follow-up of 65 depressed patients age 80 or older who had been treated with ECT with that of patients treated with other modalities. The 2-year survival rate was 54% in the group treated with ECT, versus 90% in the group treated with medications. This group difference was related to more severe depression and physical illness in the patients who had received ECT. The course of ECT itself was remarkably well tolerated by these elderly patients, with a median interval between ECT and time of death of 20 months. The authors called for further attention to medical comorbidity as a prognostic factor in future outcome studies of geriatric depression. Abrams (1997b) noted that the estimated mortality rate among community-dwelling elderly patients (approximately 0.26% per each 3 weeks) was an order of magnitude higher than that observed after a 3-week course of eight ECT treatments in elderly patients (approximately 0.016%).

## Cardiovascular Side Effects

A proportion of elderly patients referred for ECT have serious preexisting cardiovascular disease. Common cardiac conditions such as hypertension, angina, previous myocardial infarction, atrial and ventricular arrhythmia, aneurysm, and conduction system disease require evaluation and optimized treatment before ECT, to minimize any adverse effects from the hemodynamic events that occur during ECT.

Uncontrolled retrospective studies comparing the cardiovascular complication rate of ECT in older and younger patients have found an increase in transient and treatable complications in elderly patients. In a nonblinded, retrospective chart review of 293 patients, Alexopoulos et al. (1984) found cardiovascular complications in 9% of the patients age 65 and over, compared with 1% of the patients under 65. Cardiac ischemia, arrhythmia, hypertension, and congestive heart failure were the most common complications, although the vast majority of complications were not clearly temporally related to ECT and did not prevent the completion of treatment. Burke et al. (1987) conducted a similar retrospective chart review of 136 subjects, 30% of whom were age 60 and over. Sine wave bilateral ECT was used in 85% of cases. These investigators found a cardiorespiratory complication rate of 15% in patients age 60 and over, compared with 3% in those under 60. Complications were correlated with the number of cardiovascular medications the patient was receiving, with more medication presumably marking those with more cardiovascular illness. These complications did not affect treatment response. In a chart review of 81 elderly patients, Cattan et al. (1990) found a 36% cardiovascular complication rate with ECT in patients over age 80, compared with 12% in younger geriatric patients. As would be expected, the older patients had notably more medical diagnoses and were receiving more cardiovascular medication than the younger patients.

More recently, two controlled studies of ECT in a total of 66 high-risk patients with cardiovascular disease have demonstrated the safety of ECT in elderly individuals. Zielinski et al. (1993) compared the rate of cardiac complications in a group of 40 depressed patients (mean age, 68.9 years; range, 54–84 years) with serious preexisting cardiac disease (left ventricular impairment, conduction delay, and ventricular arrhythmias) with the rate of such complications in a group of 40 depressed patients (mean age, 68.3 years; range, 55–83 years) without cardiac disease. Not surprisingly, the group with preexisting cardiac disease had more complications. Most of the complications were transient (e.g., brief arrhythmias or increases in ectopy), however, and 38 of the 40 cardiac patients were able to complete their course of ECT. This group of depressed patients with cardiac disease had even more difficulty with adverse cardiac effects from prior trials of tricyclic antidepressants; 11 of 21 patients had been forced to stop tricyclic treatment because of cardiovascular complications. Rice et al. (1994) used a case-control design to compare two groups of patients over age 50 receiving ECT. One group consisted of 26 patients at increased risk for cardiac complications, and 27 patients at standard risk made up the other group. Compared with the patients at standard risk for cardiac complications, patients in the high-risk group were older, had received more pre-ECT medical consultations before ECT, and experienced more minor medical complications from ECT. However, the two groups did not differ in terms of frequency of major medical complications, and no patients died or experienced permanent cardiac morbidity from ECT.

The data just reviewed suggest that ECT is a low-risk procedure, even in elderly patients (Applegate 1997). Still, prospective studies, carefully controlled for severity of cardiovascular and other medical disease, are needed to evaluate the effects of age on cardiovascular complications of ECT.

Increasingly sophisticated medical management during ECT should decrease the cardiovascular risk of treatment in elderly patients (Applegate 1997; Weiner et al., in press). The primary areas of concern are bradycardia, tachycardia, hypertension, and ventricular arrhythmia. Anticholinergic premedications (atropine and glycopyrrolate) may be used to prevent vagally induced bradycardia, but in elderly patients their use may be complicated by confusion, tachycardia, constipation, and urinary retention. We generally reserve the use of anticholinergic premedication for patients who develop unusually prolonged or severe bradyarrhythmias. The method of serial electrical stimulations to determine a patient's seizure threshold (described earlier) may involve administration of subconvulsive stimuli, with a vagal surge unaccompanied by the sympathetic outflow associated with a seizure. The use of this method, as well as the presence of conduction delay on the ECG, may indicate the need for premedication with an anticholinergic, particularly if the patient is also receiving a β-blocker medication.

Hypertension and tachycardia during ECT in elderly patients may be attenuated by short-acting intravenous β-blockers such as labetalol or esmolol (Howie et al. 1990; Stoudemire et al. 1990). It should be kept in mind that β-blockers have anticonvulsant effects, and their use during ECT may limit the intensity of the ECT seizure and, in turn, its therapeutic potency. Kalayam and Alexopoulos (1989) described the safe use of sublingual nifedipine before administration of anesthesia in an elderly patient with a severe hypertensive response to ECT. Hydralazine (an α-adrenergic antagonist), as well as nitroglycerine (sublingual, transdermal, or intravenous), may also be used when clinically indicated. Trimethaphan produces transient sympathetic and parasympathetic ganglionic blockade and has also been used in this setting (Maneksha 1991). Although the hemodynamic responses to ECT are robust, they are well tolerated by most patients, including elderly individuals (Webb et al. 1990). In addition, indiscriminate use of antihypertensive medication may lead to clinically important hypotension in elderly patients. Therefore, we do not routinely blunt the cardiovascular response to ECT in elderly patients unless such changes are extreme or are clearly associated with evidence of cardiovascular compromise. Finally, in patients receiving adrenergic blockers, anticholinergic premedication should be considered so as to prevent a disproportionate decrease of sympathetic tone below parasympathetic tone, with resultant bradycardia (Abrams 1997a).

Marked posttreatment ventricular ectopy (multifocal premature ventricular contractions [PVCs] or several consecutive PVCs) may be treated with lidocaine (1–1.5 mg/kg body weight). Because of its anticonvulsant properties, lidocaine should be given after termination of the seizure (Drop and Welch 1989). Stoudemire et al. (1990) found that ventricular ectopy could also be reduced by pretreatment with labetalol.

## Cerebral Side Effects

There is no evidence that ECT causes structural brain damage (Devanand et al. 1994; Weiner 1984). Carefully controlled prospective brain imaging studies in humans reveal no changes in brain structure for up to 6 months after a course of ECT (Coffey 1993; Coffey et al. 1991). Neuropathological studies in animals, including cell counts in regions thought to be at highest risk, reveal no evidence of brain damage when the seizures are induced under conditions that approximate standard clinical practice (i.e., when the seizures are spaced, relatively brief, and modified by oxygenation and muscle relaxation). Furthermore, studies of the pathophysiology of seizure-induced structural brain damage in animals indicate that the conditions necessary for injury do not apply to the modern practice of ECT (Weiner 1984).

The incidence of cerebrovascular complications with ECT is exceedingly rare. ECT has been given successfully to patients with cerebral aneurysms, with close management of blood pressure elevation (Krystal and Coffey 1997). The intracerebral hemorrhage reported in a normotensive patient during ECT was probably related to cerebral amyloid angiopathy (Weisberg et al. 1991). We know of no other reported case of intracerebral hemorrhage with ECT, nor of any documented case of ischemic stroke during the treatment.

The amount of time that must elapse before ECT can be safely administered after an acute cerebral infarction is unclear. Alexopoulos et al. (1984) reported the uneventful delivery of ECT 4 days after a cerebral infarct (whether it was hemorrhagic or ischemic was not specified), and others (Currier et al. 1992; Murray et al. 1986) reported successful ECT 1–2 months after ischemic stroke. Patients with a recent cerebral infarction may have more friable vasculature with a propensity to rebleed. These patients require time for cerebral vessels to heal before ECT, as well as careful management of blood pressure during the procedure. Titratable agents with short half-lives (e.g., esmolol or nitrates) are helpful in this situation. Care must be taken to avoid hypotension in all elderly patients with cerebrovascular disease.

