Series Editor: Andrew B. Newberg, MD

Acupuncture in Theory and Practice Part 1: Theoretical Basis and Physiologic Effects

Bruce Y. Lee, MD
Patrick J. LaRiccia, MD
Andrew B. Newberg, MD

The use of acupuncture, a standard treatment modality in Asia for more than 2000 years, has been growing dramatically in North America and Europe over the past decade. The first documented mention of acupuncture dates back to a Chinese medical textbook from the first century BCE, but its actual use may predate this time period. The Western world first gained knowledge of this technique about 300 years ago, when European missionaries in China observed and reported its use.[1]

Various surveys and organizations have estimated that approximately 5000 students are currently enrolled in acupuncture and traditional Chinese medicine (TCM) schools in the United States. In addition, 75% of US medical schools offer courses on complementary and alternative medicine (CAM). More than 12,000 certified acupuncturists are estimated to be practicing in the United States, and Americans in 1993 made nearly 12 million visits to acupuncturists.[2–4] Surveys by Eisenberg and colleagues[5] showed that the percentage of Americans using acupuncturists over the past year more than doubled to 1% between 1990 and 1997. Cherkin and colleagues[6] found that in a typical week in 1999, Massachusetts and Washington acupuncturists had medians of 25 and 20 patient visits, respectively. With these numbers expected to grow, the likelihood of a physician either employing acupuncture or seeing a patient who has or will use acupuncture continues to rise, making a basic understanding of acupuncture increasingly important.

This is the first of a 2-part series that aims to provide an overview of acupuncture. Part 1 reviews basic TCM concepts, acupuncture principles, and current theories on the physiologic mechanisms and effects of acupuncture. Part 2 will address the current indications for acupuncture, efficacy and safety data, licensing and certification information, and potential applications to Western medicine.

TRADITIONAL CHINESE MEDICINE CONCEPTS

Behind the theory of acupuncture are the basic underlying theories involving *yin*, *yang*, and *qi* (pronounced "chee"). According to TCM concepts, everything in nature can be classified as either yin or yang.[4] For every yin, there is a corresponding yang. For example, light is yin and dark is yang. In the human body, the tendons and bones are yin and the skin is yang. The internal organs are yin, and the external portion of the body is yang. Harmony and good health occur when the yin and the yang are perfectly balanced, whereas unbalance results in disease. All TCM techniques aim to restore the balance of yin and yang. The balance of yin and yang determines the presence and flow of 3 components: energy (qi), blood, and body fluids. Imbalanced yin and yang results in shortage, excess, or improper flow of these components.

Qi is thought to flow through pathways in the body that are called *meridians*. These meridians travel longitudinally along the body, interconnect with each other, and often connect with specific visceral organs, such as the heart, gallbladder, and liver (**Figure 1**). There are 14 main meridians used in acupuncture. Each meridian consists of an internal pathway that runs inside the body and an external pathway on which the acupuncture points lie. Two of the meridians, the conception

Dr. Lee is a physician-scientist fellow, Division of General Internal Medicine, University of Pennsylvania, Philadelphia, PA. Dr. LaRiccia is a clinical associate, Department of Rehabilitation Medicine; Dr. Newberg is an assistant professor, Division of Nuclear Medicine, Department of Radiology. Both are at the Hospital of the University of Pennsylvania, Philadelphia, PA.

