Foreword

One of the most tedious and often unrewarding tasks in medical investigation is obtaining massive normative data on a general population, so that normal standards can be made available to physicians throughout the world. Dr. Hung-Chi Lue and his colleagues have completed a monumental effort of gathering electrocardiographic data on over 1,800 normal infants, children and adolescents, and they have produced a unique monograph which provides normal standards and percentile charts. These published tables will undoubtedly be the basis for comparing values obtained from all components of electrocardiograms on pediatric cardiac patients to the normal range of measurements. These data also should be the basis for the development of valid computer analyses of pediatric electrocardiograms; the present interpretation packages being woefully inadequate.

Although the morphologic diagnostic aspects of electrocardiography have less impact in the modern era because of the advent of echocardiography, the electrocardiogram is vital for the diagnosis and evaluation of patients with cardiac rhythm disorders. Reliable standards for P-QRS-T wave intervals are required to evaluate children with tachyarrhythmias, bradyarrhythmias, first, second, and third degree heart block, WPW, and long QT syndromes.

The format is an especially attractive feature of this monograph. The authors provide 95^{th} and 5^{th} percentile data for all interval and amplitude measurements for all ages, giving access to the limits of normality, so that data from an individual patient can be quickly interpreted in terms of comparison to the general population. The easy-to-use tables will result in data being accessed more often by clinicians and investigators in the field.

This monograph will be especially helpful to those who teach pediatric electrocardiography to medical students, residents, and pediatric cardiology fellows. Many of the teaching points regarding the diagnosis of left, right, and biventricular hypertrophy at various stages, in terms of what is abnormal amplitude of Q, R and S waves as well as RS ratios in the right and left precordial leads, can now be validated (or invalidated), on the basis of this extensive data base for normals.

Those of us in pediatric cardiology owe a debt of thanks to Dr. Lue and his associates for collecting this data, analyzing the material by age groups, and presenting the results in table form which is so easily accessible. The painstakingly careful methodology and large patient population gives us confidence in the reliability of this database, which I hope will be used for the development of accurate computer analyses of pediatric ECG's. Dr. Hung-Chi Lue has made so many contributions to pediatric cardiology that the success of this endeavor

is to be expected. He is an international leader in our field, and the widespread use of this reference manual by his colleagues throughout the world will be another milestone in his outstanding career.

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At the beginning of the twenty-first century, pediatric cardiologists face a uniquely different situation than half a century ago. The diagnostic tools and therapeutic methods available today were almost unimaginable then. Even thinking back only several decades to the days when a combination of the physical examination, the chest roentgenogram, and the electrocardiogram were all that was available to assist in the outpatient clinic and subsequently to the time when physiologic and anatomic data obtained in the catheterization laboratory became more completely understood, the cardiologist today fully appreciates these practical clinical advantages.

Unfortunately, for many present day physicians and students alike, there is a feeling that these valuable diagnostic implements have fully given way to the newer tools such as echocardiography. This is obviously unwarranted.

Important practical clinical information and understanding are made available by the electrocardiographic examination. Of particular importance to both pediatricians and pediatric cardiologists, however, is the fact that the electrocardiogram varies so extensively with the age of the patient. Understanding this has been an issue since the ECG began to be used in pediatric patients and continued later when the difficulties were even more problematic at the time when computerization of pediatric electrocardiography was initially undertaken.

The ECG has stood the test of time and, in contrast to the phonocardiogram, remains important to the cardiologist each and every day. To assist in the implementation of this clinical tool, Professor Hung-Chi Lue has created an impressive and inclusive database showing what is normal and what is not. The careful electrocardiographic examination of almost two-thousand youngsters has provided new and valuable categorized information.

It should not be surprising that Professor Lue has successfully undertaken and completed this gigantic task. As one of the world's leaders in so many aspects of pediatric cardiology, Dr. Lue's continuing contributions – again and again – have been recognized and favorably received not only by the international medical community, but also by his peers in pediatric cardiology. No doubt this book will be equally well received because of the extraordinary detail with which he has displayed these unique data in a clinically usable format.

Professor Hung-Chi Lue is to be congratulated for this effort which will be used by clinicians around the world.

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CHAPTER 1.1

Heart rate by age

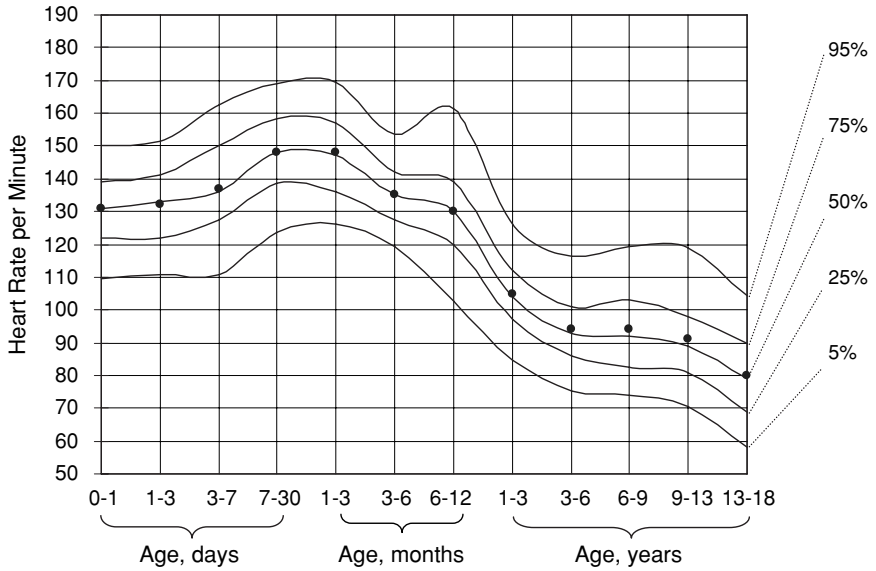

Figure 1.1 Heart rate by age, each curve corresponding to the indicated percentile level (• = mean). Striking changes in heart rate are noted from newborn to adolescence. The heart rate increases from birth to ages 7–30, days and 1–3 months. From that age forward, the heart rate decreases with increasing age, most rapidly from age 6–12 months to 1–3 years.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	150	152	163	169	169	154	161	126	117	119	119	105
Mean	**131**	**132**	**137**	**148**	**148**	**135**	**130**	**105**	**94**	**94**	**91**	**80**
(±SD)	**12.86**	**13.07**	**15.91**	**15.58**	**14.66**	**11.70**	**18.67**	**13.09**	**11.96**	**14.68**	**14.08**	**14.50**
5%	109	111	111	124	126	120	103	85	75	74	70	58
(N)	109	128	95	100	113	91	97	113	107	99	289	510