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Vasopressin vs. Epinephrine in ACLS Resuscitation

A B S T R A C T & C O M M E N T A R Y

Source: Stiell IG, et al. Vasopressin versus epinephrine for in-hospital cardiac arrest: A randomized, controlled trial. *Lancet* 2001;358:105-109.

The American Heart Association's (AHA) most recent Advanced Cardiac Life Support (ACLS) guidelines recommend vasopressin as an alternative to epinephrine in the treatment of cardiac arrest.¹ Stiell and colleagues conducted a triple-blind, randomized, controlled trial comparing vasopressin with epinephrine as the initial vasopressor in the treatment of 200 in-patient cardiac arrests. The primary outcomes were survival to hospital discharge, survival to one hour, and neurologic function.

Patients in the emergency departments (EDs), critical care units, and wards of three Canadian teaching hospitals were eligible if they had a cardiac arrest and required epinephrine according to AHA/ACLS protocols for asystole, pulseless electrical activity, or refractory ventricular fibrillation. Patients received one dose of vasopressin 40 U or epinephrine 1 mg intravenously as the initial vasopressor. All patients who failed to respond to the study intervention were given standard doses of epinephrine every 3-5 minutes as rescue therapy. Of the 200 patients, 104 received vasopressin and 96 received epinephrine. The study patients overall had a mean age of 70 years, 64% were male, and the arrest was witnessed in 81% of cases. The most common initial rhythm was pulseless electrical activity (48%), followed by asystole (31%) and ventricular fibrillation (18%).

Outcomes did not differ in the vasopressin and epinephrine groups for one-hour survival (39% vs 35%, $P = 0.66$; absolute difference 3.1%, 95% CI -10.5%-17.3%) or survival to hospital discharge (12% vs 14%, $P = 0.67$; absolute difference -2.0%, 95% CI -11.6%-7.8%). There were no differences between the two groups for any secondary survival outcomes, including any return of pulse, survival for 24 hours or for 30 days, or in adverse outcomes. Even in the subgroups of myocardial ischemia/infarction or ventricular fibrillation/tachycardia, no modest trend favoring vasopressin was detected. The neurologic

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state and quality of life of survivors in both groups were good, with similar median mini-mental state examination scores and median cerebral performance category scores.

■ COMMENT BY STEPHANIE B. ABBUHL, MD, FACEP

This study puts a significant damper on the enthusiasm that had been generated by a few previous, smaller studies. One study in particular was a randomized trial comparing vasopressin with epinephrine in 40 pre-hospital patients.² Many more patients were alive after 24 hours (60% vs 20%, $P < 0.05$) in the vasopressin group.

There are several potential explanations for these apparent contradictions. It is possible that differences do exist between vasopressin and epinephrine but that a larger study would be required to detect a smaller, but significant, difference. The sample size of 200 patients used in this study was chosen to detect a 20% absolute difference in survival to

one hour. It also is possible that the value of vasopressin is fundamentally different in pre-hospital patients compared to in-patients. It may be that the differences between vasopressin and epinephrine are only to be found in important subgroup analyses, which only a much larger study would have enough power to detect. Finally, it also is possible that there are truly no differences between the two drugs and that the initial promise shown by vasopressin simply will not be fulfilled when put to the test of larger, randomized, controlled trials involving more diverse patients.

The authors conclude that they “strongly disagree” with the AHA decision to recommend vasopressin as an alternative to epinephrine. It is not entirely clear to me why the authors came down so strongly against this recommendation. While the results of this study failed to show any advantage for vasopressin over epinephrine, it failed to show any worse outcomes or harm. In an accompanying editorial,³ the important point is made that epinephrine itself has never been shown to be more beneficial than placebo for cardiac resuscitation in human beings. ❖

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Carpal Tunnel Syndrome — A New Twist for the Wrist?

ABSTRACT & COMMENTARY

Source: Wong SM, et al. Local vs. systemic corticosteroids in the treatment of carpal tunnel syndrome. *Neurology* 2001;56: 1565-1567.

The most frequent form of entrapment neuropathy is carpal tunnel syndrome (CTS). Patients present with median nerve paresthesias, which may progress or recur enough to interrupt sleep, dexterity, or employment. Several nonoperative therapies are available for CTS, although surgical decompression is regarded as definitive for cure. Occupational disability frequently occurs, escalating this condition to one of major clinical and economic importance.

