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Editorial

Misperception of Survival in Adult Congenital Heart Disease and Importance of Both Anatomic and Functional Indices: Educate Your Patients!

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Congenital heart disease (CHD) is one of the greatest success stories in medicine; survival prospects of babies born with CHD have shifted away from natural selection with poor survival in the 1950s to an expected survival to adulthood of more than 90%.[1] The adult population with CHD exceeds the pediatric population with a very rapid increase of adults with CHD of moderate and great complexity. If the reported prevalence from the 2010 Québec population is extrapolated to a Canadian population of 34 million, there were approximately 166,000 adults and 91,000 children with a CHD in 2010.[2] Congenital heart disease is not a pediatric disease anymore. Morbidity and mortality have shifted away from the youth to the adult. They are substantial, and we are facing a rapidly changing profile of resource-intense patients in the adult health care system.[3-6] Life-saving catheter-based interventions and surgical procedures repair the CHD and modify the pathophysiology, allowing most patients to live beyond the age of 18, but their heart conditions are not cured; their hearts are repaired. Late complications—including heart failure, arrhythmias, valve and conduit complications, infective endocarditis, and premature death—are inevitable. Cardiovascular deaths are common,[7,8] and heart failure is the most common cause of CHD death in the contemporary era, particularly in adults post-repair of CHD of moderate and great complexity.[9,10] Not surprisingly, noncardiac-related deaths (eg, malignancy) are becoming more frequent in the aging CHD population, particularly in those with simple CHD.[10]

Risk stratification and prognostication of life expectancy are important for the individual patient. Adult survivors of CHD are young, plan to have families, and the survival prospect affects not only the patients but their families and professional careers. The Bethesda Disease Classification and New York Heart Association (NYHA) Class are used to estimate mortality risk and, not surprisingly, previous studies documented higher mortality risks in patients with more complex CHD and in those with higher functional class.[5,11-13] However, disease classification systems are either based on anatomical complexity of the original congenital heart defect, without taking into consideration the evolution of functional and hemodynamic changes after repair, or are based on the functional status only.[14,15] Clinicians are struggling to prognosticate survival prospects of their individual patients because of the diversity of CHD, variety and modification of the surgical procedure for the same congenital heart defect during the last 60 years, and limitations of the classification systems based on disease complexity and/or functional indices. In addition, the classification systems have not been directly compared and validated against each other.

In a recent issue of *Canadian Journal of Cardiology*, Ombelet et al.[16] evaluated the predictive value of 5 different disease-severity and functional indices for 15-year all-cause and cardiac mortality and determined whether one classification is superior to another in identifying adults with CHD at higher risk for mortality. Between 2000 and 2002, 629 patients (median age = 24 years at the time of inclusion, 60% male patients) included in a previous cross-sectional study on quality of life and perceived health status and followed in the adult CHD outpatient clinic of the University Hospitals Leuven, Belgium, were classified according to the 5 different scales for disease complexity or functional status at study inclusion:[17] Task Force 1 of the 32nd Bethesda disease severity Index,[14] NYHA functional class,[15] Ability Index,[18] Disease Severity Index,[19] and Congenital Heart Disease Functional Index (CHDFI).[17] Representation of patients with simple (26%), moderate (58%), and complex CHD (16%), as defined by the Bethesda disease complexity classification, reflects the population followed at tertiary and quaternary care centres. During a follow-up of 15 years (82% of the patients reached the maximum duration of 15 years), 40 patients (6.4%) of this patient cohort died (81% of a cardiac cause), which represents a mortality rate of 4.56 per 1000 person-years. As anticipated, and already previously reported, patients classified in a higher complexity category of CHD and those with worse functional indices had lower probability

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of survival. The proportion of deceased patients increased with more severe categories for all 5 classification systems. There were significant differences in the Kaplan-Meier survival curves for all-cause mortality and cardiac mortality across the categories of studied classification systems, with the exception of the Disease Severity Index, regarding cardiac mortality. The Harrell's C-index to discriminate performance of each classification system identified the CHDFI as having the highest C-index for all-cause mortality (0.74; $P < 0.001$) and cardiac mortality (0.76, $P < 0.01$); that is, the CHDFI has the highest discrimination ability to predict 15-year all-cause mortality and cardiac mortality. After comparison of the C-indices of the different classification systems, the C-index of the CHDFI was significantly higher than the C-index of the Disease Severity Index for all-cause and cardiac mortality; the difference with the other C-indices did not reach statistical significance.[16]

What Do We Learn?

