A 50-year-old university professor originally from South America had a 3-day history of paroxysmal attacks of rapid palpitations accompanied by near syncope and followed by transient flushing of her head and neck. She had a history of rheumatic mitral valve stenosis due to rheumatic fever at age 15, for which successful mitral commissurotomy was performed at age 36. Subsequently, recurrent attacks of paroxysmal atrial fibrillation require digitation therapy to control the patient’s ventricular rate.

The management prior to this hospitalization was digitoxin 0.1 mg daily (normal values 10-30 ng/mL), a low-sodium diet, and moderate restriction of physical activities. Digitoxin, a long-acting digitalis preparation, has a longer clinical effect than digoxin and thus controls the ventricular rate more efficiently in patients with atrial fibrillation and normal left ventricles (eg, in patients with isolated rheumatic mitral stenosis, the heart rate at rest and especially during activity is more easily controlled with the longer acting glycosides). Upon admission to the coronary care unit, the rhythm shown in Figure 1 was recorded.

**QUESTIONS**

1. Which of the following interpretation(s) is/are correct?
   a. atrial tachycardia with 2:1 atrioventricular (AV) block → Mobitz type II and junctional escape beats → supraventricular tachycardia
   b. atrial tachycardia with 2:1 AV block → sinus arrest (or sinoatrial [SA] block) with junctional escape beats → paroxysmal atrial tachycardia
   c. atrial tachycardia with 2:1 AV block followed by complete AV block with junctional escape beats → paroxysmal atrial tachycardia
   d. sinus rhythm with SA arrest and junctional escape beats → paroxysmal atrial tachycardia

2. The arrhythmia in Figure 1 coupled with a history of digitalis therapy and syncopal attacks is consistent with which of the following diagnoses?
   a. digitalis-induced SA arrest resulting in alternating rhythms of bradycardia and tachycardia
   b. bradycardia-tachycardia syndrome
   c. sick sinus syndrome from intrinsic causes
   d. disease of the AV node

3. Which of the following statement(s) regarding digitalis toxicity is/are true?
   a. a digoxin level over 2.0 ng/mL always indicates digitalis toxicity
   b. assessment of physical signs and symptoms is key in confirming digitalis toxicity
   c. electrocardiographic abnormalities are always present
   d. atrial tachycardia with block is frequently a result of digitalis toxicity

On the patient’s fifth hospital day, the rhythm shown in Figure 2 occurred following right carotid sinus massage.

4. In Figure 2, what is the clinical significance of the response to carotid sinus massage?
   a. a normal response to carotid sinus massage
b. a digitalis glycoside therapy is required
to control the rapid ventricular
response rate
c. the dromotropic effect of digitalis
persists

Six days after discontinuing the digitoxin,
pauses in rhythm were no longer noted. On the sev-
enth day, conversion to sinus rhythm occurred
spontaneously. The patient was transferred from the
coronary care unit after maintaining a regular sinus
rhythm for 48 hours.

ANSWERS
1. b. atrial tachycardia with 2:1 AV block →
sinus arrest (or SA block) with junc-
tional escape beats → paroxysmal atrial
tachycardia

Paroxysmal atrial tachycardia can have atrial
rates between 120 and 280 beats per minute. The
slower rates overlap with higher rates of sinus tachy-
cardia. The faster rates overlap the slower rates of
atrial flutter. Two-to-one AV block is seen in the first
portion of the upper trace (Figure 1). The notching
at the apex and distal slope of the T wave is similar
in configuration to the conducted P waves that have
P-P intervals of 0.45 ms. The atrial rate is 130 beats
per minute; the ventricular response is 65 beats per
minute. The P wave after the second QRS complex
is followed by a prolonged period of sinus arrest
measuring 7.1 s. Four spontaneous escape beats
appear 5.6 s after the last conducted QRS. The
inscription of the P wave before the first complex in
the bottom trace (Figure 1) is interrupted by a junc-
tional escape beat, and this is followed by paroxys-
mal atrial tachycardia at a rate of 134 beats per
minute.

