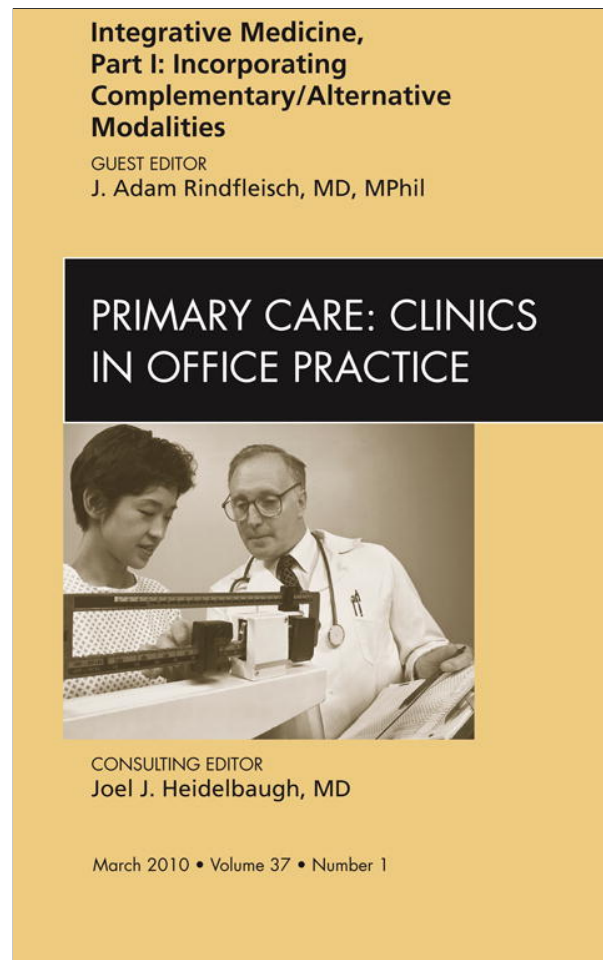


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Meditation in Medical Practice: A Review of the Evidence and Practice

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KEYWORDS

- Meditation • Mindfulness • Stress • Burnout • Mind-body
- Medical education • Contemplation • Contemplative prayer

WHAT IS MEDITATION?

Found in cultures, spiritual traditions, and healing systems throughout the world, meditation is a mind-body practice with many methods and variations, all of which are grounded in the silence and stillness of compassionate, nonjudgmental present-moment awareness. Although contemplative meditation practices are largely rooted in the world's spiritual traditions, the practice of meditation does not require belief in any particular religious or cultural system. The increased research and familiarization of mindfulness meditation within the fields of neuroscience, psychology, and medicine have led to an increased understanding of consciousness and improved treatment for many health conditions.

Mindfulness is one aspect of the meditation experience that reflects the basic and fundamental human capacity to attend to relevant aspects of experience in a nonjudgmental and nonreactive way, which in turn cultivates clear thinking, equanimity, compassion, and openheartedness. According to University of Massachusetts Center for Mindfulness founder Jon Kabat-Zinn, "Meditation is simplicity itself. It's about stopping and being present. That is all." The stated goal of mindfulness is to maintain fluid awareness in a moment by moment experiential process that helps one disengage from strong attachment to beliefs, thoughts, or emotions in a way that generates greater sense of emotional balance and well-being.¹ This simple yet radical assertion holds the potential for wide-reaching therapeutic benefit for many current health care challenges such as rising health care costs,² chronic lifestyle-influenced illness,³

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practitioner burnout,⁴ patient dissatisfaction,⁵ and generalized stress for the practitioner⁶ and the patient.⁷

WHY MEDITATE?