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To evaluate two conservative options for this neuropathy, Wong and colleagues studied 60 patients in Hong Kong with CTS. These patients had: 1) sensory symptoms over the median nerve distribution, 2) nerve conduction velocity (NCV) and electromyographic (EMG) studies of median and ulnar nerves that confirmed CTS by American Academy of Neurology criteria, and 3) failed splinting for two months. Cases were excluded if they had received prior steroids for CTS, had disorders associated with CTS (diabetes, rheumatoid arthritis, pregnancy, hypothyroidism), or had severe CTS requiring surgical decompression based on the presence of thenar wasting or fibrillation on EMG.

Patients were randomized to oral placebo for 10 days plus carpal tunnel injection of 15 mg of methylprednisolone, or oral prednisolone 25 mg daily for 10 days plus saline injection into the carpal tunnel. A single investigator performed all injections with opaque, taped syringes to ensure double blinding. Global symptom score (GSS) ratings from 0 (no symptoms) to 10 (severe) were determined at baseline, two weeks, eight weeks, and 12 weeks in each of five categories—paresthesia, pain, numbness, weakness, and nocturnal awakening. Average age was 50 years. Females comprised 70% of cases. Baseline GSS averaged 25.7 (maximum score: 50).

Significant advantages were observed for steroid injection over placebo at two of three assessment periods. At eight weeks, GSS was 13.7 vs. 20.8 ($P = 0.002$), and at 12 weeks GSS was 14.3 vs. 21.4 ($P = 0.004$), for steroid injection vs. placebo, respectively. At two weeks, GSS for steroid injection vs placebo was 13.6 vs. 17.8, a non-significant ($P = 0.07$) difference. Side effects were minimal. Injection pain occurred in two patients in each group, and seven patients in the oral steroid group reported bloating, polyphagia, and insomnia. The authors conclude that local steroid injection was superior to oral steroids over a three-month period in patients with mild to moderate CTS.

■ COMMENT BY MICHAEL FELZ, MD

Many clinicians are familiar with splints, diuretics, non-steroidal anti-inflammatory drugs (NSAIDs), and prednisone for the management of CTS. This study by Wong and colleagues is the first published randomized, controlled study comparing steroid injection to oral therapy in a cohort of typical patients with confirmatory NCV/EMG data. Symptomatic improvement was statistically impressive at weeks eight and 12 after injection. The trend at two weeks also favored injection. Duration of injection effect persisted for 12 weeks, again with persuasive statistical significance. In contrast, oral steroid therapy was associated with steadily worsening GSS scores over time, and more side effects.

How can physicians apply these data in the ED or office? First, the clinical diagnosis of CTS is based on paresthesias of the three radial digits, sparing the 5th finger. Symptoms worsen at night. Clinical reproduction is possible by percussion over the flexor retinaculum (Tinel's sign), extreme palmar wrist flexion (Phalen's sign), or dorsiflexion (reverse Phalen's). Second, management consists of splints, diuretics, and NSAIDs, with oral prednisone for poorly responsive symptoms. I am aware of two recent studies demonstrating benefit for low-dose oral prednisone (20 mg/d) for CTS.^{1,2} Yet recurrences are common, and some patients seek treatment in the ED due to refractory symptoms, sleepless nights, or desire for more effective medication. For such patients, ED clinicians trained in wrist injection may choose to perform steroid injection for refractory CTS, based on the data from Wong et al, or may refer patients to colleagues experienced in injection techniques. It is no longer acceptable to tell patients that oral medications, splints, and surgery are "all we have" for CTS. Injection of the wrist is in widespread use in many practices. My own experience with carpal tunnel injection spans 15 years and more than 200 cases. Patient satisfaction seems high, especially after failed attempts at splinting and medication. One executive banker phoned me days after CTS injection with methylprednisolone, so excited that he had slept through the night for the first time in months. He insisted that I inject the contralateral wrist as soon as possible. Several of my patients have returned to work or avoided CTS surgery after timely steroid injection every 3-6 months. Hence, I join Wong et al in supporting the role of steroid injection for CTS. It's a helpful twist for the problem wrist. ❖

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Fosphenytoin—A New Option for Trigeminal Neuralgia Crisis

ABSTRACT & COMMENTARY

Source: Cheshire WP. Fosphenytoin: An intravenous option for the management of acute trigeminal neuralgia crisis. *J Pain Symptom Manage* 2001;21:506-510.