2. a. digitalis-induced SA arrest resulting in
alternating rhythms of bradycardia and
tachycardia

The sick sinus syndrome from intrinsic causes is
a clinical diagnosis made when any of the following
symptomatic arrhythmias are present, provided they
are unrelated to drug overdosage or electrolyte
imbalance: (1) sinus bradycardia or any sympto-
matic bradycardia regardless of the type of atrial
arrhythmia that is unresponsive to atropine or exer-
cise; (2) SA block or arrest with long pauses; (3)
sinus arrest with an escape atrial or junctional
rhythm; (4) alternating bradycardia and tachycardia
(the bradycardia is characteristic of either [1] or [2]
above); (5) SA arrest with failure of subsidiary pace-
maker resulting in asystole; (6) chronic atrial fibril-
lation with failure of sinus rhythm to return after
electrical cardioversion.

3. b. assessment of physical signs and symp-
toms is key in confirming digitalis
toxicity
c. electrocardiographic abnormalities are always present 
d. atrial tachycardia with block is frequently a result of digitalis toxicity 

As in this case, more than one arrhythmia may occur, which can complicate the clinical picture. Heart block may be present in combination with tachycardia or bradycardia and an escape rhythm. Healthcare providers should be able to distinguish the signs and symptoms of digitalis toxicity. It is generally accepted that digitalis levels greater than 2.0 ng/mL are toxic (normal values 0.8-2.0 ng/mL). However, levels as low as 1.6 ng/mL have been reported in digitalis toxicity. On the other hand, levels as high as 3.0 ng/mL have not been associated with digitalis toxicity. Digitalis levels may not reflect how much digitalis is bound to the cell membranes, thus digitalis levels should not be the only measures used to assess digitalis toxicity. Electrocardiographic changes and assessment of the patient are fundamental in the recognition of digitalis overdose or toxicity. Early intervention is critical because of the potentially lethal effect of this drug.

Noncardiac signs of digitalis toxicity include the classic gastrointestinal signs and symptoms of anorexia, nausea, and vomiting and the visual abnormalities of scotomas and halos. A change in color perception is a valuable sign, but such assessment is not often emphasized. Patients should be asked if they can identify colors (particularly green and yellow) while watching television. Color perception will be overlooked if specific inquiries are not made. Neurological changes such as disorientation, restlessness, headache, and malaise may also be present. A complete medication history should be elicited because drugs such as amiodarone, diltiazem, verapamil, and quinidine increase digitalis levels (not digitoxin levels). In medical emergencies that involve patients who are receiving digitalis therapy, the intravenous administration of fab fragments of cardiac glycosides (which are specific antibodies that reverse the cellular effects of digitalis) are recommended.

Sick sinus syndrome is characterized by abnormalities of function in both the SA node and AV junctional tissue. The abnormality may be due to idiopathic fibrosis, cardiomyopathy, pericarditis, rheumatic fever, or coronary artery disease. As exemplified in this case, sick sinus syndrome from intrinsic causes may be mimicked by toxic effects of digitalis in which the SA node is more sensitive to the physiologic suppression of SA nodal discharge by rapid atrial rates. Discontinuing the drug eliminates the arrhythmia, which then establishes the diagnosis of iatrogenic digitalis toxicity.

4. c. the dromotropic effect of digitalis persists 

The trace reveals a supraventricular tachycardia at a rate of 150 beats per minute converting to 3:2 and then 2:1 Wenckebach AV block following right carotid sinus massage. The clinical significance of the arrhythmias that resulted from the effects of bedside maneuvers is that it indicates that the negative dromotropic effect of digitalis still persisted. The AV node may be more sensitive to vagal stimulation (carotid sinus massage) after digitalization.

Summary

All digitalis preparations and especially the longer acting preparations have potentially serious adverse side effects and consequences that may result from drug overdosage. However, therapeutic doses of digitalis preparations may also produce drug toxicity by alterations in electrolyte balance. Low serum levels of potassium, food- or drug-related or iatrogenic, require prompt corrective therapy because digitalis toxicity is a potentially serious complication, especially in patients with serious cardiac ailments.

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REFERENCES


Figure 2 Electrocardiogram recorded when right carotid sinus massage was applied (arrow).
SELECTED REFERENCES


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Iatrogenic Sick Sinus Syndrome
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