Prescribed meditation practice can elicit physical ease and mental stability, which provide a foundation for health and wellness as they directly influence one's ability to meet the challenges resulting from stress, burnout, and illness for patient and practitioner alike. For most people, illness brings out feelings of confusion, anxiety, fear, and anger. Shock, isolation, depression, fear, and helplessness are some common experiences patients face when dealing with chronic disease.⁸ Feeling out of control or losing one's ground can give rise to reactivity of the mind and body that leads to increased pain and suffering. Applying the simple practice of nonjudgmental present-moment awareness and experiencing how this process influences one's relationship with life stressors is one way that meditation practice addresses the epidemic of mind-body afflictions that are expressed physically, such as acid reflux, migraine headache, low back pain, restless legs, fibromyalgia, chronic fatigue, irritable bowel, and many other conditions. These and other conditions disproportionately burden health care systems and often do not respond to conventional treatment alone.² Meditation is an inward-orienting, self-empowering practice that can stimulate the healing process and help patients and health care practitioners navigate through unsettling and turbulent experiences. According to experienced meditation teacher Charlotte Joko Beck,⁹ "The practice of meditation provides a skill that affords a greater sense of self-determination—the ability to cultivate and draw upon inner resources to help meet all circumstances with equanimity and clarity."

REVIEW OF MEDITATION RESEARCH

Evidence pointing to the medical benefits of meditation has been widely documented, and continues to increase in quality and quantity. In 2007 there were more than 70 scientific articles published on mindfulness meditation practice. In particular, the biologic correlates of meditation experience have received the most attention in research, quite out of proportion to the complete meditative experience, which includes objective external effects and subjective internal experience. However, research is only beginning to elucidate how the mind-body connection affects health in promoting wellness and managing and preventing disease.

The interplay between the mind and body has been difficult to describe and operationalize from a scientific standpoint. However, many examples reveal the potential value in developing clinically oriented mind-body therapies. As early as 1935, French cardiologist Brosse studied Indian yogis capable of decreasing their heart rates to almost 0 on electrocardiographic (ECG) recordings.¹⁰ In 1961, Bagchi and Wenger¹¹ found that some meditation experts could produce bidirectional changes in every measurable autonomic variable. The *Lancet* published an account of the voluntary live burial of a yogi who sat cross-legged underground for 62 hours while continuous vital sign recordings revealed no distress.¹² Hoenig witnessed an experiment in 1968 where a yogi confined for 9 hours in a small enclosed pit and monitored with electroencephalography and an ECG showed a normal waking rhythm for the full 9 hours, leading the researchers to conclude that the subject was awake and relaxed throughout the experiment. They also observed a variable heart rate from 40 to 100 beats a minute

in recurring cycles on ECG.¹³ As in fetal heart monitoring, later research showed that synchronous increases in heart rate variability in adults predicts a decrease in cardiovascular mortality,^{14,15} which can be reproduced using meditation practices.^{16,17}

Benson helped pioneer an academic interest in meditation through his research on the physiologic and neurochemical principles of the relaxation response, which is defined as a hypometabolic state of parasympathetic activation.¹⁸ Many studies have shown that meditation training reduces anxiety and increases positive affect,¹⁹⁻²¹ whereas others show that mindfulness meditation prevents recurrence of depression.^{22,23} In a 1985 study by Kabat-Zinn and colleagues,²⁴ patients with chronic pain showed a statistically significant reduction in various measures of pain symptoms when trained in MBSR. Meditation practices have shown beneficial effects in the treatment of tension headaches,²⁵ psoriasis,²⁶ blood pressure,²⁷⁻²⁹ serum cholesterol,²⁹ smoking cessation,^{30,31} alcohol abuse,³² carotid atherosclerosis,³³ coronary artery disease,^{3,34,35} longevity and cognitive function in the elderly,³⁶ psychiatric disorders,^{18-23,37} excessive worry,³⁸ use of medical care,³⁹ and medical costs in treating chronic pain.⁴⁰ A 2004 meta-analysis found MBSR training useful for a broad range of difficult-to-treat chronic disorders such as depression, anxiety, fibromyalgia, mixed cancer diagnoses, coronary artery disease, chronic pain, obesity, and eating disorders. The authors noted consistent and strong effect sizes across these very different situations, indicating a generalized application of meditation for daily life distress and extraordinary medical disorders and Iversen.⁴¹

