Natural history of postoperative heart block in congenital heart disease: Implications for pacing intervention

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After half a century of major progress in congenital heart disease management, atrioventricular conduction block continues to complicate 1–3% of surgical procedures. Unless treated with an implanted pacemaker, permanent postoperative heart block is associated with 28–100% mortality. Postoperative heart block often proves to be transient, typically resolving within 10 days of onset. The duration of postoperative heart block is widely used as a key determinant for permanent pacemaker implantation. Current professional pacemaker implantation guidelines are largely based on this criterion. However, available natural history data suggest that other factors, such as residual conduction system injury, likely play a role in increasingly recognized cases of very late postoperative mortality and morbidity in patients who have experienced transient postoperative heart block. As growing numbers of congenital heart disease patients survive into adulthood, and artificial pacemaking capabilities continue to improve, it might be necessary to reconsider and refine currently accepted pacing indications for postoperative heart block.

KEYWORDS Heart block; Heart surgery; Congenital heart disease; Permanent pacemaker

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Tremendous advances in the surgical management of congenital heart disease (CHD) have been achieved over the past half century. Nevertheless, conduction system injury continues to be a leading cause of long-term postoperative cardiac morbidity. The incidence of postoperative AV conduction block has declined significantly since it was first explored in detail in a landmark paper by Lillehei et al in 1963, but heart block continues to complicate approximately 1% to 3% of operations performed at major CHD surgical centers.

This review was undertaken in response to a management conundrum that arises quite regularly at our institution and is reflected in current practice guidelines endorsed by leading professional organizations. Postoperative heart block reportedly resolves spontaneously in 43% to 92% of cases,1,5–10 with the large degree of variation among studies attributable to a variety of factors, such as era, case identification and inclusion criteria, and follow-up duration. Decisions with respect to permanent pacemaker implantation are fraught with uncertainty regarding optimal timing of intervention and long-term risks associated with nonintervention, as well as the morbidity of lifelong pacemaker therapy.

Based on mortality data from the “dark days” before permanent pacing became available in 1962 and widely implemented in the years that followed (Table 1), it seems clear that pacemaker implantation is appropriate in CHD patients whose postoperative heart block does not resolve. Indeed, current American College of Cardiology/American Heart Association/North American Society of Pacing and Electrophysiology (ACC/AHA/NASPE) guidelines list “postoperative advanced second- or third-degree AV block that is not expected to resolve or persists at least 7 days after cardiac surgery” as a class I indication for pacemaker im-
Interestingly, the full text version of the document provides slightly less interpretive latitude, stating that “the presence of advanced second- or third-degree AV block persisting for 7 to 14 days after cardiac surgery is considered a Class I indication for pacemaker implantation.”

Conversely, the notion that transient, spontaneously resolving heart block does not require permanent pacing is also broadly accepted, but its application is rendered less clear by the risk of late recurrence of heart block (discussed later). The ACC/AHA/NASPE guidelines list “transient postoperative AV block with return of normal AV conduction” as a class III indication—essentially a contraindication—for pacemaker implantation.

Notwithstanding the possibility of a late return of AV conduction, two contemporary considerations weigh against protracted delay in the decision to proceed with permanent pacemaker implantation. The first consideration is the ongoing improvement in longevity and miniaturization of pacing systems available for infants and children, reducing concerns over pacing-related morbidity. The second is cost-driven pressure for reductions in hospital length-of-stay, where a patient’s need for temporary epicardial pacing while awaiting recovery of conduction can be a major limiting factor in discharge planning.

Although the immediate time course of recovery from transient postoperative heart block impacts significantly on management decisions, the risk of late heart block recurrence is a more ominous and poorly defined problem with potentially life-threatening implications. To begin with, the very concept of “recurrence” is challenged by the observation that heart block can appear, presumably de novo, long after CHD surgery. In a report from our institution, Goldman et al divided 114 CHD patients undergoing permanent pacemaker implantation for postoperative AV block into “early”- and “late”-onset groups, defined as those whose heart block was initially detected either less than 30 days or at least 30 days after surgery, respectively. Fully 36% of the patients fell into the “late” group, with heart block identified at a mean of 4.7 years after CHD surgery in that group. Although prophylactic pacemaker implantation in all surgical CHD patients judged to be at risk is impractical, cardiologists providing long-term follow-up care should be alert to this issue and respond promptly and proactively to suggestive symptoms such as syncope while undertaking heart rhythm monitoring at regular intervals in asymptomatic patients.

