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NASPE POSITION STATEMENT

The Revised NASPE/BPEG Generic Code for Antibradycardia, Adaptive-Rate, and Multisite Pacing

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BERNSTEIN, A.D., ET AL.: The Revised NASPE/BPEG Generic Code for Antibradycardia, Adaptive-Rate, and Multisite Pacing. *In light of evolving pacemaker technology and increasing interest in multisite pacing, the Committee on the Development of Position Statements (CDPS) of the North American Society of Pacing and Electrophysiology (NASPE) created an ad hoc Pacemaker Mode Code Task Force in April 2001 under the chairmanship of David L. Hayes, MD, for the purpose of bringing the NASPE/British Pacing and Electrophysiology Group (BPEG) Generic Pacemaker Code (NBG Code) up to date. The task force, whose members are the authors of this article, designed a revised NBG Code in which three major issues were taken into account. First, it was recognized that all modern pacemaker pulse generators are capable of extensive bidirectional communication with an external programming device, making them "communicating" pulse generators as defined by the current (1987) NBG Code. Second, it was decided that a means of providing basic information regarding the location of multisite pacing would be a useful ingredient of the NBG Code. Third, in view of the extensive antibradycardia pacing capabilities common in modern implantable cardioverter defibrillators and the availability of the NASPE/BPEG Defibrillator Code (NBD Code), it was considered unnecessary for the NBG Code to address the presence or absence of antitachycardia features. The resulting updated version of the NBG Code as described herein was endorsed by the BPEG on September 20, 2001 and adopted by the NASPE Board of Trustees on October 18, 2001. The structure of the revised NBG Code differs from that of the previous version in two respects alone: Position IV specifies only the presence or absence of rate modulation, and Position V specifies only the location or absence of multisite pacing (i.e., biatrial or biventricular pacing with at least two stimulation sites in each case) more than one stimulation site in any single cardiac chamber, or any combination of these. The revised NBG Code is deliberately configured to avoid confusion with earlier mode codes, and it is the authors' hope that it will serve as an enhanced resource for communication among those engaged in every phase of the multidisciplinary practice of cardiac rhythm management. (PACE 2002; 25:260–264)*

pacemaker, mode, code, NASPE, BPEG, NBG Code

Introduction

The first conversational ("generic") pacemaker mode code was proposed in 1974.[1] The relatively few changes found necessary in a series of subsequent revisions prompted by the evolution of pacemaker technology and clinical practice stand as a testament to the wisdom and foresight of the earliest designers. The North American Society of Pacing and Electrophysiology and British Pacing and Electrophysiology Group (NASPE/BPEG) Generic Code (the NBG Code), the antibradycardia pacing mode code currently in use, was published in 1987 after being adopted by NASPE and BPEG.[2]

In April 2001, a Pacemaker Mode Code Task Force was created by the NASPE Committee on the Development of Position Statements (CDPS) under

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the chairmanship of David L. Hayes, MD. Its members, who are the authors of this article, were charged with the task of proposing a revised NBG Code that would be more compatible with contemporary and emerging pacing technology and practice, with particular attention to the issue of multisite pacing. The resulting updated version of the NBG Code as described herein was endorsed by the BPEG on September 20, 2001, and adopted by the NASPE Board of Trustees on October 18, 2001.

This revised code replaces the version of the NBG Code published in 1987.[2]

Design Considerations

The task force agreed to maintain the basic design philosophy reflected in the current version of the NBG Code, as may be seen in the specifications outlined below.

Among the objectives considered in revising the code were (1) avoiding any possibility of confusion between the revised version and the version currently in use, (2) maintaining the simplicity that makes the code convenient for use in conversation, (3) deleting specifications no longer needed, like the degree of programmability, or those that can be communicated more appropriately by other means, like the basic antitachycardia functions that can be described succinctly by the NASPE/BPEG Defibrillator Code (the NBD Code),[3] and (4) providing a means of representing the presence of multisite pacing, defined for this purpose as stimulation sites in both atria, both ventricles, more than one stimulation site in any single chamber, or any combination of these.

Revised Definition of the NBG Code

The revised NBG Code is summarized in Table I, and several examples of its use are shown in Table II. It has five positions, of which the first three are the same as in the previous version of the code. Unlike the previous version, however, all five positions are used exclusively to describe antibradycardia pacing.

Positions I, II, and III indicate the chambers in which pacing and sensing occur, and the effect of each instance of sensing on the triggering or inhibition of subsequent pacing stimuli. In this context, "sensing" refers specifically to the detection of spontaneous cardiac depolarizations (or spurious interference signals that are interpreted mistakenly as spontaneous cardiac depolarizations) outside the pulse generator's refractory periods.

