Pacemaker therapy: the newborn and the nonagenarian

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This editorial refers to ‘Long-term outcome of cardiac pacing in octogenarians and nonagenarians’ by E. O. Udo et al., on page 502 and ‘Permanent epicardial pacing in children: long-term results and factors modifying outcome’ by P. Kubuš et al., on page 509

The average age of patients with an indication for pacing is ~75 years at the time of implantation. However, permanent pacemaker therapy can be necessary at all ages, from newborn to the nonagenarian. Particularly in these age groups, age matters: in small children, there are technical and anatomical considerations that render pacemaker implantation difficult; in very old patients, their relatives, in particular, but also physicians may have concerns about pacemaker implantation that is perceived as too invasive for such an old patient with significant comorbidity. Two publications in this issue of the journal address pacemaker therapy in these two age groups.1,2

Pacemaker therapy in children faces several challenges. Transvenous implantation may not be feasible due to lack of venous access to cardiac cavities, or may be difficult due to the small venous diameter that either prevents lead introduction or—if the lead can be introduced—obliterates soon after implantation. Lead dysfunction (lead fracture, exit block, and sensing failure) during growth can occur despite formation of loops of the lead at the time of implant. Therefore, epicardial pacing remains the preferred mode of implantation in small children. As an advantage, the epicardial approach allows dual-chamber pacing earlier than transvenous implantation and left ventricular pacing to prevent adverse haemodynamic long-term consequences of right ventricular pacing.

Even though pacing is increasingly applied in paediatric patients, only few long-term data are available on the performance of modern epicardial pacemaker systems. However, these data are necessary to balance advantages and disadvantages of permanent pacing in children in indications outside immediately vital indications.

Studies using newer implantable materials and operation techniques have shown improvements in system longevity and long-term function, in particular, lead function has been improved in recent years (Table 1).3–11 Yearning a 5-year epicardial lead survival of >90% as shown in a study by Kubuš et al.1 Pacing performance has been improved by the addition of steroids to the lead tip which reduced the risk of exit block by 80%.1 In this retrospective analysis, the bipolar lead model Medtronic 4968 demonstrated chronic lead integrity similar to the unipolar lead model Medtronic 4965. Thus, advantages of bipolar sensing in epicardial leads come at no cost in terms of lead longevity. Also, the resistance of the lead body and insulation material of epicardial leads has been improved. Lead fractures accounted for only 31% of epicardial lead failures in a recent study,12 whereas pacing (54%) and sensing problems (14%), most likely due to exaggerated scar formation at the epicardial lead tip, played a more dominant role. In addition to lead improvements with lower chronic pacing thresholds, algorithms such as automatic capture control features prolong battery life significantly.1

Epicardial pacing with new bipolar leads, which are more resistant to lead fracture and insulation failure and are fitted with steroids at the lead tip, facilitate pacing in small children. With the addition of batteries with extended service duration and automatic algorithms that minimize energy consumption, modern systems can be expected to last much longer than earlier devices, thus reducing the need for battery exchange or lead revision, as shown in the study by Kubuš et al.1 The possibility to pace the left ventricle and prevent the deleterious effects of chronic right ventricular pacing represents another potential improvement of paediatric pacing therapy.13

At the other end of the age spectrum, it is a topic of daily discussion in clinical practice—with relatives and patients themselves—if pacing therapy should be applied at an age >85 or 90 years. Arguments used against applying pacing in octogenarians and nonagenarians, particularly in non-life-threatening indications such as sinus node disease, atrial fibrillation with a slow ventricular response, or intermittent high-degree atrioventricular block, include sometimes obvious frailty of the patient, the risk of...
complications, in-hospital mortality, and comorbidity that reduces life expectancy independently of bradycardia.

In the Olmsted County study, the clinical course of 157 octogenarians and nonagenarians who received a pacemaker between 1962 and 1988 was followed through 1992. While permanent pacing alleviated bradycardia-related symptoms, placement of the patient in a nursing home frequently occurred after implantation. Development or worsening of cardiac, neurological, or orthopaedic disabilities were more frequent, and mortality was higher among patients ≥80 years of age at implantation than in an age-matched control group, but no difference in adverse outcome was, however, found in those pacemaker patients who were not affected by heart disease.

Data from the PASE (PAcemaker Selection in the Elderly) trial conducted in mid-1990s seem to confirm these concerns. A Dutch population-based cohort study conducted in 23 centres, 481 patients aged ≥80 years at implantation were enrolled. This report is particularly valuable because it provides a follow-up of 5 years. Unlike data from PASE, the early complication rate was not increased compared with patients aged <80 years. Unlike data from the Olmsted county study (with pacemaker implantations between 1962 and 1988), in this study with implantations between 2003 and 2007, survival of patients receiving a pacemaker at ≥80 years was similar to age-matched Dutch control patients, even though 5-year survival was only 49% in contrast to 75% in patients implanted at age <80 years. Of note, most patients (approximately two-thirds) died from non-cardiac causes.

These data suggest that old age and perceived frailty should not be used as arguments against pacemaker implantation if there is an established indication in the elderly patients. In fact, the improvement in mobility, cognitive function, and daily life activity may be particularly strong in this patient group.

In conclusion, new data on octogenarians and nonagenarians are presented that merit attention. In a Dutch population-based cohort study conducted in 23 centres, 481 patients aged ≥80 years at implantation were enrolled. This report is particularly valuable because it provides a follow-up of 5 years. Unlike data from PASE, the early complication rate was not increased compared with patients aged <80 years. Unlike data from the Olmsted county study (with pacemaker implantations between 1962 and 1988), in this study with implantations between 2003 and 2007, survival of patients receiving a pacemaker at ≥80 years was similar to age-matched Dutch control patients, even though 5-year survival was only 49% in contrast to 75% in patients implanted at age <80 years. Of note, most patients (approximately two-thirds) died from non-cardiac causes.

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**Conflict of interest:** none declared.

**References**

5. Thomson JD, Blackburn ME, Van Doorn C, Nicholls A, Watterson KG. Pacemaker therapy in the very young and the very old, where concerns about increased perioperative and long-term risks may represent an obstacle to provision of this therapy.

### Table 1 Selection of studies on epicardial pacing lead survival in children

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>Patients (n; mean age)</th>
<th>1-year lead survival (%)</th>
<th>2- and 3-year lead survival (%)</th>
<th>5-year lead survival (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaufort-Krol (1999)</td>
<td>33; 7.6</td>
<td>–</td>
<td>91</td>
<td>–</td>
</tr>
<tr>
<td>Cohen (2001)</td>
<td>123; 4.1*</td>
<td>96</td>
<td>90</td>
<td>74</td>
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<tr>
<td>Thomson (2004)</td>
<td>59; 1.9*</td>
<td>–</td>
<td>–</td>
<td>75</td>
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<tr>
<td>Fortescue (2005)</td>
<td>184; 9*</td>
<td>96</td>
<td>92</td>
<td>58</td>
</tr>
<tr>
<td>Silvetti (2006)</td>
<td>127; 4*</td>
<td>–</td>
<td>–</td>
<td>80</td>
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<td>138; 12*</td>
<td>91</td>
<td>85</td>
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<td>100</td>
<td>–</td>
<td>89</td>
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<tr>
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<td>83</td>
<td>–</td>
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<td>99</td>
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<td>84</td>
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<td>Kubuš (2011)</td>
<td>119; 1.8*</td>
<td>–</td>
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</table>

*Median age.*