This study is the first to document the superior prediction of all-cause mortality and cardiac mortality when anatomic and physiologic variables are integrated. CHDs comprise a very wide anatomic and pathophysiological spectrum, which is further modified by catheter-based and surgical interventions during a lifetime, from the neonate to the adult. Hence, consideration of either anatomic or functional indices alone can never fully reflect the patient's condition, which is not static but changes and evolves over time. A simple congenital heart defect by anatomy is not always simple. The native anatomy, interventions, pathophysiology (sequelae and residua) affect and determine the outcome. The writing committee of the recently published American College of Cardiology/American Heart Association (ACC/AHA) guidelines on the management of CHD developed an ACHD Anatomic and Physiologic classification system to categorize CHD severity in a more comprehensive way.[20] This Ombelet study underscores the importance of integrating anatomic and physiologic variables to predict outcome.[16]

Unrealistic Life Expectations: Implications of Living With Chronic Disease

Adults with CHD often have a misperception of their longevity and report unrealistic expectations regarding their life expectancy. Even patients with moderate or complex CHD believe that their survival prospects are similar to those of their healthy peers. In one study, it was reported that patients expected to live to age 75 ± 11 years, only 4 years fewer than their peers, and they showed poor awareness and understanding of CHD-specific risks.[21] Patients have important knowledge gaps about their conditions, and education and discussion of sensitive topics, including mortality risk, are critical to bridge these gaps.[22,23] It is important for young adults to understand the broader implications of living with CHD and to develop strategies to coexist with their lifelong disease to make informed and independent decisions for their future, such as career and family planning.[24] There are patient barriers to receiving and accepting mortality risk and shortened life expectancy information; patients may not be emotionally ready for this sensitive discussion or may focus on enjoying life rather than speaking about dying and facing the threat of death, or patients with complex CHD may use denial to better adapt to their chronic conditions.[25,26] In addition, patients with neurodevelopmental and neurocognitive deficits and disorders may not be able to understand the implications of their CHD with shortened survival prospects; their parents or substitute decision makers may then need to be partners for this discussion. An honest discussion about life expectancy is fundamental for a trustworthy patient-physician relationship, and individualized risk stratification is essential for the provision of patient-centred care and development of self-management strategies. However, care providers have to respect patient preferences regarding such overwhelming information as mortality and life expectancy to avoid a stressful reaction with negative impact on the quality of life. It requires great sensitivity to perceive patients' desires and readiness for very sensitive information to guide their futures to provide it fully, as appropriate. The diversity of our society, with its different ethnic backgrounds and religious and cultural beliefs, makes the discussion about life expectancy even more complex.

Should We Communicate the Facts of Real Survival Prospects?

Only educated patients have realistic expectations about their future health and life-threatening complications and can make rational long-term decisions; develop strategies to live with a chronic, potentially life-threatening disease; and express their wishes about advance care planning (ACP).[27] However, there is the physician misperception that only patients with CHD of moderate or great complexity may be ready to speak about life expectancy and ACP.[25,28] Even patients with simple CHD may want to discuss life expectancy and ACP, in obvious contrast to physicians' perceptions.[25,28,29] Hence, sensitive discussion about life expectancy and ACP should be encouraged in all patients and should not be reserved for patients with complex CHD or (even more so) delayed until they face life-threatening complications, or avoided in more anxious patients.[29,30] Although many adults are ready for early discussion of ACP, care providers are struggling to initiate this important conversation; difficult prognostication is 1 reason, among others, for this delay.[25] Excellent documents are available to guide discussions about long-term health, including ACP in adolescents and young adults with CHD during the transition period.[27,31]

How Should We Communicate the Facts of Survival Prospects?