Position IV is used only to indicate the presence **(R)** or absence **(O)** of an adaptive-rate mechanism (rate modulation). Unlike the remaining positions, all of which refer to the location of stimulation and spontaneous depolarization detection or the response to such detection, Position IV is unique. It refers to the automatic adjustment of the pacing rate (i.e., the lower rate limit) to compensate for chronotropic incompetence, and in some pulse generators, the concomitant variation of other timing related pacing parameters like refractory periods and atrioventricular (AV) intervals, all under the control of an appropriate measured variable like mechanical vibration, acceleration, or minute ventilation. Unlike pacemaker sensing as defined above (i.e., the detection of spontaneous cardiac depolarizations), Position IV addresses a very different process, even though the term *sensor* is often used in this connection.

Position V is used to indicate whether multisite pacing, as described above, is present in **(0)** none of the cardiac chambers, **(A)** one or both of the atria (i.e., with stimulation sites in each atrium, more than one stimulation site in either

Table I.

The Revised NASPE/BPEG Generic Code for Antibradycardia Pacing

Position:	I	II	III	IV	V
Category:	**Chamber(s) Paced**	**Chamber(s) Sensed**	**Response to Sensing**	**Rate Modulation**	**Multisite Pacing**
	O = None	**O** = None	**O** = None	**O** = None	**O** = None
	A = Atrium	**A** = Atrium	**T** = Triggered	**R** = Rate modulation	**A** = Atrium
	V = Ventricle	**V** = Ventricle	**I** = Inhibited		**V** = Ventricle
	D = Dual (A + V)	**D** = Dual (A + V)	**D** = Dual (T + I)		**D** = Dual (A + V)
Manufacturers' designation only:	**S** = Single (A or V)	**S** = Single (A or V)			

Table II.

Examples of the Revised NASPE/BPEG Generic Code

Code	Meaning
VOO, VOOO, or VOOOO	Asynchronous ventricular pacing; no sensing, rate modulation, or multisite pacing.
VVIRV	Ventricular inhibitory pacing with rate modulation and multisite ventricular pacing (i.e., biventricular pacing or more than one pacing site in one ventricle). This mode is often used in patients with heart failure, chronic atrial fibrillation, and intraventricular conduction delay.
AAI, AAIO, or AAIOO	Atrial pacing inhibited by sensed spontaneous atrial depolarizations; no rate modulation or multisite pacing.
AAT, AATO, or AATOO	Atrial pacing with atrial outputs elicited without delay on atrial sensing during the alert period outside the pulse generator's refractory period (used primarily as a diagnostic mode to determine exactly when atrial depolarizations are sensed); no rate modulation or multisite pacing.
AATOA	Atrial pacing with atrial outputs elicited without delay on atrial sensing during the alert period outside the pulse generator's refractory period, without rate modulation but with multisite atrial pacing (i.e., biatrial pacing, more than one pacing site in one atrium, or both features).
DDD, DDDO, or DDDOO	Dual chamber pacing (normally inhibited by atrial or ventricular sensing during the alert portion of the VA interval or by ventricular sensing during the alert portion of the AV interval, and with ventricular pacing triggered after a programmed PV interval by atrial sensing during the alert portion of the VA interval); no rate modulation or multisite pacing.
DDI, DDIO, or DDIOO	Dual chamber pacing without atrium synchronous ventricular pacing (atrial sensing merely cancels the pending atrial output without affecting escape timing); no rate modulation or multisite pacing.
DDDR or DDDRO	Dual chamber, adaptive-rate pacing; no multisite pacing.
DDDRA	Dual chamber, adaptive-rate pacing with multisite atrial pacing (i.e., biatrial pacing, more than one pacing site in one atrium, or both features). This mode was assessed in the multicenter DAPPAF study.[6]
DDDOV	Dual chamber pacing without rate modulation, but with multisite pacing (i.e., biventricular pacing, more than one pacing site in one ventricle, or both features).[7]
DDDRD	Dual chamber pacing with rate modulation and multisite pacing both in the atrium (i.e., biatrial pacing, pacing in more than one site in one atrium, or both features) and the ventricle (i.e., biventricular pacing, pacing in more than one site in one ventricle, or both features).

atrium, or any combination of the two), **(V)** one or both of the ventricles, (i.e., with stimulation sites in both ventricles, more than one stimulation site in either ventricle, or any combination of the two), or **(D)** any combination of **A** or **V** as just described.