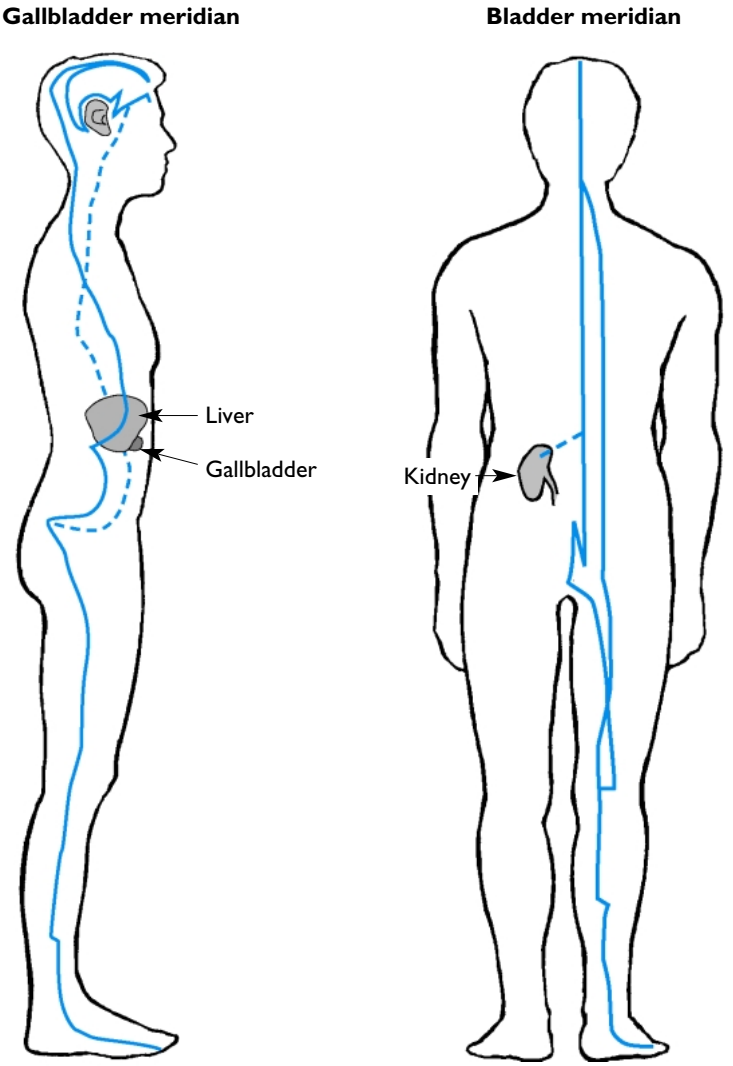

Figure 1. The approximate paths of 2 meridians, the bladder (BL) and gallbladder (GB). This diagram shows only the right counterpart of the BL and GB meridians. The *solid lines* represent the external pathway of the meridians; the *dotted lines* represent the internal continuation of the meridians to the organs. The internal portions of the meridians run deep in the body and thus are not accessible to acupuncture.

vessel and the governing vessel, run through the midline of the body. The remaining 12 meridians are bilateral; each have a right and left mirror-image counterpart and each traverse either the arm or the leg. Using the World Health Organization nomenclature (many alternative names exist), all of the bilateral meridians are named for their organ of origin. The "triple energizer" meridian originates from an organ, called *sanchiao*, which has 3 portions (upper, middle, and lower) and exists in classical Chinese anatomy. The meridians are interconnected, forming a closed circuit, so that needling of sites distant from a site of injury can theoretically affect symptoms.

According to TCM concepts, half of the vessels are predominantly yin and half are predominantly yang (**Table**). Each yang meridian is associated with a hollow, or *zang* organ. Each yin meridian is associated with a solid, or *fu* organ. Each yin meridian is paired with a yang meridian, and the pair work closely together. There is a time of day when each meridian and afflictions of the corresponding organ are most active. For example, asthma symptoms are expected to be worst between 3:00 AM and 5:00 AM, when the lung meridian is most active.

In the TCM approach, fatigue occurs when the amount of qi in the body is low, and disease occurs when the flow of qi through the meridians is hindered or obstructed. The goal of acupuncture is to restore the proper circulation of qi. Acupuncture points are located where the qi moves to the surface of the body.[7] A total of 361 regular acupuncture points fall on the 14 main meridians, whereas 40 (extra-meridian) acupuncture points do not. *Ashi points* (ie, tender spots) can be used as acupuncture points and were the primary points used