In a meta-analysis of brain imaging studies on various meditation styles, Newberg and Iversen⁴² suggests that the neurophysiologic effects derived from various meditation practices seem to outline a consistent and reproducible pattern of significant brain activity in key cerebral structures. Research focusing more specifically on these physiologic effects of meditation by Davidson and colleagues⁴³ described a positive correlation between meditation practice and left-sided prefrontal cortex activity, which is associated with positive affect. In this study, mindfulness meditation was associated with increases in antibody titers to influenza vaccine suggesting correlation among meditation, positive emotional states, localized brain activity, and improved immune function. Corroborating research shows a direct link between immune function and mood, with positive affective states resulting in stronger immune function and decreased incidence of illness.⁴⁴⁻⁴⁶ Lutz observed increased left-sided prefrontal cortex gamma wave activity and synchronicity in expert Tibetan Buddhist meditators with more than 10,000 hours of meditation experience compared with novice mediator controls, at rest and during meditation.⁴⁷ This finding suggests that attention and affective processes are flexible skills that can be learned.

Although ongoing research aims to elucidate the measurable biologic correlates of meditation and its significance to health, it is important to acknowledge the experiential knowledge that has arisen from time-tested practices of the great spiritual traditions. Meditation practitioners within these spiritual systems continue to explore the subtle inner dimensions of meditative experience using methodologies and perspectives that equally address the human condition and its search for truth.

MINDFULNESS IN MEDICAL EDUCATION AND PRACTICE

Medical training is a unique experience. Students and practitioners are expected to retain a vast amount of information and at the same time cultivate qualities of professionalism, which include compassion and empathy. Maintaining a balance between personal needs and the demands of medical training and practice is a balance

many physicians neglect at the cost of their own well-being and health. Sleep, exercise, relaxation, and personal interests often take a back seat to long clinical hours and academic demands that contribute to burnout.⁴⁸

Ironically, the medical learning environment can dampen the very characteristics it seeks to promote. Empathy, a core trait of quality medical care, is significantly diminished throughout medical school.⁴⁹ Stress, along with its many physical manifestations, is heightened throughout the many years of medical training and practice. It is troubling, therefore, to consider that cortisol, a biomarker of chronic stress, is implicated in diminished attention and memory function.⁵⁰ Research also shows that stress generates proinflammatory cytokines that have been directly linked with depression.⁵¹

Box 1

An example of getting started with mindfulness meditation practice: SOLAR (stop, observe, let it be, and return) and TIES (thought, image, emotion, and/or sensation)

STOP

- Find a quiet place where you will not be interrupted for the next several minutes.
- Set your cell phone alarm to vibrate in 5 or more minutes, and then forget about time altogether. You can adjust the length of your meditation time as you feel is appropriate.
- Sit comfortably in an alert position with a straight and relaxed back. With eyes open or closed, position your hands as you like.
- Allow an intention for this time, such as, "May I allow myself to be present to the simplicity of movements in the body as breathing, feeling, and sensing. May I enjoy the benefits of silence and stillness."

OBSERVE

- Direct your attention to noticing sensations in the body, noticing posture, feet on the floor, hips on the chair, or feeling a sense of being balanced and grounded.
- Allow the breath to flow in and out of the nose at a natural and unforced rate and depth. Avoid manipulating either a slower or a faster rate. Just let the body breathe. In your own bodily experience, notice the sensations of simply breathing.
- Moment by moment, allow yourself to take a pause, breathe, and feel exactly what arises in your experience.

LET IT BE

- For this time now let everything be as it is without reacting to or trying to change any of it. Like a watchful bystander, just witness your experience moment by moment as it happens right now, however it may be, pleasant or unpleasant.
- If you get caught up in any particular storyline, fantasy, daydream, rumination, compulsive thought, or distraction gently stop, drop into your body, and allow all experiences to roll on past the screen of your awareness like moving frames in a film.

AND...

RETURN

- Let the breath be your anchor in the present moment. If you get distracted or caught up in any particular TIES, just bring your attention back to the breath, returning repeatedly to the experience of breathing in a nonjudgemental and self-forgiving way.
- At the end of your meditation period, be still for a few more moments. Be aware of how you feel. Invite the intention to be mindfully present by taking a moment to pause, breathe, and feel whatever is happening in any experience throughout your day.

