Needle Phobia: A Neglected Diagnosis

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Needle phobia is a recently defined medical condition that affects at least 10% of the population. Because persons with needle phobia typically avoid medical care, this condition is a significant impediment in the health care system. The etiology of needle phobia lies in an inherited vasovagal reflex of shock, triggered by needle puncture. Those who inherit this reflex often learn to fear needles through successive needle exposure. Needle phobia is therefore both inherited and learned.

In a family practice, needle phobia can be managed by reassurance and education, avoidance of needles, postural and muscle tension techniques, benzodiazepines, nitrous oxide gas, and topical anesthesia applied by iontophoresis.

Key words. Needle phobia; phobic disorders; needles; vasovagal reflex; syncope; vasovagal syncope; iontophoresis. (*J Fam Pract 1995; 41:169-175*)

Needle phobia is a condition that has become an increasingly important issue in medicine because of the modern reliance on injections and blood testing. Contrary to popular belief, needle phobia is not confined to children, is not an emotion-driven or transient phenomenon, and is not a rare condition. Clinicians need to be aware of needle phobia because it is a common condition and because needle-phobic persons tend to avoid medical treatment, which can lead to serious health problems as well as social and legal problems.

Needle phobia has been defined as a formal medical condition[1,2] and has recently been included in the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (*DSM-IV*) within the diagnostic category of Blood-Injection-Injury Phobia.[3] A review of the background medical literature and suggestions for management of needle phobia are presented here.

The etiology of needle phobia is rooted in an inherited vasovagal reflex that causes shock with needle puncture. With repeated needle exposure, those with an inherited vasovagal shock reflex tend to develop a fear of needles. Unlike most other phobias, in which exposure to the feared object excites tachycardia, victims of needle phobia typically experience a temporary anticipatory tachycardia and hypertension, which on needle insertion turns into bradycardia and hypotension (Figure), accompanied by pallor, diaphoresis, tinnitus, syncope or near-syncope, and sometimes asystole or death.[1]

According to the *DSM-IV*, a phobia is defined by the presence of fear and by avoidance behavior.[3] The symptom of avoidance of needles, doctors, dentists, etc, is central to the definition of needle phobia, since avoidance of health care is surely a health care problem. However, because needle phobia is also accompanied by numerous physiological changes in blood pressure, pulse, electrocardiogram (ECG) waveforms, and stress hormone levels,[1,2] these measurements can also be used to define this condition (Table 1). While a dislike or mild fear of needles is very common, needle phobia can be more rigorously defined by objective clinical findings in addition to subjective symptoms.

Needle Phobia in Family Practice

Those with needle phobia are often terrified of routine needle procedures, and a few are so frightened that they would rather die than have a needle procedure.[4] Even such relatively minor needle procedures as venipuncture[1,5] or subcutaneous injection[6] can cause a vasovagal

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This paper is dedicated to the memory of the author's father, Mr Edward Winslow Hamilton, Sr, who died in 1977 of cardiac arrest after a venipuncture.

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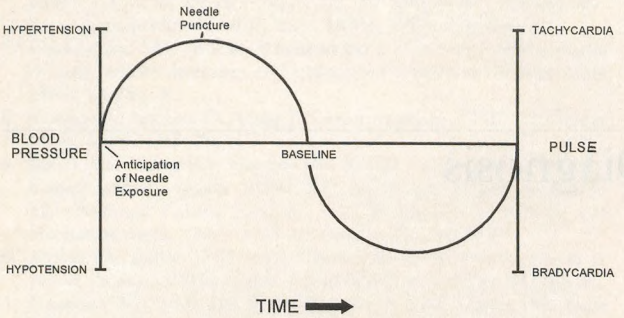

Figure. Theoretical biphasic expression of the vasovagal reflex in needle phobia.

shock reflex and evoke patient resistance. When those with needle phobia do agree to needle procedures, they often experience syncope, fall and sustain trauma, have convulsions, lose bowel and bladder control, evoke the calling of cardiac codes, or otherwise cause great concern among staff and family members. Others with needle phobia are simply noncompliant with medical treatment regimens, eg, insulin self-injections.