Table. The Major Meridians Used in Acupuncture

Name	Yin or Yang	Paired Organ	Major Role	Time of Day Most Active
Governing vessel (GV)	Yang	*	Controls all yang vessels	†
Conception vessel (CV)	Yin	*	Controls all yin vessels	†
Large intestine (LI)	Yang	LU	Metabolizes and passes water	5–7 AM
Lung (LU)	Yin	LI	Takes qi from air	3–5 AM
Stomach (ST)	Yang	SP	Receives food	7–9 AM
Spleen (SP)	Yin	ST	Transports nutrients Keeps blood within vessels	9–11 PM
Small intestine (SI)	Yang	HT	Separate waste material from nutrients in food	1–3 PM
Heart (HT)	Yin	SI	Governs blood vessels, keeps blood moving Stores spirit	11 AM–1 PM
Bladder (BL)	Yang	KI	Transform fluids into urine Excrete urine from the body	3–5 PM
Kidneys (KI)	Yin	BL	Responsible for growth and reproduction Stores basal yin and yang Control the body's liquids	5–7 PM
Gallbladder (GB)	Yang	LR	Store and excrete bile produced by liver With heart, involved in decision making	11 PM–1 AM
Liver (LR)	Yin	GB	Spreads and regulates qi through body Stores blood when body is at rest Controls lower abdomen, so affects menstrual cycles and female sexuality	1–3 AM
Triple energizer (TE)	Yang	PC	Nebulous organ that has 3 parts and is involved in processing nutrients and eliminating waste material	9–11 PM
Pericardium (PC)	Yin	TE	Dissipates excess qi from heart	7–9 PM

*The GV and CV meridians are not paired with other meridians.

†Because the GV and CV meridians serve other meridians, there is no specific time of maximum activity.

in early acupuncture and moxibustion treatments (see below). Ashi points represent the earliest stage of acupoint evolution and are used primarily for pain syndromes.[7–9]

From a Western medical perspective, it is unclear with which anatomic structures acupuncture points, qi, or the meridians correspond. Researchers have attempted to correlate TCM concepts with Western physiology and anatomy concepts and medicinal principles. At this time, the ability to fluidly interweave the underlying principles of acupuncture with those of Western medicine has yet to be fully realized.

ACUPUNCTURE TECHNIQUES

As do practitioners of Western medicine, the acupuncturist first performs a history and physical examination and, based on this information, makes a number of treatment decisions. The acupuncturist determines the points to stimulate; the frequency, duration (5 to 20 minutes), and number of treatments; and the method of stimulation. Some patients respond quickly and require shorter durations or fewer treatments. Stimulation methods include using needles alone, electrical stimulation through the needles (electro-acupuncture), lasers and sound waves (sonopuncture), suction (cupping), and heat (moxibustion). In moxibustion, the heat is provided by burning dried and aged mugwort, a medicinal plant.

There are various methods and schools of thought regarding point selection. Points may be selected in the area of affliction (local points), far from the area the area of affliction (distal points), or both. For example, for *bi* syndromes (ie, musculoskeletal problems manifested by soreness, pain, numbness, limited movement, and heavy sensation of the limbs and joints), acupuncture points are located in the area of the pain

(local points) and distal to the location of symptoms on meridians running through the involved area. Ashi points also are sometimes used.[10] Alternatively, points believed to impact certain categories of disease (*experience points*) may be selected. For example, a collection of points known as *shu-stream points* may be used to treat joint disease located in any part of the body. Points in the front of the body (*mu points*) may be selected to treat conditions considered Yang diseases, and points in the back of the body (*shu points*) selected to treat Yin diseases. Points on the left side of the body may be selected for conditions affecting the right side, and vice-versa.

If needles are used, the acupuncturist chooses the type of needles, which vary in length, width, and head shape. The acupuncturist also determines the depth (usually 0.5–8 cm) and direction (ie, angle) of insertion. The length of needle used varies depending on the location of the point being needled and the patient's body habitus. Points that do not have a large of amount of muscle beneath, such as the scalp and face, require the shortest needles, and areas with significant muscle mass require the longest needles. If the underlying muscles are thin or internal viscera are close, then needles should not be inserted perpendicularly but should be angled appropriately to avoid puncturing important structures. Following insertion, needles can be rotated, raised, thrusted, or vibrated in various ways. Such manipulation is done to further stimulate the acupuncture point and may be necessary to achieve the proper response. Overmanipulation (and consequent overstimulation) of acupuncture points actually can worsen symptoms temporarily. In general, all of the variables are tailored to the patient's disease, location of symptoms, location of acupuncture points, body habitus, and the patient's own response to acupuncture.