Box 2**Summary of mindfulness meditation practice***The experience (TIES mnemonic)*

- Talk/thoughts: mental chatter, incessant thinking, storyline narratives
- Images: mental pictures, imagined scenes, visualized scenarios
- Emotions: love, hate, fear, joy, sadness, anxiety, and so on
- Physical sensations: sound, touch, sight, taste, smell

The process (SOLAR mnemonic)

- Stop: taking pause and dropping into this experience right now
- Observe: being aware of and noticing what is actually happening in this moment
- Let it be: acknowledging and allowing this arising experience to be what it is, pleasant or unpleasant
- And...
- Returning repeatedly to the present moment, remembering to pause, breathe, and feel whatever is happening

A 2009 study found the rate of depression in medical students to be 21.2%, more than double the rate for the general population.⁵²

Mindfulness meditation addresses these concerns by offering a simple, yet effective tool to help ease many of the challenges, both personal and academic, encountered throughout medical training and practice. Medical students who participated in an 8-week MBSR course showed reduced anxiety, reduced distress and depression, and increased levels of empathy.⁵³ There is growing evidence that heightened

Box 3**Resources and links to learn meditation (links accessed 8 August 2009)**

- <http://www.umassmed.edu/content.aspx?id=41252> (UMass Center for Mindfulness)
- <http://www.amsa.org/humed/> (AMSA Humanistic Medicine Group)
- <https://www.fammed.wisc.edu/aware-medicine/mindfulness> (University of Wisconsin Aware Medicine Curriculum)
- <http://eomega.org/> (New York/east-coast Omega Institute)
- <http://nccam.nih.gov/> (NCCAM)
- <http://diydharm.org/about-us> (Do It Yourself Dharma)
- <http://www.spiritrock.org/> (California/west-coast Meditation Center)
- <http://www.contemplativeoutreach.org/site/PageServer> (Centering Prayer)
- <http://www.christinecenter.org> (Wisconsin/mid-west Retreat Center)
- Meditation for Beginners* by Jack Kornfield PhD (book and CD)
- Guided Mindfulness Meditation* by Jon Kabat-Zinn (CD)
- Full Catastrophe Living* by Jon Kabat-Zinn (book)
- Integrative Medicine*, 2nd edition, edited by David Rakel, MD (Chapter 100 Recommending Meditation)
- Open Mind Open Heart* by Fr Thomas Keating OCSO (book)
- The Beginner's Guide to Contemplative Prayer* by James Finley PhD (CD)

Box 4**Precautions and recommendations for meditation practice**

- Leg and back discomfort can be a common concern. Do not strain the body. Sit in an alert and comfortable position. Remember that meditation is about openness and not about contracting the body into discomfort.
- In the beginning, intrusive, repetitive, or disturbing thoughts may make it difficult to sit still for even 5 minutes. Keep in mind that meditation is not about making things go away. It is simply the nonjudgmental process of staying present with whatever is happening moment by moment, pleasant or unpleasant. However, over time with regular practice the mind will become more stable.
- In learning meditation, one should be guided by teachers and practices that resonate authentically, are nondivisive, and instill feelings of support. Do not forfeit personal boundaries and safety for any teacher or teaching. Listen to your intuition and reason, and trust that the experience you are having is exactly what you need in this moment.
- Meditation can at times uncover preexisting stressors or traumas, similar to peeling back the layers of an onion, revealing unpleasant underlying emotions. A professional counselor familiar with contemplative practice can help facilitate the healthy release of these emotions.
- Be attentive and honest with your experience. In a compassionate way, attend to realizations and insights that arise from regular meditation practice. This may include journaling, creative expression, and talking with a skilled meditation teacher.
- Including a gentle form of movement is encouraged, such as contemplative or mindful walking, walking the labyrinth, hatha yoga, pilates, nia, tai chi/qi gong, swimming, biking, etc. However, it is important to avoid striving and straining.