The author, a neurologist, reports three remarkable cases of immediate relief from severe trigeminal neuralgia pain with intravenous fosphenytoin.

Spinal Radiography: State-Of-The-Art

By Michael A. Gibbs, MD, FACEP

toin. A 66-year-old woman with a 10-year history of recurrent paroxysmal left mandibular pain described as “sharp jabs or electrical shocks” was treated with 0.9 g (18 mg/kg) fosphenytoin as phenytoin equivalents (PE) for 20 minutes and received immediate relief. The patient remained pain-free for two days. Prior to this therapy, she had been on carbamazepine and had increased the dose to the point of toxicity without effect. Interestingly, she had no relief with oral phenytoin or gabapentin. Her surgery revealed indentation of the trigeminal nerve by vascular structures and the patient was pain-free after decompression. An 80-year-old man with a four-year history of paroxysmal, sharp, shooting, or burning right mandibular pain, triggered by touching the lower lip, speaking, chewing, drinking, or swallowing, received 1.0 g PE (11 mg/kg) fosphenytoin, given in 100-mg doses every 10 minutes with complete relief. This patient remained pain-free for about three days. He underwent successful trigeminal nerve compression with a percutaneous balloon. Finally, a 75-year-old woman with a 14-year history of paroxysmal, left lower facial pain described as “electricity,” burning, or tingling, received 1.0 g PE (14 mg/kg) fosphenytoin with nearly complete relief. The next morning she was pain-free and remained so for two days. Oral phenytoin and a variety of other anticonvulsants failed to alleviate the recurrent pain and she underwent a successful Gasserian balloon compression.

■ COMMENT BY RICHARD J. HAMILTON, MD, FAAEM, ABMT

This is not a complex paper, but I found it a fascinating series. These patients are in the worst pain imaginable, and something that offers prompt relief like this truly is remarkable. A number of the trigeminal neuralgia patients I have seen are completely unresponsive to narcotics. While prior studies support the use of intravenous phenytoin, it is not considered as useful as fosphenytoin appears to be in this series. Fosphenytoin is a phosphate ester prodrug of phenytoin that is better tolerated parenterally and is inert until converted to phenytoin by endogenous esterase. A particular explanation is not offered for the efficacy of fosphenytoin, nor could I determine one by reviewing its mechanism of action. Please note that pain returned in all cases despite treatment with carbamazepine, gabapentin, baclofen and carbamazepine, or oral phenytoin. The patients all eventually required suboccipital craniectomy or balloon compression. I reviewed this article because I think it's something that would make a real difference for a suffering patient. If you use it and have success, get in touch with me and we'll start collecting the next case series to report! ❖

An essential part of early trauma care involves the assessment and management of the patient with the potential for spinal injury. This potentially devastating injury can have lifelong implications for the patient, and if unrecognized or poorly managed, for the treating physician as well. As specialists in emergency medicine, it is not good enough for us to be “familiar” with the management of these high-risk patients; we must become experts. This requires a thorough understanding of the biomechanics of trauma, refined clinical examination skills, an up-to-date knowledge of the indications for spinal radiography, and a sophisticated approach to the interpretation of these x-rays. This feature will outline the current indications for cervical spine radiography. In addition, I will review a series of articles published by the NEXUS (National Emergency X-ray Utilization Study) investigators in the July 2001 issue of the *Annals of Emergency Medicine*.

Epidemiology

Lowery DW, et al. *Epidemiology of cervical spine injury victims*. *Ann Emerg Med* 2001;38:12-15.

This paper was a standard epidemiologic review of the NEXUS database (n = 34,069, 818 [2.4%] with injury); 71% of subjects were male and the incidence of spinal injury was greatest in young adult males,

Table
Summary Recommendations
<ul style="list-style-type: none"> • Obtain cervical radiography in blunt trauma patients with: <ul style="list-style-type: none"> — Neck pain and midline cervical tenderness — Altered mental status, including intoxication — Focal neurological deficits — Distracting, painful injury • A 3-view series should be considered the “minimal standard” • Obtain oblique views when the 3-view is inconclusive, or the cervicothoracic junction is not well-visualized • Flexion-extension films are indicated in the patient with normal radiographs and suspected ligamentous injury • Use CT selectively: <ul style="list-style-type: none"> — To delineate anatomy at the level of injury — To define areas not well-visualized with plain films — With neurologic deficit / persistent pain and normal films — To assess C1-C2 in the intubated patient

ages 15-35. The prevalence of spinal injury increased progressively with age.