Victims of needle phobia possess a heightened risk of morbidity and mortality simply because they avoid health care, sometimes for many years,[1,7] and even when the need for treatment is compelling.[1,4,6–8] Approximately 5% to 15% of the population, for example, decline necessary dental treatment, primarily because they fear oral injections.[8] With an incidence of needle phobia of at least 10%, it is reasonable to hypothesize that a large hidden population goes without regular health care because of this condition. The recognition, acceptance, and communication of this danger by both the medical community and the public, and the development of methods to compensate for needle fear in clinical practice, represent probably the greatest challenges that this condition poses for family medicine.

Needle phobia also can cause major social and legal difficulties in one's life. A fear of blood testing or immunization can interfere with or even destroy plans for marriage, travel, education, immigration, or employment. Students may be discouraged from biological, nursing, or medical careers because of their fear of needles,[4] and women wishing to have children may be thwarted by needle fear.[4,7] Legal problems can arise when blood tests are ordered by a court in paternity cases, and some victims of needle phobia have even been charged by the police for failure to agree to blood testing.[4] The best-selling book *The Blooding* detailed the resistance that authorities in England experienced against mass blood testing to eliminate suspects in a murder case.[9] In the United States, involuntary blood testing of accused drunk drivers has led to four cases being appealed to the US Supreme Court.[10–13]

Occasionally, needle phobia can be fatal. At least 23 reported deaths can reasonably be ascribed solely to needle phobia and its vasovagal reflex during needle procedures such as venipuncture, blood donation, arterial puncture, pleural tap, and intramuscular and subcutaneous injections.[14–25] Other reports and indirect evidence further suggest that needle procedures can result in sudden death.[26–29] A death by needle phobia can be due to either or both of two mechanisms: an abrupt vasovagal drop in blood pressure and perfusion, especially in an arterial tree already compromised by atherosclerosis,

Table 1. The Primary Factors Underlying the Recognition and Diagnosis of Needle Phobia

Past medical history*

(1) Self-report by the patient of a long-term needle fear, usually from childhood, that the patient recognizes as unreasonable.

(2) Exposure to or anticipation of a needle procedure invariably triggers immediate anxiety, sometimes in the form of a panic attack. In children, the anxiety may be expressed by crying, psychomotor agitation, freezing, or clinging.

(3) Needle procedures, often along with associated medical objects or situations, are avoided either some or all of the time.

(4) The needle avoidance and fear interfere significantly with health care or with normal occupational, academic, or social activities, or the patient is markedly distressed about having the fear.

Family medical history

Approximately 80% of patients with needle phobia report strong needle fear in a first-degree relative, ie, parent, child, or sibling.

Clinical findings

(1) Physical symptoms of syncope, near-syncope, light-headedness, or vertigo upon needle exposure, along with other autonomic symptoms, eg, pallor, diaphoresis, nausea.

(2) Cardiovascular depression with a drop in blood pressure or pulse or both; with or without an initial rise in blood pressure or pulse or both.

(3) Electrocardiogram anomalies of virtually any type.

(4) Rises in any combination of several stress hormones: antidiuretic hormone, human growth hormone, dopamine, catecholamines, corticosteroids, renin, endothelin, and β-endorphin.