Other intracranial processes are risk factors for ECT. As described earlier, intracranial mass lesions and increased intracranial pressure are among the most serious risk factors for ECT. In a retrospective literature review, Maltbie et al. (1980) examined 28 patients (mean age, 47 years; range, 20–80 years) with brain tumor who were treated with ECT. Only 34% of patients improved, and 74% showed neurological deterioration, with 29% dying from neurological complications within a month of ECT. This study was flawed by a form of recall bias, with cases involving dramatic outcomes more likely to be reported. As well, a previously undiagnosed brain tumor would more likely be diagnosed during a treatment course involving complications than during an uneventful ECT course. Abrams (1997a) and Kellner (1996) reviewed reports of several cases of safe delivery of ECT to patients with brain tumors, mostly meningiomas, and ascribed the lessened risk to the fact that the tumors were small and slow growing and had no associated increased intracranial pressure. There is no report of safely delivered ECT prospectively given to a patient with documented increased intracranial pressure (Abrams 1997a). Subdural hematomas may require evacuation before ECT (Abrams 1997a).

## Side Effects in Other Organ Systems

Other organ systems that may be impaired in the elderly patient need to be considered before ECT, including the lungs, bones, eyes, and teeth (Weiner et al. 1999). Pulmonary status should be optimized before ECT. Patients with severe chronic obstructive pulmonary disease and carbon dioxide retention may require special ventilatory strategies during the treatment (Abrams 1997a). Pneumonia secondary to aspiration of gastric contents may occur rarely during ECT (Alexopoulos et al. 1989; Karlinsky and Shulman 1984).

Patients with osteoporosis, spinal disk disease, or spondylosis may require increased muscular relaxation during ECT. Such patients should receive succinylcholine doses of at least 1.0–1.5 mg/kg body weight, and they require careful attention to clinical evidence of adequate relaxation (e.g., loss of reflexes or tone, and disappearance of fasciculation) before delivery of the stimulus. Kellner et al. (1991b) reported the safe treatment of a patient with osteoporosis and cervical spondylosis with multiple subluxations of the cervical spine using succinylcholine doses of 1.3 mg/kg weight.

Because ECT produces a transient increase in intraocular pressure, patients with chronic open-angle glaucoma should receive their eyedrops before ECT. As noted earlier, treatment with echothiophate, an irreversible cholinesterase inhibitor, should be stopped several days before ECT. Patients with acute closed-angle glaucoma or retinal detachment should be stabilized before ECT and watched closely by an ophthalmologist during an ECT course.

When a patient's teeth are loose, decayed, or asymmetrical, the risk of dental injury during ECT may be increased. A major proportion of malpractice litigation with ECT is related to dental issues (Slawson 1985). A specially designed bite block must be inserted before delivery of the ECT stimulus. The tongue, cheeks, and lips must be kept clear of the clenching teeth. The bite block should be used even in edentulous patients. Occasionally, upper or lower dentures may be kept in place during the treatment to facilitate airway management. In patients with only a few remaining, and possibly loose, teeth, dental consultation or alternative bite block strategies (with the aim of shifting bite pressure to the molars) may be helpful (Welch 1993).

## Cognitive Side Effects

The cognitive side effects of ECT include acute postictal confusion, impaired retrograde and anterograde memory, and, occasionally, interictal delirium. The severity of these adverse effects is increased with bilateral electrode placement, sine waveform, higher stimulus dose relative to seizure threshold, and more frequent treatments. Conversely, cognitive side effects are reduced with right unilateral electrode placement, brief-pulse waveform, lower stimulus dose relative to seizure threshold, and longer intervals between treatments (American Psychiatric Association 2000). Although it has been suggested that elderly patients may be at greater risk for these cognitive side effects than are younger patients, controlled data on this issue are limited.

**Acute postictal disorientation.** In studies involving mixed-age samples of adults, increasing age has been found to be associated with longer or more severe disorientation immediately after ECT (Burke et al. 1987; Calev et al. 1991; Daniel et al. 1987; M.E. Miller et al. 1986; Sackeim et al. 1987). Additional risk factors for post-ECT confusion in elderly patients may include presence of major medical illness or use of psychotropic medications during ECT.

In one of the studies focusing on elderly patients, Fraser and Glass (1978) measured time to recovery of full orientation in nine elderly patients with depression who received ECT in courses in which electrode placement alternated (i.e., unilateral placement in one treatment followed by bilateral placement in the next treatment, and so on). When comparing these reorientation times with those reported in the literature for younger patients, the investigators observed that recovery in elderly patients took five times as long for unilateral treatment and nine times as long for bilateral treatment. Recovery time after bilateral ECT increased cumulatively over the course of ECT, and with closer spacing of treatments. No such relationship was found for unilateral ECT. In a subsequent study of 29 elderly patients with depression randomly assigned to courses of either unilateral (*n* = 13) or bilateral (*n* = 16) sine wave ECT, Fraser and Glass (1980) found significantly longer reorientation times after the fifth ECT session among patients receiving bilateral treatments (32.8 minutes) than among those receiving unilateral treatments (9.5 minutes) (Table 35–1). In contrast to the group undergoing bilateral ECT, patients receiving unilateral ECT had a significant reduction in recovery time from the first to the last treatment.

In a study of subjective side effects during ECT, Devenand et al. (1995) found that older patients actually reported fewer severe cognitive symptoms (i.e., confusion/disorientation and amnesia) than did younger patients.

**Agitated delirium on emergence from anesthesia.** Approximately 10% of patients receiving ECT experience an acute agitated delirium on emergence from anesthesia, characterized by restlessness, disorientation, combativeness, and poor response to commands. Age does not appear to be a risk factor for this complication (Devanand et al. 1989). The complication is usually effectively treated with intravenous benzodiazepines (e.g., midazolam or diazepam) or other sedatives (e.g., droperidol or methohexital).

**Interictal delirium.** In a small proportion of patients, ECT is associated with more prolonged disorientation and even frank interictal delirium. Most studies evaluating interictal delirium in elderly patients have used disorientation as a measure, rather than the full DSM-III-R (American Psychiatric Association 1987) or DSM-IV (American Psychiatric Association 1994) criteria for delirium. In a retrospective study involving 136 patients receiving mainly bilateral sine wave ECT, Burke et al. (1987) found disorientation (confusion severe enough to alter the treatment plan) in 18% of patients older than 60 but in 13% of younger patients. This incidence increased to 25% for patients over age 75. In a retrospective study in which mostly bilateral (waveform not specified) ECT was administered, Alexopoulos et al. (1984) found a somewhat greater incidence of confusion (disorientation to time, place, and person) in elderly patients (12.6%) than in younger patients (9.6%). Cattan et al. (1990) conducted a study involving primarily bilateral or combination bilateral-unilateral sine wave ECT and found a nonsignificant trend for more frequent severe disorientation (defined functionally by interference in ward activities) in elderly patients over 80 (59%, *n* = 39), compared with those patients 65–80 years old (45%, *n* = 42).

In the study of Alexopoulos et al. (1984), elderly patients with a history of underlying organic brain disease were found to have higher levels of severe post-ECT confusion than were the younger patients, suggesting that baseline cerebral impairment may increase the risk of adverse cognitive effects of ECT.

In several studies, subcortical structural disease has been implicated in the development of interictal delirium with ECT. We have found subcortical gray and white matter lesions to be more extensive in elderly patients who developed a prolonged interictal delirium during a course of ECT. The majority of these patients were able to continue ECT, with no decline in expected treatment response. All patients were free of delirium 1 week after ECT (Coffey et al. 1989; Figiel et al. 1990). The specificity of subcortical disease in producing delirium after ECT is further suggested by Martin et al. (1992), who found that patients with ischemic lesions of the caudate nucleus had a 92% incidence of delirium during ECT. Patients with a previous stroke in other brain regions had the same incidence of delirium as did a group of elderly depressed control (no stroke) subjects receiving ECT (Martin et al. 1992). In a prospective study of seven consecutive patients with Parkinson's disease, Figiel et al. (1991) found a 100% incidence of interictal delirium during a course of ECT. The delirium lasted 7–21 days, longer than is typical, but 86% of patients recovered from depression. Whether the delirium was due to subcortical disease or to increased intracerebral concentration of levodopa (due to transient breakdown of the blood-brain barrier with ECT) is unknown.

In summary, although the duration and severity of acute post-ECT disorientation may increase with age, the majority of elderly patients appear to recover their orientation within 60–120 minutes of the treatment. In the small percentage of elderly patients who develop more prolonged confusion or frank delirium, underlying cerebral impairment may be contributory, especially dysfunction of the basal ganglia. Clearly, more research is needed in a larger number of elderly patients to characterize post-ECT confusion and to identify its risk factors, including the effects of preexisting cerebral impairment.