Message: Recognize that young patients are the most likely to sustain cervical spine fracture, but also keep in mind that elderly patients are especially vulnerable.

Goldberg W, et al. Distribution and patterns of blunt traumatic cervical spine injury. Ann Emerg Med 2001;38:17-21.

The NEXUS database was reviewed to describe the level and location of cervical injury. The second cervical vertebra was the most common level of injury (n = 286 [24%]). Four hundred-seventy fractures (39%) occurred at C6 and C7.

Message: While cervical fractures occur at all levels, the upper and lower vertebrae are the most likely to be injured. This is especially relevant because these are the two most difficult regions to define radiographically. Physicians should pay close attention to these.

Indications For Radiography

The indications for cervical spine radiography have evolved considerably during the past 20 years. In the 1980s the American College of Surgeons recommended cervical radiography in “any patient with major blunt trauma.” While this approach was effective for excluding injury, it came at the expense of a large number of negative radiographs. In addition to the obvious financial implications, this approach resulted in unnecessary exposure to radiation, and potential delays in trauma patient evaluation and stabilization. In the decade that followed, several authors attempted to identify clinical criteria that could reliably exclude cervical injury. While these studies suggested that low-risk criteria could successfully be employed, none had the statistical power to support their conclusions.

These efforts culminated in the National Emergency X-radiography Utilization Study (NEXUS).¹ NEXUS was a prospective, multicenter, observational study of a decision rule used to identify patients at low risk of cervical spine injury and, thus, not requiring cervical radiography. The decision instrument required patients to meet five criteria in order to be classified as having a low probability of injury: 1) no midline cervical tenderness; 2) no focal neurologic deficit; 3) normal alertness; 4) no intoxication; and 5) no painful, distracting injury. More than 34,000 patients at 21 academic and non-academic medical centers were evaluated. Physicians were asked to assess each of the clinical criteria before radiographs were available. No efforts were made to influence whether physicians ordered radiographs; these were obtained at the discretion of the treating clinician. The decision rule identified all but eight of 818 patients who had cervical spine injury (sensitivity 99.0% [95% CI 90.0-99.6%]; negative predictive value 99.8%

[95% CI 99.6-100%], specificity 12.9%, positive predictive value 2.7%). Only two of the patients classified as unlikely to have an injury according to the decision rule met the pre-set definition of a clinically significant injury, and one of these two patients required surgical stabilization. Using the decision instrument, radiographic imaging could have been avoided in 4309 (13%) of the 34,069 patients. The inter-rater reliability of these criteria is substantial, although it should be remembered that they may be subjective.² The assessment of a “distracting” injury is particularly subjective and problematic. A recent article by the NEXUS study group sites that a significant fraction of blunt trauma patients may have an injury considered to be distracting.³ Ullrich and colleagues prospectively evaluated 778 patients and found that 264 (34%) had distracting, painful injuries (DPIs). Fractures accounted for the majority of DPIs (154 or 58%); 42 (16%) were soft-tissue injuries or lacerations, and 86 (34%) were due to a variety of other entities, including visceral, crush, burn, or other miscellaneous injuries. Among the 37 (5%) patients with cervical fractures, 20 (54%) had a DPI, including three (8%) who had a DPI as the only indication for cervical radiography. Clinical judgment should guide practice in these situations.

Panacek EA, et al. Test performance of the individual NEXUS low-risk clinical screening criteria for cervical spinal injury. Ann Emerg Med 2001;38:22-25.

Secondary analysis of the NEXUS database was performed to determine the contribution of each of the five individual criteria to the overall sensitivity of the decision instrument. In patients with injury, no one criterion was found in the majority of patients. Fifty percent of patients had midline tenderness; 30% had only one criterion, and one-half of these had only midline tenderness.

Message: Don't cut corners or hang your hat on any one criterion. It is interesting to note that a significant number of patients with injury and only one criterion did not have midline tenderness.

Which X-Rays Should Be Obtained?