**Modified from Diagnostic criteria for specific phobia. In:* Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition. *Washington, DC: American Psychiatric Association, 1994: 410.*

NOTE: A diagnosis of needle phobia can be made by past medical history alone. In addition, however, victims of needle phobia typically have symptoms of decreased cerebral perfusion, cardiovascular changes, electrocardiogram changes, and hormonal rises.

could cause myocardial infarction[25,29] or cerebral infarction; or a vasovagal reflex could impair the sinoatrial or atrioventricular node enough to cause ventricular fibrillation or asystole.[27,30]

Prevalence of Needle Phobia

Because needle phobia has only recently been defined, only indirect estimates of its prevalence can be inferred from the literature. One study of 449 Canadian women found that 21.2% experienced mild to intense fear, and 4.9% had a phobic level of fear of injections, blood, injury, doctors, dentists, and hospitals.[31] Another study estimated that 9% of the US population in the age bracket of 10 to 50 years old have an injection phobia, and 5.7% have seen a physician about this phobia.[32] Dread of a painful injection was present in 11% of 100 English office patients.[33] Through in-hospital interviews, 22% of 184 teenaged maternity patients in Nashville, Tennessee, were found to have a fear of blood drawing strong enough to make it hard for them to come to a public clinic for prenatal care.[34] In random surveys, 23% of 200 Swedes[35] and 27% of 177 US college students[36] reported needle fear as the main reason for not donating blood.

The prevalence of needle phobia is probably lower in population samples from clinics or hospitals since those with needle phobia tend to select themselves out of such populations. Even in a general population sample, many people express denial of their needle fear. Therefore, most of the studies done so far probably underestimate the true prevalence of needle phobia. Although the percentage is currently unknown, an estimate of at least 10% is credible.

Etiology of Needle Phobia

In the author's experience with over 50 patients with needle phobia, and in all similar cases reported in the medical literature, those afflicted inevitably display symptoms of an autonomic vasovagal reflex whenever they undergo a needle procedure. The neurophysiology of the vasovagal reflex is grounded in both a vagal bradycardia and a vasodilatation from withdrawal of α-sympathetic arteriolar tone, which together cause hypotension.[2,30] In addition, associated neurological circuits cause ECG anomalies and stress hormone release.[30] Because most victims of the vasovagal reflex do not actually lose consciousness, the term "vasovagal reflex" is more accurate than "vasovagal syncope," the term most often used in the older literature. Although the vasovagal reflex has classically been described as being biphasic, with an anticipatory rise in blood pressure and pulse before needle puncture and a sudden plunge in both after puncture[1,4,27,37] (Figure), the author has observed that some patients with needle phobia do not have this initial cardiovascular rise.

Physical Symptoms of the Vasovagal Reflex

The vasovagal reflex in needle phobia may include virtually any type and combination of autonomic symptoms, eg, a clammy diaphoresis, pallor, nausea, respiratory disturbances, and various levels of unresponsiveness.[1,4,30,37–40] Although the onset of the vasovagal reflex from the start of a needlestick is often immediate, ie, within 2 to 3 seconds, a prospective study of 84 blood donors who fainted found that 16.7% experienced syncope from 5 to 30 minutes after phlebotomy.[38] Another series of 64 blood donors who fainted found that 14% fainted after leaving the phlebotomy site and returning to work, sometimes several hours later.[39]

Although most victims of needle phobia who faint are unconscious for only a few seconds, a survey of 298 vasovagal fainters found that several had a loss of consciousness for 10 to 30 minutes, and a few lost consciousness for 1 to 2 hours.[40] Although blood pressure usually returns to normal within 2 hours, and most vasovagal victims feel well enough to resume normal activity within several hours, others have anxiety, malaise, and weakness for 1 to 2 days after a vasovagal attack.[38,40]

Convulsions during vasovagal fainting, which are much more frequent than commonly realized, are a general response of the central nervous system (CNS) to the cerebral hypoxia of vasovagal shock. Of 84 blood donors who fainted, 14.3% had prominent tonic–clonic episodes, and another 27% had tonic muscular rigidity.[38] Furthermore, even having a finger pricked for blood typing can cause syncope with convulsive seizures.[38]

Electrocardiogram Changes

In several case reports, ECG changes during the vasovagal reflex among patients with needle phobia have included sinus arrhythmia, premature atrial contractions, premature junctional contractions, unifocal and multifocal premature ventricular contractions, bigeminy, first- and second-degree block, changes in P waves, ST waves, and T waves, sinus bradycardia, sinus tachycardia, ventricular tachycardia, ventricular fibrillation, and asystole.[1,2,5,26–28,37] Presumably, these ECG changes are secondary to vagal influence on the sinoatrial and atrioventricular nodes, and perhaps also to the antagonism between the activated sympathetic and parasympathetic systems on the heart.[27]