Usage Conventions

A generic code cannot describe the operation of every conceivable device comprehensively and unambiguously. Inevitably, there will be circumstances in which it will be important to provide supplementary information. However, it will not always be necessary to use all five positions to convey information of immediate significance.

Like its predecessor, the NBG Code as revised herein remains a resource intended to represent (1) the maximal capabilities of a device (as in labeling), (2) the mode to which the pulse generator

is programmed (as in clinical records), or (3) the mode (like **AAI** or **AAIR** in the presence of sinus bradycardia with normal AV conduction) in which the device is functioning at any particular instant (as in beat-by-beat interpretation of paced electrocardiographic rhythm strips; in the example cited, what the device is doing would be indistinguishable from **AOO** or **AOOR**, depending on the programmed mode). By specifying the mode to which a pulse generator is programmed, the code may describe two different objectives of antibradycardia pacing: (1) a mode intended to function as a prosthesis for a dysfunctional component of the cardiac conduction system, like the sinoatrial (SA) node or the AV node, or (2) a mode intended as preventive, as in relatively rapid atrial pacing intended to decrease the likelihood of paroxysmal atrial fibrillation.

Although all five positions may be needed for completeness in some circumstances, the first three positions are *always* required. If adaptive-rate pacing and multisite pacing are absent, the first three positions will suffice. If rate modulation is present, Position IV is added. Position IV also may be used whenever the *absence* of adaptive-rate pacing requires emphasis. To denote the presence of multisite pacing or to emphasize its absence, all five positions are required even in the absence of rate modulation, in which case Position IV serves as a "spacer" so that Position V can be used appropriately.

Position I: Chamber(s) Paced

Position I indicates where antibradycardia pacing is available, and is restricted to that purpose. Antitachycardia pacing may be addressed more appropriately by means of the NBD Code.[3]

Position II: Chamber(s) Sensed

Position II indicates the chambers in which spontaneous cardiac depolarizations or interference signals may be detected outside of a pulse generator's refractory periods, for the purpose of triggering or inhibiting antibradycardia pacing as indicated in Position III. To avoid unnecessary ambiguity, Position II specifically excludes the detection of spontaneous depolarizations or other signals for any other purpose, like the tracking of atrial activity during supraventricular tachycardia as part of a mode switching algorithm.[4,5] As in the previous version of the code, it indicates nothing about where tachycardia detection takes place.

Position III: Response to Sensing

Position III indicates whether sensing, as defined for Position II, *inhibits* pacing (by resetting an escape interval without pacing or, as in **DDI**, by canceling the next pending atrial stimulus without affecting pacemaker timing), or *triggers* a pacemaker output, immediately in the same chamber, as in **AAT** and **VVT** pacing, or in the ventricle after an appropriate AV interval that begins with a paced or sensed atrial event, as in **DDD** pacing.

Position IV: Rate Modulation

Position IV indicates only whether adaptive-rate pacing (rate modulation) is present or absent. It is assumed that all contemporary pulse generators are capable of comprehensive noninvasive adjustment and of providing information by telemetry, so that the "programmability" hierarchy incorporated in the previous version of the code is no longer needed.

Position V: Multisite Pacing

The use of Position V, as described above, reflects the basic design philosophy of a generic code. This position indicates the presence and, to some extent, the location of multisite pacing, but without providing specific details. The definition of multisite pacing described above excludes the simultaneous activation of both atria or both ventricles by septal pacing. The issue of code design for multisite pacing may be revisited as the usefulness of additional or currently unconventional pacing sites becomes more clearly established and accepted patterns for multisite pacing emerge.

Conclusions

The NBG Code is intended as a resource for convenient and easily understood communication among those engaged in an increasingly complex interdisciplinary field. Comprehensiveness and comprehensibility must be balanced if such a code is to be useful, particularly in conversation. Considerable effort has been directed toward the design of pacemaker and defibrillator codes that can provide a substantial amount of important information in a simple, extremely concise fashion. The structure of the revised NBG Code differs from that of the previous version in that Position IV specifies only the presence or absence of rate modulation, and Position V specifies only the location or absence of multisite pacing. It is hoped that the NBG Code, revised as described herein, will continue to be useful in cardiac rhythm management.

Note: no copyright restriction is imposed on reproduction of the defining table of the revised NBG Code (Table I). Such reproduction is encouraged, provided it is done without modifications of any kind.

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Appendix:

The Elected Council of the British Pacing and Electrophysiology Group

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