Although TCM acupuncture is the most prevalent form in the United States, various other schools of acupuncture exist. During the first century CE, acupuncture theory spread to Japan and Korea, and separate variants emerged in these countries. Later, after Europeans imported acupuncture in the 1600s, additional variants arose in France and England.[3,11]

Schools of acupuncture may differ in the methods of point selection, points selected, types of needles, and needle manipulations. For example, TCM styles tend to use thicker gauge needles, Korean styles use shorter needles, and Japanese styles use finer needles. Also, many traditional Japanese acupuncturists typically do not insert needles as deeply or for as long a period of time as do other practitioners. Some schools believe that specific body parts have connections to the rest of the body and, therefore, focus on those specific body parts. For example, in ear acupuncture or *auriculotherapy*, only points in the ear are stimulated. In Korean hand acupuncture, the hand is the focus, and in scalp acupuncture, the scalp is the focus. Some practitioners, especially those in the People's Republic of China, believe that a treatment is not effective unless a temporary feeling of numbness, fullness, or heaviness (*de qi*) is elicited during needling. Many other variations exist, and such variations greatly impact the design and interpretability of acupuncture clinical trials.[3,8,11]

Several manipulative techniques are closely related to acupuncture. For example, in acupressure, either fingers or an instrument with a hard, ball-shaped head are used to stimulate acupuncture points. In reflexology, a variation of acupressure, the feet and ankles are stimulated. Each of these techniques is believed to have advantages and disadvantages, although these typically have not been completely evaluated using a classic Western research paradigm.

PHYSIOLOGIC EFFECTS OF ACUPUNCTURE

A number of researchers have attempted to elucidate the physiologic effects of acupuncture. Because acupuncture has a wide variety of applications, it is difficult to evaluate the physiologic basis of each one. The most thoroughly studied application of acupuncture is for pain relief, and a number of studies have attempted to determine how acupuncture affects pain. Studies have suggested that analgesic and anesthetic effects of acupuncture result from the release of various endorphins. Much of the evidence has come from basic laboratory research, empiric research reports, and reviews written by Han,[12–16] Cheng,[17,18] and Pomeranz.[19–22]

Pomeranz[19–22] described what he believed to be the sequence of events that occur in the spinal cord and brain during acupuncture. In a simplified version of his model, the acupuncture stimulus moves from the insertion point to the spinal cord. Once in the spinal cord, the stimulus promotes release of enkephalin and dynorphin, which attenuate pain transmission through the spinal cord. The acupuncture stimulus travels up the spinal cord and then to the midbrain, where enkephalin is again released, stimulating the descending pain inhibition pathway. Upon reaching the hypothalamus, the acupuncture stimulus prompts the arcuate nucleus and the pituitary to release β-endorphin into the midbrain, further activating the descending pain inhibition pathway. The stimulus also induces the pituitary gland to secrete β-endorphin and adrenocorticotropic hormone into the systemic circulation, resulting in systemic anti-inflammatory effects.[23,24]

A number of findings in both human and animal studies support the hypothesis that endogenous endorphins mediate the analgesic effects of acupuncture:

- Opioid antagonists naloxone, naltrexone, cyclazocine, and diprenorphine can block or inhibit acupuncture analgesia.[18,21,25–27]
- Only the L-isomer (but not the D-isomer) of naloxone has been demonstrated to block acupuncture analgesia, which suggests that the effects of acupuncture are actually mediated by a specific type of receptor rather than a side effect, such as membrane fluidization.[18,21,27]
- Injections of naloxone into the systemic circulation inhibit acupuncture analgesia. Local injections of naloxone inhibit acupuncture analgesia only if the injection reaches areas of the nervous system with endorphin activity. The same is true for local injections of antibodies to β-endorphin, enkephalin, and dynorphin. For example, intrathecal injections of antisera to dynorphin inhibit acupuncture analgesia, but midbrain injections do not.[21,27,28]
- Endorphin receptor–deficient mice and endorphin-deficient rats do not respond as well to acupuncture.[19,29]
- Following acupuncture, cerebrospinal fluid endorphins increase and brain endorphins decrease.[30,31]
- Inhibitors of enzymes that degrade endorphins enhance acupuncture analgesia.[19,32]
- When the circulation of one animal is crossed with that of another, administering acupuncture to one animal can result in analgesic effects in both animals. Additionally, administering naloxone will reverse the effect in both animals.[33,34]
- Pituitary suppression or ablation reduces acupuncture analgesia.[28,35–37]

It has been suggested that something about the experience of receiving acupuncture, rather than the acupuncture itself, produces analgesic effects (ie, a placebo response). However, this possibility does not appear to be supported by available evidence. For example, investigators have performed experiments to determine whether analgesia is the result of the body's stress response to having "noxious stimuli" applied to the body. Pomeranz's group found that while acupuncture produced analgesia in one group of mice, conditions that mimicked the stress of delivering acupuncture did not elicit analgesia in corresponding control mice.[21,38,39] Some studies have utilized "sham" acupuncture—acupuncture at incorrect points. However, owing to methodologic problems with these studies, their results are difficult to interpret.[40–43] (Methodology issues in acupuncture research are addressed in the second part of this series.)