**Amnesia.** A course of ECT is associated with transient disturbances in memory, including both retrograde and anterograde amnesia. Retrograde amnesia (forgetting of material known before the ECT) may extend back to several months before ECT and is more pronounced with bilateral electrode placement, sine waveform, grossly suprathreshold stimulus intensity, and increased treatment frequency (Abrams 1997a). These same factors also increase anterograde amnesia (forgetting of information acquired after the start of ECT). These side effects subside within weeks of completion of ECT, but some patients may have permanent loss of specific memories for some events that occurred before, during, or shortly after the treatment course. Although some patients may report persistent memory difficulties, objective testing has demonstrated that ECT is not likely to produce persistent impairment in the ability to remember past information or acquire new information (American Psychiatric Association 2000).

Given the large body of data on the amnestic effects of ECT, it is surprising that there has been relatively little controlled research on age as a risk factor (Abrams 1997a; Calev et al. 1993; Fink 1979). Some (Fromholt et al. 1973; Heshe et al. 1978) but not all (d'Elia and Raotma 1977; Strömgren et al. 1976) early studies found that ECT-induced amnesia is worse in older patients.

Zervas et al. (1993) examined age effects on memory in a study comparing twice-weekly and three-times-a-week bilateral ECT administered using contemporary techniques (pulse waveform given at "moderately suprathreshold" stimulus intensity). The sample consisted of 42 inpatients with a mean age (± SD) of 53.5 ± 16.1 years; no patient was older than 65 years, however. Correlations were found between age and decrements in retrograde memory 1–3 days after the end of ECT but not 1 month or 6 months posttreatment. Age was also correlated with decrements in verbal anterograde memory acutely and 1 month after ECT (but not 6 months after ECT) and with changes in figural anterograde memory acutely and 6 months after ECT.

McElhiney et al. (1995) examined autobiographical memory in a mixed-age sample (mean age [± SD], 54 ± 13.9 years) of 75 patients with depression randomly assigned with regard to electrode placement and stimulus intensity. Age was found to be a predictor of lower recall of autobiographical memories after ECT. In a follow-up report on this sample, the pre-ECT modified Mini-Mental State Exam score was predictive of the extent of retrograde autobiographical amnesia both 1 week and 2 months after ECT (Sobin et al. 1995). This study provided evidence in support of the conventional clinical wisdom that preexisting cognitive deficit is a risk factor for more severe ECT-induced amnesia. Work is under way by our group to determine whether age-related structural changes on brain images might also be predictive of cognitive impairment after ECT (Coffey 1996).

Memory performance has been reported to improve in elderly patients with the pseudodementia of depression who are treated successfully with ECT (Reynolds et al. 1987; Stoudemire et al. 1995). In the study of Fraser and Glass (1980) described earlier (also see Table 35–1), all elderly patients showed impairment of memory function before ECT, but during treatment, memory improved and was normal in all patients by 3 weeks after completion of the ECT course. No group differences were found on the basis of electrode placement.

There has been relatively little research into the effects of age on subjective memory complaints after ECT. As noted previously, Devanand et al. (1995) found that older patients actually reported fewer severe cognitive symptoms (i.e., confusion/disorientation and amnesia) than did younger patients.

In summary, recent controlled data appear to support the clinical wisdom that elderly patients are at greater risk for the amnestic side effects of ECT. More work is needed in a larger number of elderly patients (especially very old patients) to characterize the extent and severity of ECT-induced amnesia and to identify relevant risk factors, including the effects of preexisting cerebral impairment. Recommendations for lessening ECT amnesia in elderly patients include using unilateral electrode placement and brief pulse stimuli, avoiding maximally suprathreshold stimulus dosing, and lessening the frequency of treatments (e.g., giving ECT on Monday and Friday instead of Monday, Wednesday, and Friday). A variety of pharmacological agents have shown antiamnestic activity in animal models of ECT, but clinical trials in humans have been limited by methodological issues (Prudic et al. 1998).

## Psychosocial Issues

In addition to its myriad biological effects, ECT has important intrapsychic and interpersonal effects. A powerful treatment, during which the patient is put to sleep and has an electrical stimulus delivered to the head, may arouse predictable fears and fantasies in the patient. Issues of trust and autonomy over one's body while in a vulnerable position may predominate, especially in patients with a history of trauma. Patient education—in particular, educational videotapes—may be effective and reassuring for these fears. Patients who are vulnerable to idealized fantasies of a nurturant, all-caring, supportive other may overvalue the ECT procedure and practitioner. Conversely, these patients may excessively devalue the treatment when their distorted expectations are not realized. Such patients may be at increased risk for a bad psychological outcome from the treatment. Overidealization of the treatment should be challenged by the ECT practitioner, and the informed consent process should be firmly grounded in factual information.

Patient attitude surveys indicate that those undergoing ECT typically find the experience no more upsetting than a trip to the dentist (Fox 1993; Hughes et al. 1981; Malcolm 1989). In the only study that has systematically examined the effects of age on patients' perception and knowledge of ECT, Malcolm (1989) found that patients over 65 had less knowledge of the procedure before treatment and were also less fearful of it. In addition, fewer elderly patients viewed the treatment as frightening after completing a course of ECT.

Medicolegal issues surrounding the use of ECT in elderly patients include the informed consent process (discussed earlier in this chapter), do-not-resuscitate (DNR) orders, and consideration of driving after ECT. A patient with DNR status may still experience improved quality of life with aggressive treatment of his or her affective disorder and may still be considered for ECT (Sullivan et al. 1992). In such cases, strategies for the management of major complications that could occur during ECT should be discussed with the patient and the family before treatment. Patients should not drive until that point after a course of ECT when cognitive side effects have substantially resolved (Fink 1994). This issue may be an especially sensitive one for elderly patients who consider driving a means of maintaining their mobility and functional independence.

Financial concerns are of increasing importance in today's cost-conscious health care marketplace. A growing literature suggests that ECT has economic advantages over other forms of treatment for severe mood disorders. The cost-effectiveness of ECT has been demonstrated for both inpatient treatment of the index episode as well as for maintenance therapy on an ambulatory basis (Markowitz et al. 1987; McDonald et al. 1998; Olfson et al. 1998; Steffens et al. 1995). Despite these advantages, there remains much variation in ECT reimbursement patterns, and it is not uncommon to encounter payers who will reimburse only for ECT when it is given on an inpatient basis. In addition, reimbursement rates are very low and thus discourage the use of this safe and highly effective treatment.

## Transcranial Magnetic Stimulation

Transcranial magnetic stimulation (TMS) is a relatively new technology that uses an electrically induced magnetic field to generate small electrical currents that can depolarize brain neurons. Repeated TMS (rTMS) can cause repeated neuronal firing that (depending on a variety of technical factors related to the TMS, as well as possible host factors) can either augment or suppress neuronal network functioning. Many ECT research groups throughout the world are currently investigating rTMS as a possible antidepressant treatment. Most studies have been open trials, relatively few elderly patients have been studied, and results indicate that there are minimal side effects but only modest improvements in mood (for a concise review, see George 1998). Although it is unclear what role rTMS will play in the management of elderly patients who are candidates for ECT, rTMS holds great promise as a tool for understanding the neurobiology of mood regulation.

## Conclusions

Sixty years after its introduction, ECT remains a cornerstone of the treatment of severe affective disorder and selected other neuropsychiatric illnesses in elderly patients. Recent modifications in ECT technique have reduced the risk of severe side effects in this population. There is, however, a paucity of controlled studies comparing the efficacy and safety of ECT versus pharmacotherapy in elderly patients. ECT also appears to be an effective treatment in patients with preexisting brain disease and in some cases may even have a beneficial effect on the underlying neurological disorder. Further study is needed to determine the impact of age-related changes in brain structure or function and of preexisting cerebral disease on the beneficial and adverse effects of ECT in the elderly.