Is the Cross Table Lateral View Sufficient? No! It has been demonstrated that the use of a cross table lateral view alone is inadequate to rule-out cervical spine injury, with a sensitivity of between 57% and 85%. MacDonald and colleagues found that the addition of the axial projection (AP) and odontoid views to the cross table lateral increased the sensitivity from 83% to 99%.⁴ For this reason, at least three views should be obtained in all cases.

It has been argued that a cross table lateral may be useful to “clear” the cervical spine prior to endotracheal intubation. This approach has several important pitfalls: 1) it may delay definitive airway management; 2) it does not exclude

cervical injury, and thus may provide the operator with a false sense of security; and 3) there is no evidence to support an increased risk of neurologic injury during endotracheal intubation, provided in-line stabilization and effective immobilization are maintained at all times.

Three Views or Five? The issue of whether oblique views are routinely needed remains controversial. These views are held by some to be essential because they provide superior visualization of the posterior column (pedicles, articular pillars, neural foramina, and lamina). Turetsky and colleagues found that the oblique views demonstrated certain fractures that were not detected on the three-view series.⁵ Conversely, Freemyer and colleagues found no fractures or dislocations detected on the five-view series that were not identified on the three-view series.⁶ While there is no consensus concerning the necessity for routine oblique radiographs in cervical trauma, these views may be useful for evaluating poorly visualized areas of the posterior column. In addition, the supine oblique view provides excellent definition of the cervicothoracic junction, and may be used instead of the often-inadequate swimmer's view.^{7,8} Ireland and colleagues compared 60 patients whose cervical spines were imaged with swimmer's views to evaluate the cervicothoracic junction to those of 62 patients whose junctions were imaged with bilateral supine oblique radiographs.⁹ Oblique views identified the junction adequately in 38%, compared to 37% in the swimmer's group. However, the facet joints and posterior elements were fully interpretable in 70% of those imaged obliquely, compared to only 37% in the swimmers group. It is reasonable to use the oblique view selectively, after a three-view series has been evaluated.

Mower WR, et al. Use of plain radiography to screen for cervical spine injuries. Ann Emerg Med 2001;38:1-7.

This was a review of the NEXUS database to document the efficacy of plain film radiography and to categorize the frequency and type of injuries missed. A "standard" three-view series was obtained in all patients, with additional imaging studies left to physician discretion. Two hundred thirty-seven patients (0.67% of total, 29% of injury group) with inadequate films had missed injuries. Twenty-three patients with adequate films had missed injuries (0.069% of total, 2.8% of injury group); three of these (0.36% of injury group) were unstable.

Message: In patients with adequate radiographs, the number of significant missed injuries is small, although not zero. More importantly, settling for inadequate radiographs, which can be anticipated in up to one-third of patients, is a recipe for disaster.

What is the Role of Flexion-Extension (F/E) Views? Neurologically intact patients with persistent neck pain and

tenderness despite normal radiographs should have F/E views performed to exclude ligamentous injury. It is essential that the patient be alert and cooperative, as all neck movement must be patient-initiated and discontinued immediately should pain occur. Manipulation of the neck by the physician or radiology technologist to overcome spasm is absolutely contraindicated. Filming in the erect position is preferred because this position better demonstrates ligamentous instability.¹⁰

Pollack CV, et al. Use of F/E radiographs of the cervical spine in blunt trauma. Ann Emerg Med 2001;38:8-11.

Review of the NEXUS database was performed to describe the contribution of F/E films to radiographic evaluation. Of 818 patients with cervical injury, 86 (10.5%) underwent F/E testing. Two patients (0.24% of total, 2.3% of F/E group) sustained stable bony injuries detected only on F/E views, but all of these had other injuries detected on routine cervical imaging.

Message: While F/E films have been recommended for patients with persistent neck pain and normal radiographs, the actual contribution of these to decision-making is marginal at best.