It also has been suggested that the effects of acupuncture are the consequences of hypnosis, but studies have not supported this hypothesis. Peng et al[44] and Ulett et al[16] reported no correlation between the degree of hypnotizability and acupuncture results. Researchers have not been able to inhibit hypnotic analgesia with naloxone. Moreover, acupuncture can successfully produce analgesia in various animal species that cannot be hypnotized.[45,46]

Some studies have looked for Western anatomic correlates to acupuncture points and meridians. Cadaver studies have failed to identify consistent correlates.[47,48] During needling, however, patients may feel aching, numbness, or fullness (de qi) radiating down the meridian being needled. This sensation can occur in amputated phantom limbs and can be blocked by local anesthetic, cold, or mechanical pressure, favoring the presence of distinct anatomic structures.[1] Many acupuncture points correspond to trigger points and are in the vicinity of motor points of neuromuscular attachments and of blood vessels near neuromuscular attachments. Physiologically, acupuncture points sometimes have less electrical resistance than that of surrounding tissue,[1,49–51] but this characteristic has not been identified consistently.

More recently, functional brain imaging studies have demonstrated a number of changes in structures that underlie the experience and sensation of pain and the effects of acupuncture. For example, a single photon emission computed tomography study demonstrated that blood flow in the thalamus increased in control subjects undergoing acupuncture.[52] Patients with pain were found to have asymmetric thalamic activity when experiencing pain; this asymmetry changed after pain relief from acupuncture (**Figure 2**). Studies using functional magnetic resonance imaging and positron emission tomography have suggested a complex network of interactions among the thalami, cingulate gyri, sensorimotor cortices, dorsolateral prefrontal cortices, and midbrain in acupuncture analgesia.[53–55] These imaging studies have not been able to discern whether the changes are directly related to the mechanism of acupuncture or simply reflect the alleviation of pain. It is hoped that future physiologic and imaging studies will better clarify the underlying mechanism of acupuncture analgesia and provide a springboard for understanding some of acupuncture's other clinically observed effects.

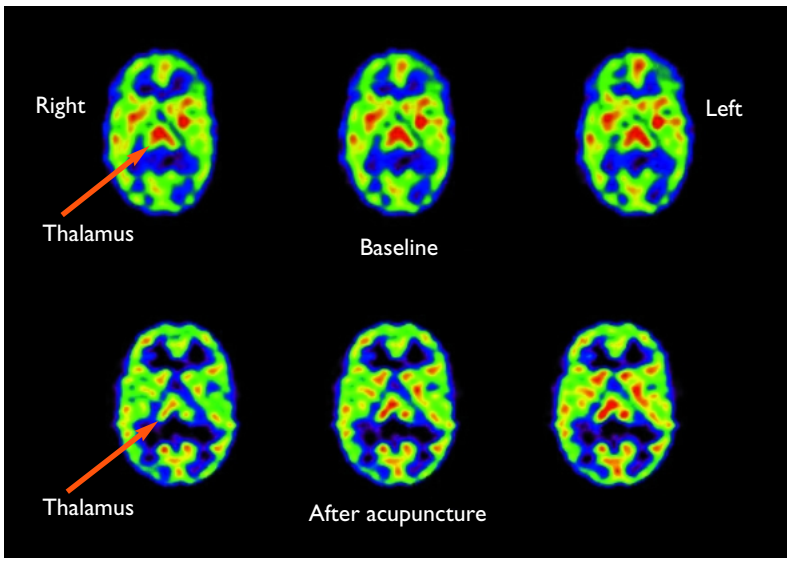

Figure 2. Brain single photon emission computed tomography (SPECT) images demonstrating cerebral blood flow changes in the brain between the baseline state with pain and post-acupuncture, when the pain was relieved. Red indicates the highest activity level, followed by yellow, blue, and black (in descending order). With pain (ie, baseline), thalamic activity is initially asymmetric, with activity on the left side greater than on the right. After acupuncture, the thalamic activity has shifted, with activity on the right side now greater than on the left.