## References

Aarsland D, Larsen JP, Waage O, et al: Maintenance electroconvulsive therapy for Parkinson's disease. Convulsive Therapy 13:274–277, 1997

Abrams R: Electroconvulsive Therapy, 3rd Edition. New York, Oxford University Press, 1997a

Abrams R: The mortality rate with ECT. Convulsive Therapy 13:125–127, 1997b

Alexopoulos GS: Clinical and biological findings in late-onset depression, in American Psychiatric Press Review of Psychiatry, Vol 9. Edited by Tasman A, Goldfinger SM, Kaufman CA. Washington, DC, American Psychiatric Press, 1990, pp 249–262

Alexopoulos GS, Shamoian CJ, Lucas J, et al: Medical problems of geriatric psychiatric patients and younger controls during electroconvulsive therapy. J Am Geriatr Soc 32: 651–654, 1984

Alexopoulos GS, Young RG, Abrams RC: ECT in the high-risk geriatric patient. Convulsive Therapy 5:75–87, 1989

American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders, 3rd Edition, Revised. Washington, DC, American Psychiatric Association, 1987

American Psychiatric Association: The Practice of Electroconvulsive Therapy: Recommendations for Treatment, Training and Privileging, 2nd Edition. Washington, DC, American Psychiatric Association, 2000

American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders, 4th Edition. Washington, DC, American Psychiatric Association, 1994

Andersen K, Balldin J, Gottfries CG, et al: A double-blind evaluation of electroconvulsive therapy in Parkinson's disease with "on-off" phenomena. Acta Neurol Scand 76:191–199, 1987

Applegate RJ: Diagnosis and management of ischemic heart disease in the patient scheduled to undergo electroconvulsive therapy. Convulsive Therapy 13:128–144, 1997

Arle JE, Alterman RL: Surgical options in Parkinson' disease. Med Clin North Am 83:483–498, 1999

Asnis G: Parkinson's disease, depression, and ECT: a review and case study. Am J Psychiatry 134:191–195, 1977

Atre-Vaidya N, Jampala V: Electroconvulsive therapy in parkinsonism with affective disorder. Br J Psychiatry 152: 55–58, 1988

Avery E, Winokur G: Mortality in depressed patients treated with electroconvulsive therapy and antidepressants. Arch Gen Psychiatry 33:1029–1037, 1976

Babigian HM, Guttmacher LB: Epidemiologic considerations in electroconvulsive therapy. Arch Gen Psychiatry 41: 246–253, 1984

Balldin J, Eden S, Granerus A-K, et al: Electroconvulsive therapy in Parkinson's syndrome with "on-off" phenomenon. J Neural Transm 47:11–21, 1980

Balldin J, Granerus A-K, Lindstedt G, et al: Predictors for improvement after electroconvulsive therapy in parkinsonian patients with "on-off" symptoms. J Neural Transm 52: 199–211, 1981

Benbow SM: The use of electroconvulsive therapy in old age psychiatry. Int J Geriatr Psychiatry 2:25–30, 1987

Benbow SM: The role of electroconvulsive therapy in the treatment of depressive illness in old age. Br J Psychiatry 155: 147–152, 1989

Bergman PS, Gabriel AR, Impastato DJ, et al: EEG changes following ECT with the Reiter apparatus. Conferences Neurology 12:347–351, 1953

Bergsholm P, Swartz CM: Anesthesia in electroconvulsive therapy and alternatives to barbiturates. Psychiatric Annals 26: 709–712, 1996

Birkett DP: ECT in parkinsonism with affective disorder (letter). Br J Psychiatry 152:712–713, 1988

Black DW, Winokur G, Nasrallah A: A multivariate analysis of the experience of 423 depressed inpatients treated with electroconvulsive therapy. Convulsive Therapy 9:112–120, 1993

Bodley PO, Fenwick PBC: The effects of electroconvulsive therapy on patients with essential hypertension. Br J Psychiatry 112:1241–1249, 1966

Bolwig T, Hertz M, Paulson O, et al: The permeability of the blood-brain barrier during electrically induced seizures in man. J Clin Invest 7:87–93, 1977

Bonne O, Krausz Y, Shapira B, et al: Increased cerebral blood flow in depressed patients responding to electroconvulsive therapy. J Nucl Med 37:1075–1080, 1996

Botteron K, Figiel GS, Zorumski CF: Electroconvulsive therapy in patients with late-onset psychoses and structural brain changes. J Geriatr Psychiatry Neurol 4:44–47, 1991

Braasch ER, Demaso DR: Effect of electroconvulsive therapy on serum isoenzymes. Am J Psychiatry 137:625–626, 1980

Brodersen P, Paulson OB, Bolwig TG, et al: Cerebral hyperemia in electrically induced epileptic seizures. Arch Neurol 28:334–338, 1973

Brown G: Parkinsonism, depression and ECT (letter). Am J Psychiatry 132:1084, 1973

Burke WJ, Rutherford JL, Zorumski CF, et al: Electroconvulsive therapy and the elderly. Compr Psychiatry 26:480–486, 1985

Burke WJ, Rubin EH, Zorumski CF, et al: The safety of ECT in geriatric psychiatry. J Am Geriatr Soc 35:516–521, 1987

Burke W[J], Peterson J, Rubin E: Electroconvulsive therapy in the treatment of combined depression and Parkinson's disease. Psychosomatics 29:341–346, 1988

Calabrese JR, Woyshville MJ, Kimmel SE, et al: Mixed states and bipolar rapid cycling and their treatment with divalproex sodium. Psychiatric Annals 23:70–78, 1993

Calev A, Cohen R, Tubi N, et al: Disorientation and bilateral moderately suprathreshold titrated ECT. Convulsive Therapy 7:99–110, 1991

Calev A, Pass HL, Shapira B, et al: ECT and memory, in The Clinical Science of Electroconvulsive Therapy. Edited by Coffey CE. Washington, DC, American Psychiatric Press, 1993, pp 125–142

Carney MWP, Roth M, Garside RF: The diagnosis of depressive syndromes and the prediction of ECT response. Br J Psychiatry 111:659–674, 1965

Casey DA, Davis MH: Electroconvulsive therapy in the very old. Gen Hosp Psychiatry 18:436–439, 1996

Cattan RA, Barry PP, Mead G, et al: Electroconvulsive therapy in octogenarians. J Am Geriatr Soc 38:753–758, 1990

Clarke TB, Coffey CE, Hoffman GW, et al: Continuation therapy for depression using outpatient electroconvulsive therapy. Convulsive Therapy 5:330–337, 1989

Coffey CE: Structural brain imaging and electroconvulsive therapy, in The Clinical Science of Electroconvulsive Therapy. Edited by Coffey CE. Washington, DC, American Psychiatric Press, 1993, pp 73–92

Coffey CE: Brain morphology in primary mood disorders: implications for ECT. Psychiatric Annals 26:713–716, 1996

Coffey CE: The pre ECT evaluation. Psychiatric Annals 28:506–508, 1998

Coffey CE, Weiner RD, Hinkle PE, et al: Augmentation of ECT seizures with caffeine. Biol Psychiatry 22:637–649, 1987

Coffey CE, Figiel GS, Djang WT, et al: Leukoencephalopathy in elderly depressed patients referred for ECT. Biol Psychiatry 24:143–161, 1988

Coffey CE, Figiel GS, Djang WT, et al: White matter hyperintensity on magnetic resonance imaging: clinical and neuroanatomic correlates in the depressed elderly. J Neuropsychiatry Clin Neurosci 1:135–144, 1989

Coffey CE, Figiel GS, Weiner RD, et al: Caffeine augmentation of ECT. Am J Psychiatry 147:579–585, 1990

Coffey CE, Weiner RD, Djang WT, et al: Brain anatomic effects of ECT: a prospective magnetic resonance imaging study. Arch Gen Psychiatry 48:1013–1021, 1991

Coffey CE, Lucke J, Weiner RD, et al: Seizure threshold in electroconvulsive therapy, I: initial seizure threshold. Biol Psychiatry 37:713–720, 1995a

Coffey CE, Lucke J, Weiner RD, et al: Seizure threshold in electroconvulsive therapy, II: the anticonvulsant effect of ECT. Biol Psychiatry 37:777–788, 1995b

Consensus Conference: electroconvulsive therapy. JAMA 254:2103–2108, 1985

Coryell W, Zimmerman M: Outcome following ECT for primary unipolar depression: a test of newly proposed response predictors. Am J Psychiatry 141:862–867, 1984

Currier MB, Murray GB, Welch CC: Electroconvulsive therapy for post-stroke depressed geriatric patients. J Neuropsychiatry Clin Neurosci 4:140–144, 1992

Daniel WF, Crovitz HF, Weiner RD: Neuropsychological aspects of disorientation. Cortex 23:169–187, 1987

Decina P, Sackeim HA, Kahn DA, et al: Effects of ECT on the TRH stimulation test. Psychoneuroendocrinology 12:29–34, 1987

d'Elia G, Raotma H: Memory impairment after convulsive therapy: influence of age and number of treatments. Acta Psychiat Nervenkr 223:219–226, 1977

Devanand DP, Briscoe KM, Sackeim HA: Clinical features and predictors of postictal excitement. Convulsive Therapy 5: 140–146, 1989

Devanand DP, Sackeim HA, Lo ES, et al: Serial dexamethasone suppression tests and plasma dexamethasone levels. Arch Gen Psychiatry 48:525–533, 1991

Devanand DP, Dwork AJ, Hutchinson ER: Does ECT alter brain structure? Am J Psychiatry 151:957–970, 1994

Devanand DP, Fitzsimons L, Prudic J, et al: Subjective side effects during electroconvulsive therapy. Convulsive Therapy 11:232–240, 1995

Douyon R, Serby M, Klutchko B, et al: ECT and Parkinson's disease revisited: a "naturalistic" study. Am J Psychiatry 146:1451–1455, 1989