The most disturbing indirect data concerning remote implications of transient postoperative heart block come from a 2001 study detailing long-term (mean 28 years) outcomes among 288 survivors of tetralogy of Fallot repair performed at the University of Minnesota between 1954 and 1974. The incidence of late sudden death in this cohort correlated strongly with transient postoperative heart block. Among 20 patients with postoperative heart block lasting more than 3 days, 8 (40%) subsequently died suddenly. The sudden death rate among 55 patients with heart block of shorter duration was 7.3%, similar to the 6.1% noted in the 196 patients who had no documented heart block. Beyond this study, data assessing the risk of late recurrence in

<table>
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<th>Reported mortality</th>
<th>Era</th>
<th>Reference</th>
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<tr>
<td>100%</td>
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<td>15</td>
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<tr>
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<td>10</td>
</tr>
<tr>
<td>64%</td>
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<td>8</td>
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Figure 1  Cumulative probability of recovery from transient postoperative heart block (AVB), plotted as a function of number of days from AVB onset (typically equivalent to postoperative days), based on published studies as indicated. Data points were fitted with an exponential equation ($R^2 = 0.81$).
relation to the initial duration of early postoperative heart block are extremely limited.

Several investigators have attempted to identify additional prognostic predictors in early postoperative heart block. Attention has focused on the anatomic site of conduction system disruption. Driscoll et al\textsuperscript{15} took an invasive approach, categorizing the level of block as being above, at, or below the bundle of His based on intracardiac recordings obtained in 14 patients. Spontaneous recovery occurred most often (3/5 patients) among those with supraventricular block, whereas conduction returned in one of four patients with infraventricular block, none of two who had block within the His bundle, and three of three who had block at an “indeterminate” level.\textsuperscript{15} Nishimura et al\textsuperscript{9} compared escape rhythm QRS complex morphology in heart block with that observed following recovery of conduction at a mean of 7.3 postoperative days. They found no late recurrences during 2.5 to 10 years of follow-up among nine patients whose escape rhythm QRS complex morphology matched that seen after recovery. However, two of four patients with “discordant” QRS morphology subsequently experienced heart block recurrence at 2 and 48 months. Their interpretation of this interesting observation was that infraventricular block would more likely be associated with escape rhythm QRS complex morphology dissimilar to that seen following recovery than would be the case if transient block occurred more proximally in the conduction system.\textsuperscript{9}

Krongrad\textsuperscript{16} performed an illuminating meta-analysis of the prognostic significance of electrocardiographic fascicular block patterns following CHD surgery. Culling data on 1,856 patients from eight reported surgical series, he found that 4 (5%) of 81 with transient postoperative heart block alone experienced subsequent late recurrence. Among 204 patients with bifascicular block who did not experience transient complete heart block, there was a 1.5% risk of either late-onset heart block or sudden death. The risk increased dramatically when transient heart block recovered with residual bifascicular block. Among 56 such patients, 16 (29%) experienced either late-onset complete heart block or sudden cardiac death.\textsuperscript{16} Thus, the location and degree of conduction system injury likely do carry some prognostic significance in patients with transient postoperative heart block.

Practitioners caring for CHD patients often are faced with lack of adequate data upon which to base management decisions. Transient postoperative heart block represents a case in point. The early time course of this condition is reasonably well defined and has remained remarkably constant over the past 35 years. However, its long-term implications have yet to be sufficiently elucidated, while a burgeoning population of young CHD survivors heads into later adult years and presumably increasing cumulative risk for life-threatening AV conduction disturbances. This real but as yet unquantified risk must be taken into consideration when permanently paced patients with recovered AV conduction come due for elective generator replacement.

As our pacing capabilities continue to become more reliable and user-friendly for patients of all ages, it seems inevitable that the threshold for pacing intervention will continue to migrate downward, ultimately obviating the need to agonize over whether postoperative heart block persisting beyond 7 days is “transient” or “permanent.” This hope likely will reach full fruition when integrated biologically based pacing therapies, whose promising state of the art is reviewed by Gepstein et al\textsuperscript{17,18} altogether supplant our current dependence on manufactured technology.\textsuperscript{19}

References