CONCLUSION

The physiologic changes underlying acupuncture are yet to be fully elucidated, and additional research is needed before physicians can definitively answer patient questions about the exact mechanisms and efficacy of acupuncture. The growing interest in and use of acupuncture likely will make such questions increasingly more common. The establishment of the National Institutes of Health's National Center for Complementary and Alternative Medicine (NCCAM) should stimulate more research, but it remains to be seen whether available funding and preclinical studies will match the future demand for information. A better understanding of the principles and mechanisms of acupuncture may refine and potentially expand its indications and shed additional light on its safety and efficacy. In addition, a more thorough knowledge of these aspects of acupuncture will impact training and certification programs. These topics will be covered in the second part of this series. **HP**

REFERENCES

1. Nasir LS. Acupuncture. Prim Care 2002;29:393–405.
2. Ramos-Remus C, Gutierrez-Urena S, Davis P. Epidemiology of complementary and alternative practices in rheumatology. Rheum Dis Clin North Am 1999;25: 789–804, v.
3. Wu JN. A short history of acupuncture. J Altern Complement Med 1996;2:19–21.
4. Nestler G. Traditional Chinese medicine. Med Clin North Am 2002;86:63–73.
5. Eisenberg DM, Davis RB, Ettner SL, et al. Trends in alternative medicine use in the United States, 1990–1997: results of a follow-up national survey. JAMA 1998;280: 1569–75.
6. Cherkin DC, Deyo RA, Sherman KJ, et al. Characteristics of visits to licensed acupuncturists, chiropractors, massage therapists, and naturopathic physicians. J Am Board Fam Pract 2002;15:463–72.
7. Xinnong C. Chinese acupuncture and moxibustion. 1st ed. Beijing: Foreign Languages Press; 1987.
8. Ehling D. Oriental medicine: an introduction [published erratum appears in Altern Ther Health Med 2001;7:22]. Altern Ther Health Med 2001;7:71–82.
9. Hwang YC. Anatomy and classification of acupoints. Probl Vet Med 1992;4:12–5.
10. Hu J. How to differentiate and treat bi-syndrome by acupuncture and moxibustion? J Tradit Chin Med 2002;22: 73–6.
11. Kaptchuk TJ. Acupuncture: theory, efficacy, and practice. Ann Intern Med 2002;136:374–83.
12. Han JS, Tang J, Ren MF, et al. Central neurotransmitters and acupuncture analgesia. Am J Chin Med 1980;8: 331–48.
13. Han JS, Terenius L. Neurochemical basis of acupuncture analgesia. Annu Rev Pharmacol Toxicol 1982;22: 193–220.
14. Han JS, Xie GX. Dynorphin: important mediator for electroacupuncture analgesia in the spinal cord of the rabbit. Pain 1984;18:367–76.
15. Han JS. Acupuncture analgesia [letter]. Pain 1985;21: 307–10.
16. Ulett GA, Han J, Han S. Traditional and evidence-based acupuncture: history, mechanisms, and present status. South Med J 1998;91:1115–20.
17. Cheng RS, Pomeranz B. Monoaminergic mechanism of electroacupuncture analgesia. Brain Res 1981;215: 77–92.