present-moment awareness gained through mindfulness training improves attention and memory.⁵⁴ Furthermore, Groopman⁵⁵ suggests that mindfulness meditation can help foster present-moment awareness that may reduce medical error and improve patient care. He asserts that faulty thinking such as snap judgments, distracted attention, inadvertent stereotyping, and other cognitive traps lead to critical mistakes in patient care, as opposed to the conventional understanding that medical errors are derived from lack of knowledge. These cognitive processing errors, which are not currently addressed in medical education, can be avoided by paying attention to the process of thinking by the metacognitive practice of mindfulness based self-reflection. Growing research also shows that practitioners who themselves exhibit healthy habits are more effective in motivating patients to make significant positive change in their life.⁵⁶ This is also true of health practitioners who practice meditation. In a randomized controlled trial of 124 psychiatric inpatients managed by 18 psychology residents, Grepmaier and colleagues⁵⁷ showed that patients of interns who received mindfulness training did significantly better than those patients treated by interns who did not receive mindfulness training.

According to Astin and colleagues,⁵⁸ there is a strong need for more comprehensive training during medical school and residency for the application of mind-body methods such as meditation. There are a number of factors that help promote this. First, gaining the support of key administrative and academic leaders is crucial. Second, there should be an adequate and early introduction to self-reflective relaxation techniques in medical school, and recurrent opportunities to learn and practice meditation throughout medical training and practice (see **Boxes 1–3**). Third, it is important to acknowledge that student and practitioner populations are unique. Providing experientially based meditation teaching on a regular basis and reviewing

current research will help practitioners and students better understand and skillfully use this mind-body tool personally and professionally. Finally, because it is difficult for anyone to incorporate a daily practice into his or her life (much less a stressed, sleep-deprived medical student or clinician) a responsive and pragmatic approach to meditation training in medicine is needed to address the specific needs of this time-limited professional demographic. **Boxes 1–3** offer some examples to help begin a mindful practice and opportunities for further training. **Box 4** offers recommendations and precautions to keep in mind when beginning to meditate.

SUMMARY

Meditation practice in the medical setting is proving to be an excellent adjunctive therapy for many illnesses and an essential and primary means of maintaining holistic health and wellness. Rather than being a fringe or marginal concept, meditation is now widely known and accepted as a beneficial mind-body practice by the general public and in the scientific community. Extensive research shows and continues to show the benefits of meditation practice for a wide range of medical conditions. Further efforts are required to operationalize and apply meditation practice in the clinical and medical educational settings in ways that are practical, effective, and meaningful.

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REFERENCES

1. Ludwig DS, Kabat-Zinn J. Mindfulness in medicine. *JAMA* 2008;300(11):1350–2.
2. Deyo R, Mirza SK, Turner JA, et al. Overtreating chronic back pain, time to back off? *J Am Board Fam Med* 2009;22(1):62–8.
3. Paul-Labrador M, Polk D, Dwyer JH, et al. Effects of a randomized controlled trial of transcendental meditation on components of the metabolic syndrome in subjects with coronary heart disease. *Arch Intern Med* 2006;166(11):1218–24.
4. McCray LW, Cronholm PF, Bogner HR, et al. Resident physician burnout, is there hope? *Fam Med* 2008;40(9):626–32.
5. Astin JA. Why patients use alternative medicine, results from a national study. *JAMA* 1998;279:1548–53.
6. Eckleberry-Hunt J, Lick D, Boura J, et al. An exploratory study of resident burnout and wellness. *Acad Med* 2009;84(2):269–77.
7. Chiesa A, Serretti A. Mindfulness based stress reduction for stress management in healthy people, a review and meta-analysis. *J Altern Complement Med* 2009;15(5):593–600.
8. Lerner M. Choice in cancer—integrating the best of conventional and alternative approaches to cancer. Cambridge (MA): MIT Press; 1994.
9. Beck CJ. *Everyday zen*. New York: HarperCollins; 1989.
10. Brosse T. A psychophysiological study. *Main Current Mod Thought* 1946;4:77–84.
11. Wenger MA, Bagchi BK. Studies of autonomic functions in practitioners of yoga in India. *Behav Sci* 1961;6:312–23.