Drop LJ, Welch CA: Anesthesia for electroconvulsive therapy in patients with major cardiovascular risk factors. Convulsive Therapy 5:88–101, 1989

Dubin WR, Jaffe R, Roemer R, et al: The efficacy and safety of maintenance ECT in geriatric patients. J Am Geriatr Soc 40:706–709, 1992

Dubovsky SL: Using electroconvulsive therapy for patients with neurological disease. Hosp Community Psychiatry 37:819–825, 1986

Dysken M, Evans H, Chan C, et al: Improvement of depression and parkinsonism during ECT: a case study. Neuropsychobiology 2:81–86, 1976

Fahn S: Fetal-tissue transplants in Parkinson's disease. N Engl J Med 327:1589–1590, 1992

Farah A, Beale MD, Kellner CH: Risperidone and ECT combination therapy: a case series. Convulsive Therapy 11: 280–282, 1995

Feighner JP, Robins E, Guze SB, et al: Diagnostic criteria for use in psychiatric research. Arch Gen Psychiatry 26:57–63, 1972

Figiel GS, Coffey CE, Djang WT, et al: Brain magnetic resonance imaging findings in ECT-induced delirium. J Neuropsychiatry Clin Neurosci 2:53–58, 1990

Figiel GS, Hassen MA, Zorumski C, et al: ECT-induced delirium in depressed patients with Parkinson's disease. J Neuropsychiatry Clin Neurosci 3:405–411, 1991

Fink M: Convulsive Therapy: Theory and Practice. New York, Raven, 1979

Fink M: Convalescence and ECT. Convulsive Therapy 10:301–303, 1994

Fink M: Neuroleptic malignant syndrome and catatonia: one entity or two? Biol Psychiatry 39:1–4, 1996

Fink M: Catatonia, in Contemporary Behavioural Neurology. Edited by Trimble M, Cummings J. Butterworth/Heinemann, Oxford, UK, 1997, pp 289–309

Fink M, Abrams R, Bailine S, et al: Ambulatory electroconvulsive therapy: report of a task force of the Association for Convulsive Therapy. Convulsive Therapy 12:42–55, 1996

Finklestein SD, Weintraub RJ, Karmooz N, et al: Antidepressant drug treatment for post-stroke depression: a retrospective study. Arch Phys Med Rehabil 68:772–778, 1987

Fisman M: Intractable depression and pseudodementia: a report of two cases. Can J Psychiatry 33:628–630, 1988

Fochtmann L: A mechanism for the efficacy of ECT in Parkinson's disease. Convulsive Therapy 4:321–327, 1988

Fogel BS: Electroconvulsive therapy in the elderly: a clinical research agenda. Int J Geriatr Psychiatry 3:181–190, 1988

Folstein M[F], Folstein S, McHugh PR: Clinical predictors of improvement after electroconvulsive therapy of patients with schizophrenic, neurotic reactions, and affective disorders. Biol Psychiatry 7:147–152, 1973

Fox HA: Patients' fear of and objection to electroconvulsive therapy. Hosp Community Psychiatry 44:357–360, 1993

Fragen RJ, Avram MJ: Barbiturates, in Anesthesia, 3rd Edition, Vol 1. Edited by Miller RD. New York, Churchill Livingstone, 1990, pp 225–242

Frank E, Kupfer DJ, Perel JM, et al: Three year outcomes for maintenance therapies in recurrent depression. Arch Gen Psychiatry 47:1093–1099, 1990

Fraser RM, Glass IB: Recovery from ECT in elderly patients. Br J Psychiatry 133:524–528, 1978

Fraser RM, Glass IB: Unilateral and bilateral ECT in elderly patients: a comparative study. Acta Psychiatr Scand 62: 13–31, 1980

Freeman CP (ed): The ECT Handbook: The Second Report of the Royal College of Psychiatrists' Special Committee on ECT. London, Royal College of Psychiatrists, 1995

Friedman J, Gordon N: Electroconvulsive therapy in Parkinson's disease: a report on five cases. Convulsive Therapy 8:204–210, 1992

Fromholt P, Christensen AL, Strömgren LS: The effects of unilateral and bilateral electroconvulsive therapy on memory. Acta Psychiatr Scand 49:466–478, 1973

Fromm GH: Observation on the effects of electroshock treatment in patients with parkinsonism. Bulletin of Tulane University 18:71–73, 1959

Fujikawa T, Yokota N, Muraoka M, et al: Response of patients with major depression and silent cerebral infarction to antidepressant drug therapy, with emphasis on central nervous system adverse reactions. Stroke 27:2040–2042, 1996

Gaspar D, Samarasinghe LA: ECT in psychogeriatric practice—a study of risk factors, indications and outcome. Compr Psychiatry 23:170–175, 1982

George MS: Why would you ever want to? Toward understanding the antidepressant effect of prefrontal rTMS. Hum Psychopharmacology 13:307–313, 1998

Gerring JP, Shields HM: The identification and management of patients with high risk for cardiac arrhythmias during modified ECT. J Clin Psychiatry 43:140–143, 1982

Godber C, Rosenvinge H, Wilkinson D, et al: Depression in old age: prognosis after ECT. Int J Geriatr Psychiatry 2:19–24, 1987

Gold L, Chiarella CJ: The prognostic value of clinical findings in cases treated with electric shock. J Nerv Ment Dis 100: 577–583, 1944

Gormley N, Cullen C, Walters L, et al: The safety and efficacy of electroconvulsive therapy in patients over age 75. Int J Geriatr Psychiatry 13:871–874, 1998

Gould L, Gopalaswamy C, Chandy F, et al: Electroconvulsive therapy-induced ECG changes simulating a myocardial infarction. Arch Intern Med 143:1786–1787, 1983

Greenberg L, Fink M: The use of electroconvulsive therapy in geriatric patients. Clin Geriatr Med 8:349–354, 1992

Grunhaus L, Shipley JE, Eiser A, et al: Polysomnographic studies in patients referred for ECT: pre-ECT studies. Convulsive Therapy 12:224–231, 1996

Hermann RC, Dorwart RA, Hoover CW, et al: Variation in the use of ECT in the United States. Am J Psychiatry 152: 869–875, 1995

Hermesh H, Aizenberg D, Friedberg G, et al: Electroconvulsive therapy for persistent neuroleptic-induced akathisia and parkinsonism: a case report. Biol Psychiatry 31:407–411, 1992

Heshe J, Roder E, Theilgaard A: Unilateral and bilateral ECT: a psychiatric and psychological study of therapeutic effect and side effects. Acta Psychiatr Scand Suppl 275:1–180, 1978

Hickie I, Mason C, Gordon P, et al: Prediction of ECT response: validation of a refined sign-based (CORE) system for defining melancholia. Br J Psychiatry 169:68–74, 1996

Holcomb H, Sternberg D, Heninger G: Effects of electroconvulsive therapy on mood, parkinsonism and tardive dyskinesia in a depressed patient: ECT and dopamine systems. Biol Psychiatry 18:865–873, 1983

Holzer JC, Giakas WJ, Mazure CM, et al: Dysarthria during ECT given for Parkinson's disease and depression. Convulsive Therapy 8:201–203, 1992

Howie MB, Black HA, Zvar AD, et al: Esmolol reduces autonomic hypersensitivity and length of seizures induced by electroconvulsive therapy. Anesth Analg 71:384–388, 1990

Hsiao JK, Messenheimer JA, Evans DL: ECT and neurological disorders. Convulsive Therapy 3:121–136, 1987

Huang KC, Lucas LF, Tsueda K, et al: Age-related changes in cardiovascular function associated with electroconvulsive therapy. Convulsive Therapy 5:17–25, 1989

Hughes J, Barraclough BM, Reeve W: Are patients shocked by ECT? J R Soc Med 74:283–285, 1981

Imlah NW, Ryan E, Harrington JA: The influence of antidepressant drugs on the response to electroconvulsive therapy and on subsequent relapse rates. Neuropsychopharmacology 4:438–442, 1965

Jaeckle R, Dilsaver S: Covariation of depressive symptoms, parkinsonism, and post-dexamethasone plasma cortisol levels in a bipolar patient: simultaneous response to ECT and lithium carbonate. Acta Psychiatr Scand 74:68–72, 1986

Jarvie H: Prognosis of depression treated by electric convulsive therapy. BMJ 1:132–134, 1954

Jenike MA: Handbook of Geriatric Psychopharmacology. Littleton, MA, PSG Publishing, 1985

Kahn RL, Pollack M, Fink M: Sociopsychologic aspects of psychiatric treatment in a voluntary mental hospital: duration of hospitalization, discharge ratings and diagnosis. Arch Gen Psychiatry 1:565–574, 1959