Stress Hormone Changes

At least 11 stress hormones have been reported to elevate during needle stimulation. Increased cortisol and corticotropin (ACTH) levels secondary to venipuncture and needle phobia have been documented.[1,2,41,42] In one study, cortisol levels rose above average in 7 of 15 subjects, with a positive correlation between cortisol level and the number of vasovagal symptoms.[42] In my experience, corticotropin-releasing factor also can elevate during needle procedures, as can dopamine. In 25% of 28 subjects in 112 trials, human growth hormone levels rose in response to venous catheterization.[42] In three needle-induced vasovagal subjects, β-endorphin levels were observed to rise,[42] but sometimes they do not rise.[1]

Similarly, epinephrine and norepinephrine levels do not always become elevated during episodes of needle phobia.[1] They have been observed to decrease in eight subjects who fainted after venipuncture, presumably related to the withdrawal of sympathetic vascular tone.[43] In another study, however, 21 young women dental patients had increased levels of epinephrine, but not norepinephrine, with a decrease in epinephrine after the procedure.[44] The findings of both of these studies are compatible with a biphasic cardiovascular response.

Probably because the pituitary perceives a reduced intravascular volume during vasovagal shock, vasopressin or antidiuretic hormone (ADH) rises in the vasovagal reflex with venipuncture,[1,2,45] as does endothelin.[45] Renin also increased by 200% in one patient with needle phobia,[46] but aldosterone and angiotensin levels have not yet been tested in needle phobic patients. The ADH rise causes pallor during the vasovagal reflex by sharply decreasing cutaneous blood flow, and may also contribute to nausea.[1] This ADH rise is often dramatic, reaching as high as 46 times normal values,[45] and may be responsible, along with the catecholamine elevation, for the intense fear that victims of needle phobia learn in response to their vasovagal reflexes.[1]

Needle Phobia: Inherited or Learned?

Clear evidence exists to support the hypothesis of a hereditary component to needle phobia. Both the vasovagal reflex and needle phobia strongly tend to run in families.[1,2,7,47–49] The heritability of blood-injury phobia in twin studies, including fear of injections, wounds, blood, and pain, has been estimated to be 48%.[50] Variations in PR, QRS, and QT intervals and heart rate have heritabilities of 30% to 60%,[51] and the autonomic control of the cardiovascular system in general, based on twin comparisons, is probably genetically influenced.[52] Therefore, the plunges in blood pressure and pulse and the ECG anomalies during a needle-phobic response are surely also genetically influenced. The release of stress hormones likewise can reasonably be assumed to be genetically influenced.

In addition to genetic factors, however, a learned component to needle fear also can be identified among those with needle phobia. Needle fear often first comes into awareness after a negative experience at the doctor's or dentist's office.[6–8] One patient, for example, developed needle phobia in childhood when he was verbally abused and restrained by health care personnel during several painful medical procedures.[6] In one study of 56 persons with injection phobia, 52% traced their fear to such negative conditioning, with a mean age at onset of 8.06 years, and another 24% dated their fear to an episode of vicarious conditioning at seeing another child, often a sibling, have a negative reaction to needles.[47] Over time, with more needle exposures, this fear tends to organize and solidify into a conscious phobia, with an anticipatory anxiety before needle encounters. The learning of fear often becomes generalized in that those who are initially fearful only of needles may develop fear of objects or situations associated with needles, such as blood, injuries, syringes, doctors, dentists, nurses, white laboratory coats, examination rooms, hospitals, and even the antiseptic smell of offices or hospitals.[4,31,50]

Based on these studies, one can hypothesize that the trait of needle phobia is both inherited and learned. A vasovagal reflex has been found in all patients with needle phobia tested so far, and the medical histories of most of them include an adverse learning experience that triggered the needle fear.[47] Therefore, a reasonable theoretical model might propose that needle phobia depends both on an inherited reflex that is hard-wired in neurocardiovascular and neuroendocrine pathways and on the learning of a conscious fear.