Validation of different disease classification systems helps us to predict 15-year all-cause and cardiac mortality.[16] Table 1 summarizes the estimated 15-year mortality risks of 5 individual patients and highlights the large variations among the different disease-classification systems for the same patients. No classification system is perfect, and each has its limitations. Although the estimated mortality risk applies for a patient group, the predicted risk helps an individual patient to estimate the mortality risk at any point in the course of the chronic disease. Integration of anatomic and physiologic variables certainly better predict outcome, and a classification

Table 1. Estimated risk of all-cause mortality for 5 individual patients at 15 years [5,16]

Patient characteristics	Task Force 1 of the 32nd Bethesda conference of the American College of Cardiology[14]	Disease severity index (DSI)[19]	NYHA functional class[15]	Ability index (ABI)[18]	Congenital Heart Disease Functional Index (CHDFI)[17]	"Equivalent age" and loss of life-years[5]
25-year-old woman: Ebstein anomaly, moderate tricuspid regurgitation	Moderate 5%	Low 6%	Class I 4%	Grade 2 9%	Class 3 8%	Age 43: loss of 18 years
35-year-old woman: transposition of the great arteries, intact ventricular septum, s/p balloon atrial septostomy, s/p atrial switch operation	Complex 18%	Moderate 7%	Class I 4%	Grade 2 9%	Class 3 8%	Age 55: loss of 20 years
46 -year-old woman: tetralogy of Fallot, s/p pulmonary valve-sparing intracardiac repair	Moderate 5%	Low 6%	Class I 4%	Grade 1 4%	Class 3 8%	Age 54: loss of 9 years
25-year-old man: PA, VSD, transposed great arteries. s/p previous right BTT anastomosis. s/p bidirectional Glenn anastomosis, bilateral PA plasty. s/p extracardiac Fontan connection with fenestration. s/p device closure of the Fontan fenestration	Complex 18%	High 23%	Class I 4%	Grade 2 9%	Class 4 36%	Age 65: loss of 40 years
26-year-old man: aortic atresia and VSD. s/p Yasui operation. s/p branch PA balloon dilatation. s/p right PA reconstruction, aortic arch reconstruction using an aortic homograft patch, 25-mm Dacron valve RV-PA conduit replacement. s/p PPM/ICD implantation	Complex 18%	Moderate 7%	Class III-IV 44%	Grade 3 51%	Class 5 40%	Age 59: loss of 33 years

Table 1 lists 5 patients with different disease complexity, classified according to the 5 anatomic and functional indices to illustrate the differences in the estimated risk of all-cause mortality at 15 years for each classification system. The last column lists the equivalent age for an age-matched individual in the UK population with the same 5-year mortality as the described patient and the estimated life year loss as described by Diller et al.[5] Note: There are some important differences in mortality risks for an individual patient between different classification systems.

ASD, secundum atrial septal defect; BTT anastomosis, Blalock Taussig Thomas anastomosis; ICD, implantable cardioverter-defibrillator; PA, pulmonary atresia; PPM, permanent pacemaker; VSD, ventricular septal defect.