Kalayam B, Alexopoulos GS: Nifedipene in the treatment of blood pressure rise after ECT. Convulsive Therapy 5:110–113, 1989

Kamil R, Joffe RT: Neuroendocrine testing in electroconvulsive therapy. Psychiatr Clin North Am 14:961–970, 1991

Kaplan HI, Sadock BJ (eds): Synopsis of Psychiatry, 5th Edition. Baltimore, MD, Williams & Wilkins, 1988, pp 253–269

Karlinsky H, Shulman KI: The clinical use of electroconvulsive therapy in old age. J Am Geriatr Soc 32:183–186, 1984

Kellner CH: The CT scan (or MRI) before ECT: a wonderful test has been overused (editorial). Convulsive Therapy 12:79–80, 1996

Kellner CH: Left unilateral ECT: still a viable option? Convulsive Therapy 13:65–67, 1997a

Kellner CH: Seizure interference by medications: how big a problem (editorial)? Convulsive Therapy 13:1–3, 1997b

Kellner CH, Bernstein HJ: ECT as a treatment for neurologic illness, in The Clinical Science of Electroconvulsive Therapy. Edited by Coffey CE. Washington, DC, American Psychiatric Press, 1993, pp 183–210

Kellner CH, Nixon DW, Bernstein HJ: ECT-drug interactions: a review. Psychopharmacol Bull 27:595–609, 1991a

Kellner CH, Tolhurst JE, Burns CM: ECT in the presence of severe cervical spine disease. Convulsive Therapy 7:52–55, 1991b

Kellner CH, Burns CM, Bernstein HJ, et al: Electrode placement in maintenance electroconvulsive therapy. Convulsive Therapy 7:61–62, 1991c

Kellner CH, Monroe RR, Pritchett J, et al: Weekly ECT in geriatric depression. Convulsive Therapy 8:245–252, 1992

Kellner CH, Coffey CE, Beale MD, et al: Handbook of ECT. Washington, DC, American Psychiatric Press, 1997

Kirkegaard C, Norlem N, Lauridsen UB, et al: Protirelin stimulation test and thyroid function during treatment of depression. Arch Gen Psychiatry 32:1115–1118, 1975

Kramer BA: Use of ECT in California, 1977–1983. Am J Psychiatry 142:1190–1192, 1985

Kramer BA: Electroconvulsive therapy use in geriatric depression. J Nerv Ment Dis 175:233–235, 1987

Kramer BA: Use of ECT in California, revised: 1984–1994. J ECT (in press)

Kroessler D, Fogel B: Electroconvulsive therapy for major depression in the oldest old. Am J Geriatr Psychiatry 1:30–37, 1993

Krog-Meyer I, Kirkegaard C, Kijne B, et al: Prediction of relapse with the TRH test and prophylactic amitriptyline in 39 patients with endogenous depression. Am J Psychiatry 141:945–948, 1984

Krystal AD, Coffey CE: Neuropsychiatric considerations in the use of electroconvulsive therapy. J Neuropsychiatry Clin Neurosci 9:283–292, 1997

Krystal AD, Weiner RD, Coffey CE: The ictal EEG as a marker of adequate stimulus intensity with unilateral ECT. J Neuropsychiatry Clin Neurosci 7:295–303, 1995

Krystal AD, Weiner RD, Gassert D, et al: The relative ability of 3 ictal EEG frequency bands to differentiate ECT seizures on the basis of electrode placement, stimulus intensity, and therapeutic response. Convulsive Therapy 12:13–24, 1996

Krystal AD, Coffey CE, Weiner RD, et al: Changes in seizure threshold over the course of electroconvulsive therapy affect therapeutic response and are detected by ictal EEG ratings. J Neuropsychiatry Clin Neurosci 10:178–186, 1998

Lambourn J, Barrington PC: Electroconvulsive therapy in a sample British population in 1982. Convulsive Therapy 2: 169–177, 1986

Lauritzen L, Odgaard K, Clemmesen L, et al: Relapse prevention by means of paroxetine in ECT-treated patients with major depression: a comparison with imipramine and placebo in medium term continuation therapy. Acta Psychiatr Scand 94:241–251, 1996

Lauterbach E, Moore N: Parkinsonism-dystonia syndrome and ECT. Am J Psychiatry 147:1249–1250, 1990

Lebensohn Z, Jenkins R: Improvement of parkinsonism in depressed patients treated with ECT. Am J Psychiatry 132:283–285, 1975

Lerer B, Shapira B, Calev A, et al: Antidepressant and cognitive effects of twice- versus three-times-weekly ECT. Am J Psychiatry 152:564–570, 1995

Letemendia FJ, Delva NJ, Rodenburg M, et al: Therapeutic advantage of bifrontal electrode placement in ECT. Psychol Med 23:349–360, 1993

Leuchter A: Electroencephalography, in Comprehensive Review of Geriatric Psychiatry. Edited by Sadavoy J, Lazarus LW, Jarvik LF. Washington, DC, American Psychiatric Press, 1991, pp 273–283

Levy L, Savit J, Hodes M: Parkinsonism: improvement by electroconvulsive therapy. Arch Phys Med Rehabil 64: 432–433, 1983

Lichtor JL: Psychological preparation and preoperative medication, in Anesthesia, 3rd Edition, Vol 1. Edited by Miller RD. New York, Churchill Livingstone, 1990, pp 895–928

Lingam VR, Lazarus LW, Groves L, et al: Methylphenidate in treating post-stroke depression. J Clin Psychiatry 49: 151–153, 1988

Lipper S, Bermanzohn P: Electroconvulsive therapy in patients with parkinsonism (letter). Am J Psychiatry 132:457, 1975

Lipsey JR, Robinson RG, Pearlson GD: Nortriptyline treatment of post-stroke depression: a double-blind study. Lancet 1:297–300, 1984

Loo H, Galinowski A, De Carvalho W, et al: Use of maintenance ECT for elderly depressed patients (letter). Am J Psychiatry 148:810, 1991

Lurie SN, Coffey CE: Caffeine-modified ECT in depressed patients with medical illness. J Clin Psychiatry 51:154–157, 1990

Magni G, Fisman M, Helmes E: Clinical correlates of ECT-resistant depression in the elderly. J Clin Psychiatry 49:405–407, 1988

Malcolm K: Patients' perceptions and knowledge of electroconvulsive therapy. Psychiatric Bulletin 13: 161–165, 1989

Malla AK: Characteristics of patients who receive electroconvulsive therapy. Can J Psychiatry 33:696–701, 1988

Maltbie AA, Wingfield MS, Volow MR, et al: Electroconvulsive therapy in the presence of brain tumor. J Nerv Ment Dis 168:400–405, 1980

Mander AJ, Whitfield A, Keen DM, et al: Cerebral and brain stem changes after ECT revealed by nuclear magnetic resonance imaging. Br J Psychiatry 151:69–71, 1987

Maneksha FR: Hypertension and tachycardia during electroconvulsive therapy: to treat or not to treat? Convulsive Therapy 7:28–35, 1991

Manly DT, Swartz CS: Asymmetric bilateral right frontotemporal left frontal stimulus electrode placement: comparisons with bifrontotemporal and unilateral placements. Convulsive Therapy 10:267–270, 1994

Markowitz J, Brown R, Sweeney J, et al: Reduced length and cost of hospital stay for major depression in patients treated with ECT. Am J Psychiatry 144:1025–1029, 1987

Martin M, Figiel G, Mattingly G, et al: ECT-induced interictal delirium in patients with a history of CVA. J Geriatr Psychiatry Neurol 5:149–155, 1992

McCall WV: Cardiovascular risk during ECT: managing the managers (editorial). Convulsive Therapy 13:123–124, 1997

McCall WV, Cohen W, Reboussin B, et al: Pretreatment differences in specific symptoms and quality of life among depressed inpatients who do and do not receive electroconvulsive therapy: a hypothesis regarding why the elderly are more likely to receive ECT. J ECT 15:193–201, 1999

McDonald WM, Phillips VL, Figiel GS, et al: Cost-effective maintenance treatment of resistant geriatric depression. Psychiatric Annals 28:47–52, 1998

McElhiney MC, Moody BJ, Steif BL, et al: Autobiographical memory and mood: effects of electroconvulsive therapy. Neuropsychology 9:501–517, 1995

Mendels J: Electroconvulsive therapy and depression, I: the prognostic significance of clinical factors. Br J Psychiatry 111:675–681, 1965

Messina AG, Paranicas M, Katz B, et al: Effect of electroconvulsive therapy on the electrocardiogram and echocardiogram. Anesth Analg 75:511–514, 1992

Meyers BS, Mei-Tal V: Empirical study on an inpatient psychogeriatric unit: biological treatment in patients with depressive illness. Int J Psychiatry Med 15:111–124, 1985–1986