Indications For CT? Computed tomography (CT) scanning has proven to be an excellent method for evaluating cervical spine fractures and dislocations. Its advantages include speed, wide availability, axial imaging, and excellent cortical detail. Contemporary high-resolution scanners detect between 95% and 100% of cervical fractures—a significantly higher sensitivity than plain-film radiography. So, when should this effective, albeit expensive, technology be used? The traditional approach would reserve CT imaging: 1) to delineate bony anatomy at the level of identified or suspected fractures and dislocations; 2) for those cases in which the upper or lower cervical spine cannot be adequately visualized; and 3) for patients with persistent pain and/or neurologic deficit despite normal plain films. A more aggressive strategy suggests that complete cervical helical scanning may be appropriate and cost-effective in severely injured patient who is at high-risk for cervical fracture.¹¹ In the majority of cases a selective approach seems reasonable. Local practice should be driven collaboratively by emergency physicians, trauma and spine surgeons, and radiologists.

Special mention should be made of the intubated patient. Because the presence of an endotracheal tube may alter the radiographic appearance of upper cervical spine anatomy, a significant number of high cervical injuries may be missed on plain films. Several authors have suggested that patients undergoing cranial tomography for the evaluation of traumatic brain injury should have CT imaging extending through the upper cervical spine (C1 and C2).^{12,13} ❖

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13. Blacksins MF, et al. Frequency and significance of fractures of the upper cervical spine detected by CT in patients with severe neck trauma. *Am J Roentgenol* 1995;165:1201-1204.
14. One small, randomized trial of 40 pre-hospital patients comparing vasopressin and epinephrine showed more patients alive at 24 hours in the vasopressin group.
15. Steill et al failed to show any advantage of vasopressin over epinephrine in a randomized, controlled trial of 200 in-patients with cardiac arrest.
24. For carpal tunnel syndrome, steroid therapy is of:
 - a. equal benefit by oral and injection administration.
 - b. little clinical benefit due to side effects.
 - c. superior benefit by injection compared to oral therapy.
 - d. unproven benefit due to lack of controlled trials.
25. Which of the following drugs appeared to provide temporary relief of pain from trigeminal neuralgia in a recent case series?
 - a. carbamazepine
 - b. fosphenytoin
 - c. gabapentin
 - d. phenytoin
26. The advantages of supine-oblique views include all of the following, *except*:
 - a. improved visualization of the cervicothoracic junction.
 - b. improved visualization of the odontoid.
 - c. improved visualization of the posterior column.
 - d. improved visualization of the neural foramina.
27. In the NEXUS trial, the most commonly injured vertebral body was:
 - a. C1.
 - b. C2.
 - c. C4.
 - d. C5.
 - e. C6.
28. A 24-year-old healthy male patient presents to the ED following a low velocity motor vehicle crash. He is awake and alert with no evidence of intoxication or significant injury. He has bilateral trapezius and paracervical muscle tenderness, but none at the midline. Are cervical spine X-rays required?
 - a. Yes
 - b. No
29. Approximately what percentage of cervical spine fractures are seen on the cross-table-lateral view alone?
 - a. 95%
 - b. 90%
 - c. 85%
 - d. 75%
 - e. 50%
30. CT scanning of the cervical spine is indicated in all the following, *except*:
 - a. To delineate areas not well-visualized with standard radiographs
 - b. To delineate anatomy at the area of injury
 - c. To visualize C1 and C2 in the intubated patient
 - d. To further assess ligamentous injury

CME Questions

23. When considering the use of vasopressin or epinephrine in the initial management of cardiac arrest, all of the following are correct *except*:
 - a. The American Heart Association's Advanced Cardiac Life Support guidelines recommend vasopressin as an alternative to epinephrine for the treatment of cardiac arrest.
 - b. Epinephrine had been shown to be more effective than placebo for cardiac resuscitation in human beings.