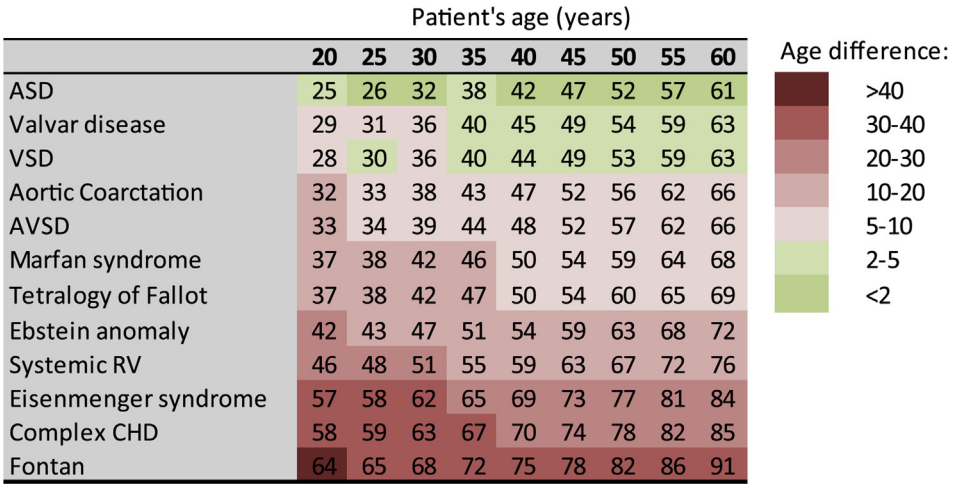

Figure 1. Mortality in subgroups of patients compared with mortality in age-matched UK population. **Numbers** on the colored surface present the equivalent age-expressed as the age of subgroup of UK population, having similar 5-year mortality rates. **Colors** reflect the difference between the relative age and the actual age of patients. ASD, atrial septal defect; AVSD, atrioventricular septal defect; CHD, congenital heart disease; RV, right ventricle; VSD, ventricular septal defect. Reproduced from Diller et al.[5] with permission from Wolters Kluwer Health.

system that combines anatomic and physiological information to categorize CHD severity should be used for prognostification.[16,20]

Traditionally, care providers use mortality percentages over defined time periods to discuss mortality risk. Diller et al. took a novel approach to illustrate survival prospects to patients and health care providers; they introduced the concept of equivalent ages and compared 5-year mortality risk with that predicted for an age-matched cohort of UK residents.[5] This approach identifies an equivalent age of an individual in the UK population with the most similar 5-year mortality risk (Fig. 1). A 25-year-old Fontan patient has a comparable 5-year risk of death to a 65-year-old person in the general UK population, with an anticipated loss of 30 to 40 years (Table 1).[5] Whereas the equivalent ages of patients with simple CHD are comparable with those of the general UK population, patients with CHD of moderate or great complexity have significantly older equivalent ages and lose many years or even decades of life.[5] This concept of an "equivalent age" is much simpler and more meaningful for patients than a percentage mortality risk figure. We frequently use this concept of equivalent ages for patients with CHD in Toronto to discuss mortality risk in an individual patient. This concept of equivalent ages, with visible illustration of loss of years, is not only a wake-up call for the patient but also for the treating physicians.

Strengths and Weaknesses of the Ombelet Study

This is the first study evaluating the predictive value of 5 disease-severity classification systems to predict 15-year mortality.[16] Accordingly, it provides extremely valuable information on their performance in a highly relevant, sizable CHD-patient sample. The evaluated cohort is probably also comparable with CHD populations followed in the tertiary and quaternary care centres of most Western countries. However, patients with neurodevelopmental and neurocognitive deficits and disorders were excluded (for methodological reasons); hence, the study does not represent the entire spectrum of CHD. In addition, the classification systems were only evaluated respective to their ability to predict mortality, but the classification systems did not distinguish between end-stage vs preventable cardiac causes of death. Comorbidities and modifiable cardiovascular risk factors—such as obesity and tobacco abuse—which present important cardiovascular risks, were not integrated into the risk model. The study might have been underpowered to find statistical differences among the 5 different systems because of the very low numbers of deaths in some classes of certain indices. Finally, only 1 experienced adult congenital heart disease cardiologist classified the patients, which does not allow for any estimate of inter-rater biases. Hence, CHDFI has yet to prove similar reliability when used by different health care professionals, with and without expertise in CHD. Every risk score describes the risk in a population and will have inherent limitations in providing a precise prediction about the course of disease for an individual person, particularly in the wide spectrum of CHD. In addition, there are many disease-specific and non—disease-specific confounders during a lifetime, which make prediction even more challenging.

Future Perspectives

The combination of physiological and anatomic indices is more robust to predict outcome than either alone.[16] Future research has to prospectively compare the CHDFI and the more comprehensive anatomic and physiological classification system proposed in the recently published ACC/AHA guidelines, which adds physiological variables to the previous anatomic classification system.[20] Practicability during our daily clinical practice and accuracy of this new classification system, in terms of individual risk assessment, will need to be evaluated. Additional carefully conducted comparative analyses, of the type performed by Ombelet et al,[16] as well as follow-up studies of their

practical application, are badly needed to advance this important area.

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Disclosures

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