Miller ME, Siris SG, Gabriel AN: Treatment delays in the course of electroconvulsive therapy. Hosp Community Psychiatry 37:825–827, 1986

Miller RD, Savarese JJ: Pharmacology of muscle relaxants and their antagonists, in Anesthesia, 3rd Edition, Vol 1. Edited by Miller RD. New York, Churchill Livingstone, 1990, pp 389–435

Monroe RR: Maintenance electroconvulsive therapy. Psychiatr Clin North Am 14:947–960, 1991

Mukherjee S: Mechanisms of the antimanic effects of electroconvulsive therapy. Convulsive Therapy 4:74–80, 1988

Mukherjee S, Sackeim HA, Schnur DB: Electroconvulsive therapy of acute manic episodes: a review of 50 years' experience. Am J Psychiatry 151:169–176, 1994

Mulsant BH, Rosen J, Thornton JE, et al: A prospective naturalistic study of electroconvulsive therapy in late-life depression. J Geriatr Psychiatry Neurol 4:3–13, 1991

Murray GB, Shea V, Conn DK: Electroconvulsive therapy for post-stroke depression. J Clin Psychiatry 47:258–260, 1986

Nelson JP, Benjamin L: Efficacy and safety of combined ECT and tricyclic antidepressant drugs in the treatment of depressed geriatric patients. Convulsive Therapy 5:321–329, 1989

Nobler MS, Sackeim HA, Solomou M, et al: EEG manifestations during ECT: effects of electrode placement and stimulus intensity. Biol Psychiatry 34:321–330, 1993

Nobler MS, Sackeim HA, Prohovnik I, et al: Regional cerebral blood flow in mood disorders, III: treatment and clinical response. Arch Gen Psychiatry 51:884–897, 1994

Oh JJ, Rummans TA, O'Conner MK, et al: Cognitive impairment after ECT in patients with Parkinson's disease and psychiatric illness (letter). Am J Psychiatry 149:271, 1992

O'Leary D, Gill D, Gregory S, et al: Which depressed patients respond to ECT? The Nottingham results. J Affect Disord 33:245–250, 1995

Olfson M, Marcus S, Sackeim HA, et al: Use of ECT for the treatment of recurrent major depression. Am J Psychiatry 155:22–29, 1998

Ottosson JO: Experimental studies of the mode of action of electroconvulsive therapy. Acta Psychiatr Scand Suppl 145:1–141, 1960

Oztas B, Kaya M, Camurcu S: Age related changes in the effect of electroconvulsive shock on the blood brain barrier permeability in rats. Mech Ageing Dev 51:149–155, 1990

Pande AC, Grunhaus LJ, Haskett RF, et al: Electroconvulsive therapy in delusional and non-delusional depressive disorder. J Affect Disord 19:215–219, 1990

Papakostas Y, Fink M, Lee J, et al: Neuroendocrine measures in psychiatric patients: course and outcome with ECT. Psychiatry Res 4:55–64, 1981

Pettinati HM, Mathisen KS, Rosenberg J, et al: Meta-analytical approach to reconciling discrepancies in efficacy between bilateral and unilateral electroconvulsive therapy. Convulsive Therapy 2:7–17, 1986

Physicians' Desk Reference, 53rd Edition. Montvale, NJ, Medical Economics, 1999

Post RM: Transduction of psychosocial stress into the neurobiology of recurrent affective disorder. Am J Psychiatry 149:999–1010, 1992

Pratt RTC, Warrington EK, Halliday AM: Unilateral ECT as a test for cerebral dominance, with a strategy for treating left-handers. Br J Psychiatry 119:79–83, 1971

Price TRP, McAllister TW: Safety and efficacy of ECT in depressed patients with dementia: a review of clinical experience. Convulsive Therapy 5:61–74, 1989

Prien R, Kupfer D: Continuation drug therapy for major depressive episodes: how long should it be maintained? Am J Psychiatry 143:18–23, 1986

Prohovnik I, Sackeim HA, Decina P, et al: Acute reductions of regional cerebral blood flow following electroconvulsive therapy: interactions with modality and time. Ann N Y Acad Sci 462:249–262, 1986

Prudic J, Sackeim HA, Decina P, et al: Acute effects of ECT on cardiovascular functioning: relations to patient and treatment variables. Acta Psychiatr Scand 75:344–351, 1987

Prudic J, Sackeim HA, Spicknall K. Potential pharmacologic agents for the cognitive effects of electroconvulsive treatment. Psychiatric Annals 28:40–46, 1998

Rasmussen K, Abrams R: Treatment of Parkinson's disease with electroconvulsive therapy. Psychiatr Clin North Am 14: 925–933, 1991

Rayburn BK: Electroconvulsive therapy in patients with heart failure or valvular heart disease. Convulsive Therapy 13: 145–156, 1997

Reynolds CF, Perel JM, Kupfer DJ, et al: Open-trial response to antidepressant treatment in elderly patients with mixed depression and cognitive impairment. Psychiatry Res 21: 111–122, 1987

Rice EH, Sombrotto LB, Markowitz JC, et al: Cardiovascular morbidity in high-risk patients during ECT. Am J Psychiatry 151:1637–1641, 1994

Rich CL, Spiker DG, Jewell SW, et al: DSM-III, RDC, and ECT: depressive subtypes and immediate response. J Clin Psychiatry 45:14–18, 1984a

Rich CL, Spiker DG, Jewell SW, et al: The efficiency of ECT, I: response rate in depressive episodes. Psychiatry Res 11: 167–176, 1984b

Rich CL, Spiker DG, Jewell SW, et al: ECT response in psychotic versus nonpsychotic unipolar depressives. J Clin Psychiatry 47:123–125, 1986

Roberts JM: Prognostic factors in the electroshock treatment of depressive states, I: clinical features from history and examination. Journal of Mental Science 105:693–702, 1959

Robinson RG, Price TR: Post-stroke depressive disorders: a follow-up study of 103 patients. Stroke 13:635–641, 1982

Roemer RA, Shagass C, Dubin W, et al: Relationship between pretreatment electroencephalographic coherence measures and subsequent response to electroconvulsive therapy: a preliminary study. Neuropsychobiology 24:121–124, 1990

Rosenberg R, Vostrup S, Andersen A, et al: Effect of ECT on cerebral blood flow in melancholia assessed with SPECT. Convulsive Therapy 4:62–73, 1988

Roth S, Mukherjee S, Sackeim H: Electroconvulsive therapy in a patient with mania, parkinsonism and tardive dyskinesia. Convulsive Therapy 4:92–97, 1988

Rubin EH, Kinsoherf DA, Wehrman SA: Response to treatment of depression in the old and very old. J Geriatr Psychiatry Neurol 4:65–70, 1991

Rudorfer M, Risby E, Hsaio J, et al: ECT alters human monoamines in a different manner from that of antidepressant drugs. Psychopharmacol Bull 24:396–399, 1988

Rummans TA, Lauterbach EC, Coffey CE, et al: Pharmacologic efficacy in neuropsychiatry: a review of placebo- controlled treatment trials—a report of the ANPA Committee on Research. J Neuropsychiatry Clin Neurosci 11: 176–189, 1999

Sackeim HA: Are ECT devices underpowered (editorial)? Convulsive Therapy 7:233–236, 1991

Sackeim HA: What's new with ECT? American Society of Clinical Psychopharmacology Progress Notes 8:27–33, 1997

Sackeim HA, Decina P, Prohovnik I, et al: Anticonvulsant and antidepressant properties of electroconvulsive therapy: a proposed mechanism of action. Biol Psychiatry 18: 1301–1310, 1983

Sackeim HA, Decina P, Kanzler M, et al: Effects of electrode placement on the efficacy of titrated, low-dose ECT. Am J Psychiatry 144:1449–1455, 1987

Sackeim HA, Prudic J, Devanand DP, et al: The impact of medication resistance and continuation pharmacotherapy on relapse following response to electroconvulsive therapy in major depression. J Clin Psychopharmacol 10:96–104, 1990

Sackeim HA, Devanand DP, Prudic J: Stimulus intensity, seizure threshold, and seizure duration: impact on the efficacy and safety of electroconvulsive therapy. Psychiatr Clin North Am 14:803–843, 1991

Sackeim HA, Prudic J, Devanand DP, et al: Effects of stimulus intensity and electrode placement on the efficacy and cognitive effects of electroconvulsive therapy. N Engl J Med 328:839–846, 1993

Salzman C: Electroconvulsive therapy in the elderly patient. Psychiatr Clin North Am 5:191–197, 1982

Scott AI, Douglas RH, Whitfield A, et al: Time course of cerebral magnetic resonance changes after electroconvulsive therapy. Br J Psychiatry 156:551–553, 1990