Blood-injury phobia, which is often linked with needle phobia,[3] probably often arises when a patient with a strong vasovagal reflex undergoes a needle procedure or has an accident that results in a vasovagal response. The victim may focus on the sight of blood or injury to the extent that the blood-injury cue serves as a conditioned stimulus to trigger a vasovagal response thereafter. Although many needle-phobic persons also have blood-injury fears, further consideration should be given to whether these two phobias should be combined into a single diagnostic category, as is now the case in *DSM-IV*.

Evolution of the Needle Phobia Trait

The presence of a genetic trait among a species automatically indicates that the trait must have been selected for

Table 2. Techniques of Managing Patients with Needle Phobia

• Reassurance: discussion about the normality and prevalence of needle fear.
• Education: explanation of the inherited, involuntary nature of needle phobia and the various methods available to counter this condition.
• Avoidance of unnecessary or excessive needle procedures limits the conditioning of a vasovagal-based fear response and facilitates patient compliance with medical treatment.
• Desensitization therapy requires a motivated patient, yet may decondition the autonomic symptoms and fear experienced by patients with mild needle phobia and can extinguish associated blood-injury fears.
• Nerve-gate blocking distracts the patient by stimulating the area of needle use.
• Elevation of lower extremities in recumbent position with applied muscle tension augments the central venous reservoir, increases stroke volume, and helps maintain cerebral perfusion.
• Rapid-acting benzodiazepines, eg, diazepam or lorazepam, have an onset of action within 5 to 15 minutes from ingestion. A relatively large dose (eg, 10 to 20 mg po of diazepam) may be necessary and can be combined with nitrous oxide.
• Topical anesthesia at the needle site, eg, ice, ethyl chloride spray, or topical anesthetics. Topical anesthetics penetrate the skin much faster and deeper when driven by iontophoresis.

during the evolution of that species. The needle phobia trait probably evolved among the human species in response to piercing, stabbing, and cutting injuries.[1] The vast majority of violent deaths in our species' evolutionary history have been caused by skin penetration from teeth, claws, fangs and tusks, and from sticks, stone axes, knives, spears, swords, and arrows. Besides death resulting from direct trauma or hemorrhage, many of these deaths were due to infections secondary to skin penetration. A reflex that promoted the learning of a strong fear of skin puncture had clear selective value in teaching humans to avoid such injuries. Over the 4+ million years of human evolution, surely many genes controlling blood pressure, pulse, cardiac rhythm, and stress hormone release were selected for to create the vasovagal reflex.

The wide variation in the subjective symptoms and physiological responses of persons with needle phobia means that this trait, like most other human traits, is not an all-or-none phenomenon. The genes that promote needle phobia, as with other polygenic traits such as height, weight, or intelligence, are probably distributed among the human population in a continuous bell-shaped curve. Thus, both strong- and weak-trait individuals interact with the medical environment in a lifelong process of learning through varying needle exposure to create a wide expression of the needle phobia trait.

Management of Patients with Needle Phobia

It is essential that family physicians be knowledgeable about how to manage needle fear if they are to adequately treat these patients (Table 2). Communicating empathy and respect for patients with needle phobia by assuring them that they are not "wimps" or "oddballs" helps them accept their condition without embarrassment. Most victims of needle phobia sincerely believe that their problem is all in their mind and that they would not be fearful if they were stronger or more mature. Many simply do not realize that there are many others with similar fears. Giving patients a name for this condition legitimatizes it to them and gives them a tool they can use to buffer their interaction with the health care system. Reassurance and education, mainstays within the family doctor's armamentarium, almost always help.