12. Vakil R. Remarkable feat of endurance of a yogi priest. *Lancet* 1950;2:871.
13. Hoenig J. Medical research on yoga. *Confin Psychiatr* 1968;11:69–89.
14. La Rovere MT, Bigger JT Jr, Marcus FI, et al. Baroreflex sensitivity and heart-rate variability in prediction of total cardiac mortality after myocardial infarction. *Lancet* 1998;351:478–84.
15. Nolan J, Batin PD, Andrews R, et al. Prospective study of heart rate variability and mortality in chronic heart failure—results of the United Kingdom heart failure evaluation and assessment of risk trial. *Circulation* 1998;98:1510–6.
16. Bernardi L, Sleight P, Bandinelli G, et al. Effect of rosary prayer and yoga mantras on autonomic cardiovascular rhythms—comparative study. *BMJ* 2001;323:1446–9.
17. Peng CK, Henry IC, Mietus JE, et al. Heart rate dynamics during three forms of meditation. *Int J Cardiol* 2004;95(1):19–27.
18. Benson H, Kotch JB, Craswell KD. The relaxation response—a bridge between psychiatry and medicine. *Med Clin North Am* 1977;61:929–38.
19. Kabat-Zinn J, Massion AO, Kristeller J, et al. Effectiveness of a mindfulness-based stress reduction program in the treatment of anxiety disorders. *Am J Psychiatry* 1992;149(7):936–43.
20. Miller J, Fletcher K, Kabat-Zinn J. Three-year follow-up and clinical implications of a mindfulness meditation-based stress reduction intervention in the treatment of anxiety disorders. *Gen Hosp Psychiatry* 1995;17(3):192–200.
21. Beauchamp-Turner D, Levinson D. Effects of meditation on stress, health, and affect. *Medical-Psychother Int J* 1992;5:123–31.
22. Teasdale J, Segal ZV, Williams JM, et al. Prevention of relapse/recurrence in major depression by mindfulness-based cognitive therapy. *J Consult Clin Psychol* 2000;68(4):615–23.
23. Ma SH, Teasdale JD. Mindfulness-based cognitive therapy for depression—replication and exploration of differential relapse prevention effects. *J Consult Clin Psychol* 2004;72(1):31–40.
24. Kabat-Zinn J, Lipworth L, Burney R. The clinical use of mindfulness meditation for the self-regulation of chronic pain. *J Behav Med* 1985;8(2):163–90.
25. Blanchard EB, Nicholson NL, Taylor AE, et al. The role of regular home practice in the relaxation treatment of tension headache. *J Consult Clin Psychol* 1991;59:467–70.
26. Kabat-Zinn J, Wheeler E, Light T, et al. Influence of a mindfulness-based stress reduction intervention on rates of skin clearing in patients with moderate to severe psoriasis undergoing phototherapy and photochemotherapy. *Psychosom Med* 1998;60:625–32.
27. Alexander CN, Schneider RH, Staggers F, et al. Trial of stress reduction for hypertension in older African Americans. *Hypertension* 1996;28:228–37.
28. Parati G, Steptoe A. Stress reduction and blood pressure control in hypertension—a role for transcendental meditation? *J Hypertens* 2004;22(11):2057–60.
29. Cooper M, Aygen M. Effect of meditation on blood cholesterol and blood pressure. *Harefuah* 1978;95(1):1–2.
30. Royer-Bounour P. The transcendental meditation technique—a new direction for smoking cessation programs. *Abstr Int* 1989;50(8):3428B.
31. Davis JM, Fleming MF, Bonus KA, et al. A pilot study on mindfulness based stress reduction for smokers. *BMC Complement Altern Med* 2007;25:2–7.
32. Zgierska A, Rabago D, Zuelsdorff M, et al. Mindfulness meditation for alcohol relapse prevention, a feasibility pilot study. *J Addict Med* 2008;2(3):165–73.
33. Fields JZ, Walton KG, Schneider RH, et al. Effect of a multimodality natural medicine program on carotid atherosclerosis in older subjects—a pilot trial of Maharishi Vedic Medicine. *Am J Cardiol* 2002;89:952–8.