18. Cheng RS, Pomeranz BH. Electroacupuncture analgesia is mediated by stereospecific opiate receptors and is reversed by antagonists of type I receptors. Life Sci 1980;26:631–8.
19. Pomeranz B. Scientific research into acupuncture for the relief of pain. J Altern Complement Med 1996;2: 53–60; discussion 73–5.
20. Pomeranz B, Cheng R, Law P. Acupuncture reduces electrophysiological and behavioral responses to noxious stimuli: pituitary is implicated. Exp Neurol 1977;54:172–8.
21. Pomeranz B, Chiu D. Naloxone blockade of acupuncture analgesia: endorphin implicated. Life Sci 1976;19: 1757–62.
22. Pomeranz B. Do endorphins mediate acupuncture analgesia? Adv Biochem Psychopharmacol 1978;18:351–9.
23. Takeshige C, Nakamura A, Asamoto S, Arai T. Positive feedback action of pituitary beta-endorphin on acupuncture analgesia afferent pathway. Brain Res Bull 1992;29:37–44.
24. Takeshige C, Oka K, Mizuno T, et al. The acupuncture point and its connecting central pathway for producing acupuncture analgesia. Brain Res Bull 1993;30:53–67.
25. Mayer DJ, Price DD, Rafii A. Antagonism of acupuncture analgesia in man by the narcotic antagonist naloxone. Brain Res 1977;121:368–72.
26. Oleson TD. Investigation of the effects of naloxone upon acupuncture analgesia [letter]. Pain 1984;19:201–4.
27. Mayer DJ, Price DD. Endorphin release as mechanism of acupuncture analgesia [letter]. Pain 1981;11:273–80.
28. Cheng R, Pomeranz B, Yu G. Dexamethasone partially reduces and 2% saline-treatment abolished electroacupunture analgesia: these findings implicate pituitary endorphins. Life Sci 1979;24:1481–6.
29. Peets JM, Pomeranz B. CXBK mice deficient in opiate receptors show poor electroacupuncture analgesia. Nature 1978;273:675–6.
30. Pert A, Dionne R, Ng L, et al. Alterations in rat central nervous system endorphins following transauricular electroacupuncture. Brain Res 1981;224:83–93.
31. Clement-Jones V, McLoughlin L, Tomlin S, et al. Increased beta-endorphin but not met-enkephalin levels in human cerebrospinal fluid after acupuncture for recurrent pain. Lancet 1980;2:946–9.
32. Ehrenpreis S. Analgesic properties of enkephalinase inhibitors: animal and human studies. Prog Clin Biol Res 1985;192:363–70.
33. Peng CH, Yang MM, Kok SH, Woo YK. Endorphin release: a possible mechanism of acupuncture analgesia. Comp Med East West 1978;6:57–60.
34. Yang MM, Kok SH. Further study of the neurohumoral factor, endorphin, in the mechanism of acupuncture analgesia. Am J Chin Med 1979;7:143–8.
35. Yang J, Song CY, Lin BC, Zhu HN. [Effects of stimulation and cauterization of hypothalamic paraventricular nucleus on acupuncture analgesia.] [Article in Chinese.] Sheng Li Xue Bao 1992;44:455–60.
36. Kasahara T, Amemiya M, Wu Y, Oguchi K. Involvement of central opioidergic and nonopioidergic neuroendocrine systems in the suppressive effect of acupuncture on delayed type hypersensitivity in mice. Int J Immunopharmacol 1993;15:501–8.
37. Takeshige C, Tsuchiya M, Guo SY, Sato T. Dopaminergic transmission in the hypothalamic arcuate nucleus to produce acupuncture analgesia in correlation with the pituitary gland. Brain Res Bull 1991;26:113–22.
38. Pomeranz B. Relation of stress-induced analgesia to acupuncture analgesia. In: Kelly DD, editor. Stress-induced analgesia. New York: New York Academy of Sciences; 1986:444—7.
39. Pomeranz B, Paley D. Electroacupuncture hypalgesia is mediated by afferent nerve impulses: an electrophysiological study in mice. Exp Neurol 1979;66:398–402.
40. NIH Consensus Conference. Acupuncture. JAMA 1998; 280:1518–24.
41. Berman BM, Swyers JP, Ezzo J. The evidence for acupuncture as a treatment for rheumatologic conditions. Rheum Dis Clin North Am 2000;26:103–15, ix–x.
42. Cherkin DC, Sherman KJ, Deyo RA, Shekelle PG. A review of the evidence for the effectiveness, safety, and cost of acupuncture, massage therapy, and spinal manipulation for back pain. Ann Intern Med 2003;138:898–906.
43. Ernst E, White AR. Acupuncture for back pain: a meta-analysis of randomized controlled trials. Arch Intern Med 1998;158:2235–41.
44. Peng AT, Behar S, Yue SJ. Long-term therapeutic effects of electro-acupuncture for chronic neck and shoulder pain—a double blind study. Acupunct Electrother Res 1987;12:37–44.
45. Lewith GT, Kenyon JN. Physiological and psychological explanations for the mechanism of acupuncture as a treatment for chronic pain. Soc Sci Med 1984;19: 1367–78.
46. Liao SJ. Recent advances in the understanding of acupuncture. Yale J Biol Med 1978;51:55–65.
47. Omura Y, Takeshige C, Shimotsuura Y, Suzuki M. Imaging of the stomach, and localization of the stomach meridian & its acupuncture points in a human cadaver by the use of the indirect "Bi-Digital O-Ring Test Imaging Technique". Acupunct Electrother Res 1988;13:153–64.
48. Gao W, Peng G. [The surface anatomic observation of cerebral porecentral and postcentral gyrus for scalp acupuncture.] [Article in Chinese.] Zhen Ci Yan Jiu 1994; 19:17–20.
49. Chapman CR, Chen AC, Bonica JJ. Effects of intrasegmental electrical acupuncture on dental pain: evaluation by threshold estimation and sensory decision theory. Pain 1977;3:213–27.
50. Melzack R, Stillwell DM, Fox EJ. Trigger points and acupuncture points for pain: correlations and implications. Pain 1977;3:3–23.
51. Dung H. Anatomical features contributing to the formation of acupuncture points. Am J Acupunct 1984;12: 139–43.
52. Alavi A, LaRiccia P, Sadek A, et al. Neuroimaging of