Scott AI, Dougall N, Ross M, et al: Short-term effects of electroconvulsive treatment on the uptake of $^{99m}$Tc-exametazime into brain in major depression shown with single photon emission tomography. J Affect Disord 30:27–34, 1994

Seager CP, Bird RL: Imipramine with electrical treatment in depression: a controlled trial. Journal of Mental Science 108: 704–707, 1962

Shapira B, Lerer B: Speed of response to bilateral ECT: an examination of possible predictors in two controlled trials. J ECT 15:202–206, 1999

Shettar MS, Grunhaus L, Pande AC, et al: Protective effects of intramuscular glycopyrrolate on cardiac conduction during ECT. Convulsive Therapy 5:349–352, 1989

Slawson P: Psychiatric malpractice: the electroconvulsive therapy experience. Convulsive Therapy 1:195–203, 1985

Small JG, Klapper MH, Kellams JJ, et al: ECT compared with lithium in the management of manic states. Arch Gen Psychiatry 45:727–732, 1988

Small JG, Milstein V, Small IF: Electroconvulsive therapy for mania. Psychiatr Clin North Am 14:887–903, 1991

Sobin C, Prudic J, Devanand DP, et al: Who responds to electroconvulsive therapy? Br J Psychiatry 169:322–328, 1995

Solan WJ, Khan A, Avery DH, et al: Psychotic and nonpsychotic depression: comparison of response to ECT. J Clin Psychiatry 49:97–99, 1988

Staton RD: Electroencephalographic recording during bitemporal and unilateral non-dominant hemisphere (Lancaster position) electroconvulsive therapy. J Clin Psychiatry 42:264–269, 1981

Steffens DC, Krystal AD, Sibert TE, et al: Cost effectiveness of maintenance ECT (letter). Convulsive Therapy 11: 283–284, 1995

Stoudemire A, Knos G, Gladson M, et al: Labetalol in the control of cardiovascular responses to electroconvulsive therapy in high-risk depressed medical patients. J Clin Psychiatry 51:508–512, 1990

Stoudemire A, Hill CD, Morris R, et al: Improvement in depression-related cognitive dysfunction following ECT. J Neuropsychiatry Clin Neurosci 7:31–34, 1995

Strömgren LS: Unilateral versus bilateral electroconvulsive therapy: investigations into the therapeutic effect in endogenous depression. Acta Psychiatr Scand Suppl 240:8–65, 1973

Strömgren LS: ECT in acute delirium and related clinical states. Convulsive Therapy 13:10–17, 1997

Strömgren LS, Juul-Jensen P: EEG in unilateral and bilateral electroconvulsive therapy. Acta Psychiatr Scand 51: 340–360, 1975

Strömgren LS, Christensen AL, Fromholt P: The effects of unilateral brief-interval ECT on memory. Acta Psychiatr Scand 54:336–346, 1976

Sullivan MO, Ward NG, Laxton A: The woman who wanted electroconvulsive therapy and do-not-resuscitate status. Gen Hosp Psychiatry 14:204–209, 1992

Swartz CM: Clinical and laboratory predictors of ECT response, in The Clinical Science of Electroconvulsive Therapy. Edited by Coffey CE. Washington, DC, American Psychiatric Press, 1993, pp 53–71

Tew JD, Mulsant BH, Haskett RF, et al: Acute efficacy of ECT in the treatment of major depression in the old-old. Am J Psychiatry 156:1865–1870, 1999

Thienhaus OJ, Margletta S, Bennett JA: A study of the clinical efficacy of maintenance ECT. J Clin Psychiatry 51: 141–144, 1990

Thompson JW, Weiner RD, Myers CP: Use of ECT in the United States in 1975, 1980, and 1986. Am J Psychiatry 151:1657–1661, 1994

Tomac TA, Rummans TA, Pileggi TS, et al: Safety and efficacy of electroconvulsive therapy in patients over age 85. Am J Geriatr Psychiatry 5:126–130, 1997

Turek IS: EEG correlates of electroconvulsive treatment. Dis Nerv Syst 33:584–589, 1972

Volavka J, Feldstein S, Abrams R, et al: EEG and clinical change after bilateral and unilateral electroconvulsive therapy. Electroencephalogr Clin Neurophysiol 32:631–639, 1972

Volkow ND, Bellar S, Mullani N, et al: Effects of electroconvulsive therapy on brain glucose metabolism: a preliminary study. Convulsive Therapy 4:199–205, 1988

Ward C, Stern GM, Pratt R, et al: Electroconvulsive therapy in parkinsonian patients with the "on-off" syndrome. J Neural Transm 49:133–135, 1980

Webb MC, Coffey CE, Saunders WR, et al: Cardiovascular response to unilateral electroconvulsive therapy. Biol Psychiatry 28:758–766, 1990

Weiner RD: The role of electroconvulsive therapy in the treatment of depression in the elderly. J Am Geriatr Soc 30: 710–712, 1982

Weiner RD: Does ECT cause brain damage? Behav Brain Sci 7:1–53, 1984

Weiner RD, Coffey CE: Indications for use of electroconvulsive therapy, in American Psychiatric Press Review of Psychiatry, Vol 7. Edited by Frances AJ, Hales RE. Washington, DC, American Psychiatric Press, 1988, pp 458–481

Weiner RD, Krystal AD: EEG Monitoring of ECT seizures, in The Clinical Science of Electroconvulsive Therapy. Edited by Coffey CE. Washington, DC, American Psychiatric Press, 1993, pp 93–109

Weiner RD, Whanger AD, Erwin CW, et al: Prolonged confusional state and EEG seizure activity following concurrent ECT and lithium use. Am J Psychiatry 137: 1452–1453, 1980

Weiner RD, Rogers HJ, Davidson JRT, et al: Effects of stimulus parameters on cognitive side effects. Ann N Y Acad Sci 462: 315–325, 1986

Weiner RD, Coffey CE, Krystal AD: Electroconvulsive therapy in the medical and neurological patient, in Psychiatric Care of the Medical Patient, 2nd Edition. Edited by Stoudemire A, Fogel B, Greenberg D. New York, Oxford University Press, 2000

Weisberg LA, Elliott D, Mielke D: Intracerebral hemorrhage following electroconvulsive therapy. Neurology 41:1849, 1991

Welch CA: ECT in medically ill patients, in The Clinical Science of Electroconvulsive Therapy. Edited by Coffey CE. Washington, DC, American Psychiatric Press, 1993, pp 167–182

Welch CA, Drop LJ: Cardiovascular effects of ECT. Convulsive Therapy 5:35–43, 1989

Wesner RB: Prolonged T-wave inversion associated with electroconvulsive therapy. Convulsive Therapy 2:203–206, 1986

Wesner RB, Winokur G: The influence of age on the natural history of unipolar depression when treated with electroconvulsive therapy. Eur Arch Psychiatry Neurol Sci 238:149–154, 1989

Wilkinson AM, Anderson DN, Peters S: Age and the effects of ECT. Int J Geriatr Psychiatry 8:401–406, 1993

Young R, Alexopoulos G, Shamoian A: Dissociation of motor response from mood and cognition in a parkinsonian patient treated with ECT. Biol Psychiatry 20:566–569, 1985

Yudofsky SC: Parkinson's disease, depression and electroconvulsive therapy: a clinical and neurobiologic synthesis. Compr Psychiatry 20:579–581, 1979

Zervas I[M], Fink M: ECT for refractory Parkinson's disease. Convulsive Therapy 7:222–223, 1991

Zervas IM, Calev A, Jandorf L, et al: Age-dependent effects of electroconvulsive therapy on memory. Convulsive Therapy 9:39–42, 1993

Zibrak JD, Jensen WA, Bloomingdale K: Aspiration pneumonitis following electroconvulsive therapy in patients with gastroparesis. Biol Psychiatry 24:812–814, 1988

Zielinski, RJ, Roose SP, Devanand DP, et al: Cardiovascular complications of ECT in depressed patients with cardiac disease. Am J Psychiatry 150:904–909, 1993

Zis AP, Goodwin FK: Major affective disorder as a recurrent illness: a critical review. Arch Gen Psychiatry 36:835–839, 1979

Zorumski CF, Rubin EH, Burke WJ: Electroconvulsive therapy for the elderly. Hosp Community Psychiatry 39:643–647, 1988

Zwil A, McAllister TW, Price TRP: Safety and efficacy of ECT in depressed patients with organic brain disease: review of a clinical experience. Convulsive Therapy 8:103–109, 1992

Zvara DA, Brooker RF, McCall WV, et al: The effects of esmolol on ST-segment depression and arrhythmias after electroconvulsive therapy. Convulsive Therapy 13: 165–174, 1997