Alternative methods of drug delivery can sidestep the issue of needle fear by avoiding needles altogether. Nasal sprays that deliver vasopressin, calcitonin and insulin, sprays that immunize against influenza and dust-mite allergens, and an oral form of insulin are all now in investigative trials in the United States. Topical analgesic patches and opiate suppositories can be used in cases of severe pain, eg, metastatic cancer, which might otherwise be managed with intravenous drips. Many other medicines could obviously be administered without needles.

When needle use is necessary, any one of several methods or a combination of methods may be useful. Desensitization therapy by a psychiatrist or clinical psychologist is usually lengthy, expensive, and of variable efficacy.[1,6–8] Nerve gate–blocking methods, eg, pinching or rubbing the area to distract the patient during a needlestick, can be helpful. Shock and syncope are reduced among phobic patients by having them lie supine with legs elevated and tense their muscles during needle procedures to increase cerebral blood flow.[53] Needle-phobic patients should also be routinely premedicated with oral, sublingual, or intranasal benzodiazepines,[2] with NO_2,[8] or

both. Sublingual atropine to block bradycardia also may be beneficial.[2] Since a vasovagal reaction can injure or even kill a patient, having on hand an oxygen source and a "crash cart" for cardiac resuscitation is mandatory with any needle-phobic patient undergoing a needle procedure.

Topical anesthesia of the autonomic sensory neural net at the needle site can be used to interrupt the vasovagal reflex at its origin so that the reflex is not triggered. Ethyl chloride spray can temporarily anesthetize the skin, but this affects only the superficial skin layers and lasts for only a few seconds. The skin can also be anesthetized by an ice pack, although freezing is unpleasant and can damage tissue. In placebo-controlled studies, topical anesthetics containing a mixture of lidocaine and prilocaine have been shown to work well in pediatric patients,[54] and topical mixtures of tetracaine, adrenalin, and cocaine (TAC ointment) or tetracaine, adrenalin, and lidocaine have been long used in emergency departments for surface anesthesia.[55] To work on intact skin, however, all these mixtures must be applied for 1 to 2 hours and have a depth of anesthesia of only 2 to 3 mm.

The depth and effectiveness of topical anesthesia is greatly enhanced by the technique of iontophoresis (or ionphoresis). Iontophoresis involves soaking an absorbent pad with lidocaine and driving it through the skin with a tiny electrical current from a battery-powered unit.[35,56] Because lidocaine is a positively charged molecule, the electrode pad's positive charge repels the lidocaine, propelling it through the skin by way of the sweat ducts. Using iontophoresis, an injection or venipuncture site can be completely anesthetized to a depth of 1 to 2 cm in less than 10 minutes.[56]

The procedure of iontophoresis has been assigned insurance reimbursement codes, and an iontophoresis unit* for use with needle phobic persons has been cleared by the Food and Drug Administration. This instrument has been demonstrated to be effective for venipuncture and joint injections[56] and has applications, for example, in blood donor drives[35] and pediatric immunization programs. The ease of use of iontophoresis raises the intriguing possibility of creating in the near future medical environments that are completely free of needle phobia.

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This unit, the NeedleBuster, is now available commercially from Life-Tech, Inc, Houston, Texas; (800) 231-9841.