acupuncture in patients with chronic pain. J Altern Complement Med 1997;3 Suppl:475–535.
53. Hui KK, Liu J, Makris N, et al. Acupuncture modulates the limbic system and subcortical gray structures of the human brain: evidence from fMRI studies in normal subjects. Hum Brain Mapp 2000;9:13–25.
54. Hsieh JC, Tu CH, Chen FP, et al. Activation of the hypothalamus characterizes the acupuncture stimulation at the analgesic point in human: a positron emission tomography study. Neurosci Lett 2001;307:105–8.
55. Kong J, Ma L, Gollub RL, et al. A pilot study of functional magnetic resonance imaging of the brain during manual and electroacupuncture stimulation of acupuncture point (LI-4 Hegu) in normal subjects reveals differential brain activation between methods. J Altern Complement Med 2002;8:411–9.

Code Blue Stories

Waiting for an Inevitable Code Blue

In the Medical Ward

A 58-year-old man was admitted to the male medical ward of a general hospital in Saudi Arabia with anemia. He had hepatosplenomegaly but no lymphadenopathy. His hemoglobin level was only 5.6 g/dL. We started diagnostic evaluations, but that same afternoon the patient's son came to the hospital during visiting hours with a medical report from a tertiary care medical center in Riyadh. The patient had been admitted and evaluated there previously and had been diagnosed with myelodysplastic syndrome. We were relieved that the patient would be spared the difficult diagnostic tests that would have followed, including a bone marrow biopsy, but sad to learn that he had a disease with such a poor prognosis.

Unfortunately, his blood group was B Rh-negative, a blood group uncommon in the general population. We had 6 pints of B Rh-negative blood in the blood bank, and we started transfusing him over a period of a few days. Two of the patient's relatives were confirmed to be matches, and both agreed to donate blood to the patient.

Three weeks from the day of admission, the blood supply was running low, and we contacted two other hospitals in the region to no avail. Two more weeks passed and the situation was looking dire—blood seemed to evaporate from his body. As a last-ditch effort, we transfused O Rh-negative blood. After a total of 32 transfusions, we realized our efforts were futile.

He had been on hematinics for weeks now, and the patient's health gradually was worsening. He became breathless, and we expected the worst. He was moved to the intensive care unit.

Upon being transferred, the patient pulled the oxygen mask aside and asked, "When am I going to die, doctor?" He had appreciated our efforts during his stay and knew that blood was the only medical option that could save him from death. The hospitals we had contacted still had no B Rh-negative blood nor did we. Other than providing him with oxygen and attending to his physical comfort, the only solace we could give him was to suggest that he recite verses from the Holy Koran.

After several weeks of waiting for the inevitable, the patient finally went into cardiac arrest. We started cardiopulmonary resuscitation but aborted efforts within a few minutes. It had been a painful wait for us and for the patient.

–Sarosh Ahmed Khan, MBBS, MD
Kashmir, India
–Abdul Rahman Bhat, MBBS, MD
Najran, Saudi Arabia