A Question-Inducing SVT

By Ken Grauer, MD

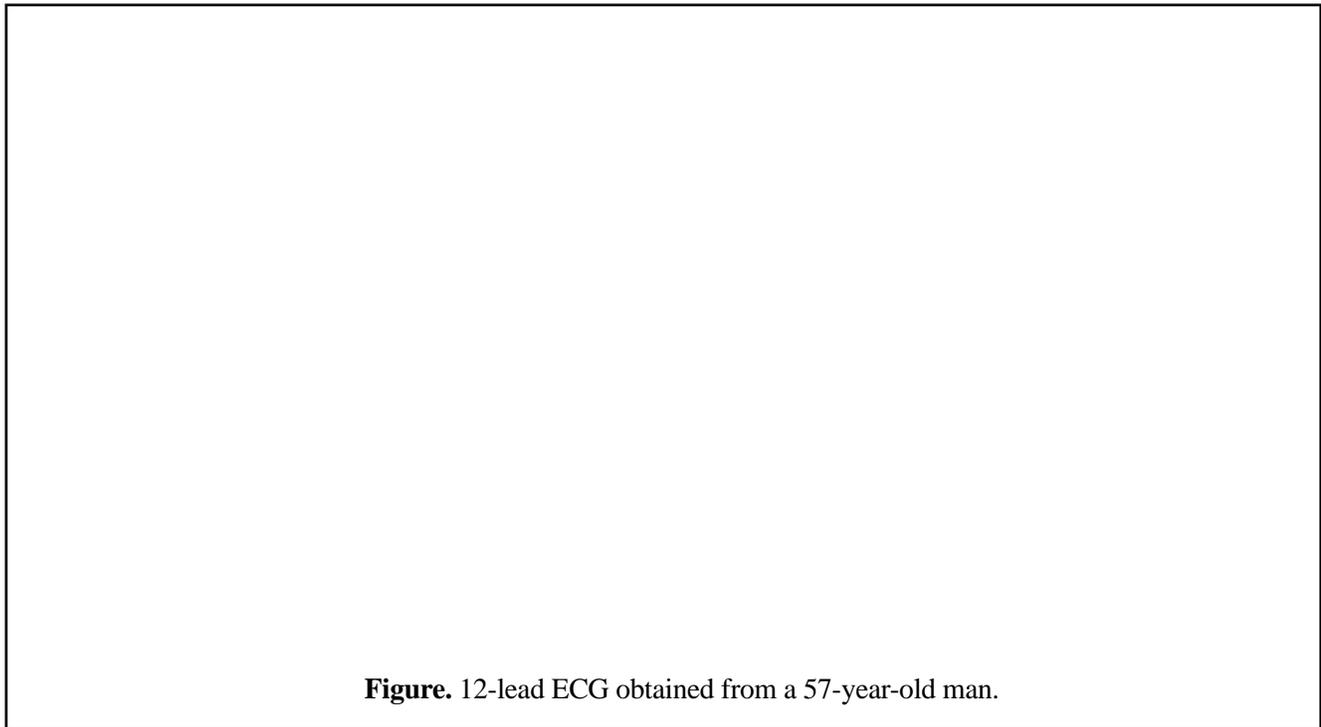


Figure. 12-lead ECG obtained from a 57-year-old man.

Clinical Scenario: The 12-lead ECG shown in the Figure was obtained from a 57-year-old man. Review of this ECG should raise (induce) several questions in your mind. Which questions? Answer this even though you have not been provided with any clinical information about the patient.

Interpretation: The ventricular rhythm is irregularly irregular. A supraventricular etiology is confirmed by recognition that the QRS complex is narrow in all 12 leads. Despite the irregularity, this rhythm does not represent atrial fibrillation because organized atrial activity is present. Instead, the regular sawtooth pattern of atrial activity in the inferior leads identifies the rhythm as atrial flutter. The first unusual point about this tracing is the exceedingly large amplitude of the pointed flutter waves in lead V_1 . The second unusual point is the rate of flutter activity, which at 220/minute is clearly slower than the usual atrial range for flutter. This raises the first question, which is whether the patient might be taking any drug(s) that may act to slow the flutter rate (i.e., antiarrhythmic agents such as quinidine or amiodarone—or

AV nodal blocking drugs such as verapamil or diltiazem). Although the most common ventricular response to atrial flutter is with 2:1 AV conduction, followed by 4:1 AV conduction—a variable ventricular response (as occurs here) also may be seen often.

The second question raised on interpreting this tracing is whether the patient has had an inferior infarction. Although QRS amplitude is markedly reduced in all six limb leads—small q waves do appear to be present in leads II, III, and aVF. Assessment for ST segment changes in these inferior leads is impeded by a relatively large amplitude of flutter activity, thus making it impossible to comment on the acuity of inferior changes.

A final question raised by interpreting this tracing relates to the meaning of ST segment changes in the lateral precordial leads. The very deep S wave in lead V_2 strongly suggests left ventricular hypertrophy (LVH). We suspect ST changes in leads V_4 , V_5 , and V_6 represent repolarization changes of LVH (i.e., “strain”)—but simultaneous occurrence of flutter activity makes it difficult to verify this assumption. ❖