References

1. Ellinwood EH, Hamilton JG. Case report of a needle phobia. J Fam Pract 1991; 32:420–3.
2. Hamilton J, Ellinwood E. Needle phobia [abstract]. South Med J 1991; 84(Suppl):2S–27.
3. Diagnostic and statistical manual of mental disorders. 4th ed. Washington, DC: American Psychiatric Association, 1994:405–11.
4. Marks I. Blood-injury phobia: a review. Am J Psychiatry 1988; 145:1207–13.
5. Galena HJ. Complications occurring from diagnostic venipuncture. J Fam Pract 1992; 34:582–4.
6. Jacobsen PB. Treating a man with needle phobia who requires daily injections of medication. Hosp Community Psychiatry 1991; 42: 877–8.
7. Hsü LKG. Novel symptom emergence after behavior therapy in a case of hypodermic injection phobia. Am J Psychiatry 1978; 135: 238–9.
8. Lemasney NJ, Holland T, O'Mullane D, O'Sullivan VR. The aetiology and treatment of needle phobia in the young patient—a review. J Ir Dent Assoc 1989; 35:20–3.
9. Wambaugh J. The blooding. New York, NY: William Morrow, 1989:210–4, 217.
10. *Schmerber v California*, 384 US 757, 86 SCt 1826 (1966).
11. *Breithaupt v Abram*, 352 US 432, 77 SCt 408 (1957).
12. *South Dakota v Neville*, 459 US 553, 103 SCt 916 (1983).
13. *Hammer v Gross*, 932 F2d 842 (USCA, 9th Cir, 1991). *cert denied*, 112 SCt 582 (1991).
14. Boas EP. Some immediate causes of cardiac infarction. Am Heart J 1942; 23:1–15.
15. Cass N [letter]. Anaesth Intensive Care 1978; 6:169–70.
16. Dale WA. Cardiac arrest: review and report of 12 cases. Ann Surg 1952; 135:376–93.
17. Kulvin MM. Scared to death [letter]. JAMA 1966; 198:90.
18. Lockey RF, Benedict LM, Turkeltaub PC, Bukantz SC. Fatalities from immunotherapy (IT) and skin testing (ST). J Allergy Clin Immunol 1987; 79:660–7.
19. Lockhart RJ. Toxic erythema; T.A.B. (intravenously); coronary thrombosis; sudden death. Br J Dermatol Syphilis 1939; 51:318–21.
20. Morland A. Pleural shock. Lancet 1949; 2:1021–3.
21. Rutsky EA. Bradycardic rhythms during peritoneal dialysis. Arch Intern Med 1971; 128:445–7.
22. Sauls LJ. Sudden death at impasse. Psychoanal Forum 1966; 1:88–93.
23. Turk LN, Glenn WWL. Cardiac arrest. N Engl J Med 1954; 251: 795–803.
24. Turkeltaub PC, Gergen PJ. The risk of adverse reactions from percutaneous prick-puncture allergen skin testing, venipuncture, and body measurements. J Allergy Clin Immunol 1989; 84:886–90.
25. Zukerman CM. Fatality in a blood donor; a case report, with a review of the literature. Ann Intern Med 1947; 26:603–8.
26. Caplan RA, Ward RJ, Posner K, Cheney FW. Unexpected cardiac arrest during spinal anesthesia. Anesthesiology 1988; 68:5–11.
27. Engel GL. Psychologic stress, vasodepressor (vasovagal) syncope, and sudden death. Ann Intern Med 1978; 89:403–12.
28. Schlesinger Z, Barzilay J, Stryjer D, Almog CH. Life-threatening "vagal reaction" to emotional stimuli. Isr J Med Sci 1977; 13:59–61.
29. Spiess BD, Sassetti R, McCarthy RJ, Narbone RF, Tuman KJ, Ivankovich AD. Autologous blood donation: hemodynamics in a high-risk patient population. Transfusion 1992; 32:17–22.
30. van Lieshout JJ, Wieling W, Karemaker JM, Eckberg DL. The vasovagal response. Clin Sci 1991; 81:575–86.
31. Costello CG. Fears and phobias in women. J Abnorm Psychol 1982; 91:280–6.
32. Agras S, Sylvester D, Oliveau D. The epidemiology of common fears and phobias. Compr Psychiatry 1969; 10:1511–56.
33. Keep PJ, Jenkins JR. From the other end of the needle. The pa-