34. Zamarra JW, Schneider RH, Besseghini I, et al. Usefulness of the transcendental meditation program in the treatment of patients with coronary artery disease. *Am J Cardiol* 1996;77:867–70.
35. Ornish D, Brown SE, Scherwitz LW, et al. Can lifestyle changes reverse coronary heart disease? *Lancet* 1990;336:129–33.
36. Alexander CN, Langer EJ, Newman RI, et al. Transcendental meditation, mindfulness, and longevity—an experimental study with the elderly. *J Pers Soc Psychol* 1989;57:950–64.
37. Shannahoff-Khalsa D. An introduction to kundalini yoga meditation techniques that are specific for the treatment of psychiatric disorders. *J Altern Complement Med* 2004;10(1):91–101.
38. Shearer S, Gordon L. The patient with excessive worry. *Am Fam Physician* 2006;73(6):1049–56.
39. Orme-Johnson D. Medical care utilization and the transcendental meditation program. *Psychosom Med* 1987;49:493–507.
40. Caudill M, Schnable R, Zuttermeister P, et al. Decreased clinic use by chronic pain patients—response to behavioral medicine intervention. *Clin J Pain* 1991;7:305–10.
41. Grossman P, Niemann L, Schmidt S, et al. Mindfulness-based stress reduction and health benefits—a meta-analysis. *J Psychosom Res* 2004;57:35–43.
42. Newberg AB, Iversen J. The neural basis of the complex mental task of meditation—neurotransmitter and neurochemical considerations. *Med Hypotheses* 2003;61(2):282–91.
43. Davidson RJ, Kabat-Zinn J, Schumacher J, et al. Alterations in brain and immune function produced by mindfulness meditation. *Psychosom Med* 2003;65:564–70.
44. Hayney MS, Love GD, Buck JM, et al. The association between psychosocial factors and vaccine-induced cytokine production. *Vaccine* 2003;21:2428–32.
45. Rosenkranz MA, Jackson DC, Dalton KM, et al. Affective style and in vivo immune response—neurobehavioral mechanisms. *Proc Natl Acad Sci U S A* 2003;100(19):11148–52.
46. Cohen S, Herbert TB. Health psychology—psychological factors and physical disease from the perspective of human psychoneuroimmunology. *Annu Rev Psychol* 1996;47:113–42.
47. Lutz A, Greischar LL, Rawlings NB, et al. Long-term meditators self-induce high-amplitude gamma synchrony during mental practice. *Proc Natl Acad Sci U S A* 2004;101(46):16369–73.
48. Dyrbye LN, Thomas MR, Massie FS, et al. Burnout and suicidal ideation among US medical students. *Ann Intern Med* 2008;149:334–41.
49. Newton B, Barber L, Clardy J, et al. Is there a hardening of the heart during medical school? *Acad Med* 2008;83:244–9.
50. Newcomer J, Selke G, Melson A, et al. Decreased memory performance in healthy humans induced by stress-level cortisol treatment. *Arch Gen Psychiatry* 1999;56:527–33.
51. Dowlati Y, Herrmann N, Swardfager W, et al. A meta-analysis of cytokines in major depression. *Biol Psychiatry* 2009, in press.
52. Goebert D, Thompson D, Takeshita J, et al. Depressive symptoms in medical students and residents: a multischool study. *Acad Med* 2009;84:236–41.
53. Shapiro S, Schwartz G, Bonner G. Effects of mindfulness-based stress reduction on medical and premedical students. *J Behav Med* 1998;21:581–99.

54. Jha A, Krompinger J, Baime M. Mindfulness training modifies subsystems of attention. *Cogn Affect Behav Neurosci* 2007;7(2):109–19.
55. Gropman J. *How doctors think*. Boston: Houghton Mifflin; 2007.
56. Frank E, Breyan J, Elon L. Physician disclosure of healthy personal behaviors improves credibility and ability to motivate. *Arch Fam Med* 2000;9:287–90.
57. Grepmaier L, Mitterlehner F, Loew T, et al. Promoting mindfulness in psychotherapists in training influences the treatment results of their patients, a randomized double blind controlled study. *Psychother Psychosom* 2007;76:332–8.
58. Astin JA, Sierpina VS, Forsys K, et al. Integration of the biopsychosocial model, perspectives of medical students and residents. *Acad Med* 2008;83:20–7.