tient's experience of routine anesthesia. Anaesthesia 1978; 33:830–2.
34. Cartwright PS, McLaughlin FJ, Martinez AM, Caul DE, Hogan IG, Reed GW, Swafford MS. Teenagers' perceptions of barriers to prenatal care. South Med J 1993; 86:737–41.
35. Arvidsson SB, Ekroth RH, Hansby AMC, Lindholm AH, William-Olsson G. Painless venipuncture. A clinical trial of iontophoresis of lidocaine for venipuncture in blood donors. Acta Anaesthesiol Scand 1984; 28:209–10.
36. Oswalt RM, Napoliello M. Motivations of blood donors and non-donors. J Appl Psychol 1974; 59:122–4.
37. Greenfield ADM. An emotional faint. Lancet 1951; 1:1302–3.
38. Lin JT-Y, Ziegler DK, Lai C-W, Bayer W. Convulsive syncope in blood donors. Ann Neurol 1982; 11:525–8.
39. Poles FC, Boycott M. Syncope in blood donors. Lancet 1942; 2:531–5.
40. Wayne HH. Syncope. Am J Med 1961; 30:418–38.
41. Kraemer RR, Blair S, Kraemer GR, Castracane VD. Effects of treadmill running on plasma beta-endorphin, corticotropin, and cortisol levels in male and female 10K runners. Eur J Appl Physiol Occup Physiol 1989; 58:845–51.
42. Rose RM, Hurst MW. Plasma cortisol and growth hormone responses to intravenous catheterization. J Hum Stress 1975; 1:22–36.
43. Ziegler MG, Echon C, Wilner KD, Specho P, Lake CR, McCutchen JA. Sympathetic nervous withdrawal in the vasodepressor (vasovagal) reaction. J Auton Nerv Syst 1986; 17:273–8.
44. Taggart P, Hedworth-Whitty R, Carruthers M, Gordon PD. Observations on electrocardiogram and plasma catecholamines during dental procedures: the forgotten vagus. BMJ 1976; 2:787–9.
45. Kaufmann H, Oribe E, Oliver JA. Plasma endothelin during upright tilt: relevance for orthostatic hypotension? Lancet 1991; 338: 1542–5.
46. Goldstein DS, Spanarkel M, Pitterman A, Toltzis R, Gratz E, Epstein S, Keiser HR. Circulatory control mechanisms in vasodepressor syncope. Am Heart J 1982; 104:1071–5.
47. Öst L-G. Acquisition of blood and injection phobia and anxiety response patterns in clinical patients. Behav Res Ther 1991; 29: 323–32.
48. Kleinknecht RA, Lenz J. Blood/injury fear, fainting and avoidance of medically-related situations: a family correspondence study. Behav Res Ther 1989; 27:537–47.
49. Camfield PR, Camfield CS. Syncope in childhood: a case control clinical study of the familial tendency to faint. Can J Neurol Sci 1990; 17:306–8.
50. Torgersen S. The nature and origin of common phobic fears. Br J Psychiatry 1979; 134:343–51.
51. Hanson B, Tuna N, Bouchard T, Heston L, Eckert E, Lykken D, et al. Genetic factors in the electrocardiogram and heart rate of twins reared apart and together. Am J Cardiol 1989; 63:606–9.
52. Losse H, Kretschmer M, Kuban G, Bottger K. Die vegetative struktur des individuums I and II. Acta Neuroveg 1956; 13:337–99.
53. Öst L-G, Fellenius J, Sterner U. Applied tension, exposure in vivo, and tension-only in the treatment of blood phobia. Behav Res Ther 1991; 29:561–74.
54. Joyce TH III. Topical anesthesia and pain management before venipuncture. J Pediatr 1993; S24–9.
55. Ernst AA, Marvez E, Nick TG, Chin E, Wood E, Gonzaba WT. Lidocaine adrenalin tetracaine gel versus tetracaine adrenaline cocaine gel for topical anesthesia in linear scalp and facial lacerations in children aged 5 to 17 years. Pediatrics 1995; 95:255–8.
56. Hamilton JG, Wrenn R, Garcia-Caro M, Hamilton N. Office management of needle fear and needle phobia by lidocaine iontophoresis. Presented at 87th Scientific Assembly, Southern Medical Association, New Orleans, La, Oct 31, 1993.