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Short Communication

A guide to interpreting estimated median age of survival in cystic fibrosis patient registry reports

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Abstract

Survival statistics, estimated using data collected by national cystic fibrosis (CF) patient registries, are used to inform the CF community and monitor survival of CF populations. Annual registry reports typically give the median age of survival, though different registries use different estimation approaches and terminology, which has created confusion for the community. In this article we explain how median age of survival is estimated, what its interpretation is, and what assumptions and limitations are involved. Information on survival from birth is less useful for individuals who have already reached a certain age and we propose use of conditional survivor curves to address this. We provide recommendations for CF registries with the aim of facilitating clear and consistent reporting of survival statistics. Our recommendations are illustrated using data from the UK Cystic Fibrosis Registry.

Keywords: Annual report; Birth cohort; Conditional survival; Median survival; Patient registry; Period estimates; UK Cystic Fibrosis Registry

1. Rationale

Survival statistics, estimated using data collected by national cystic fibrosis (CF) patient registries, are used inform the CF community and monitor survival of CF populations. Annual registry reports typically give the median age of survival, though different registries use different estimation approaches and terminology. Recently there have been efforts to standardize methodology and reporting [1,2]. Nonetheless, there remain disparities in how survival is explained [3–5] (Supplementary Table 1), creating confusion for the community. Our aim is to provide clear descriptions of survival statistics and recommendations for reporting.

2. Median age of survival

Here we explain how median age of survival estimates are obtained, their interpretation, and the assumptions involved.

2.1. Survivor curves

A survivor curve shows the probability of living beyond a specific age for a range of ages. The median survival age is the age at which the survival probability is 0.5. Survivor curves are estimated from a mathematical formula that uses the proportion of individuals alive at each age who die before their next birthday (the 'age-specific mortality rate'), or an extension of this which uses a finer time scale [6] (Supplementary materials S1–S3). In addition to using information on deaths, the calculations importantly also use the ages of people still alive.

A survivor curve refers to the probabilities of living beyond specific ages from birth. To know the survivor curves for babies born today we would need to look into the future; instead, we must use information available now. There are two main ways of estimating curves: 1) the 'period approach' (a cross-sectional method) and 2) the 'birth cohort approach' (a longitudinal method). As illustrated in Fig. 1, these use

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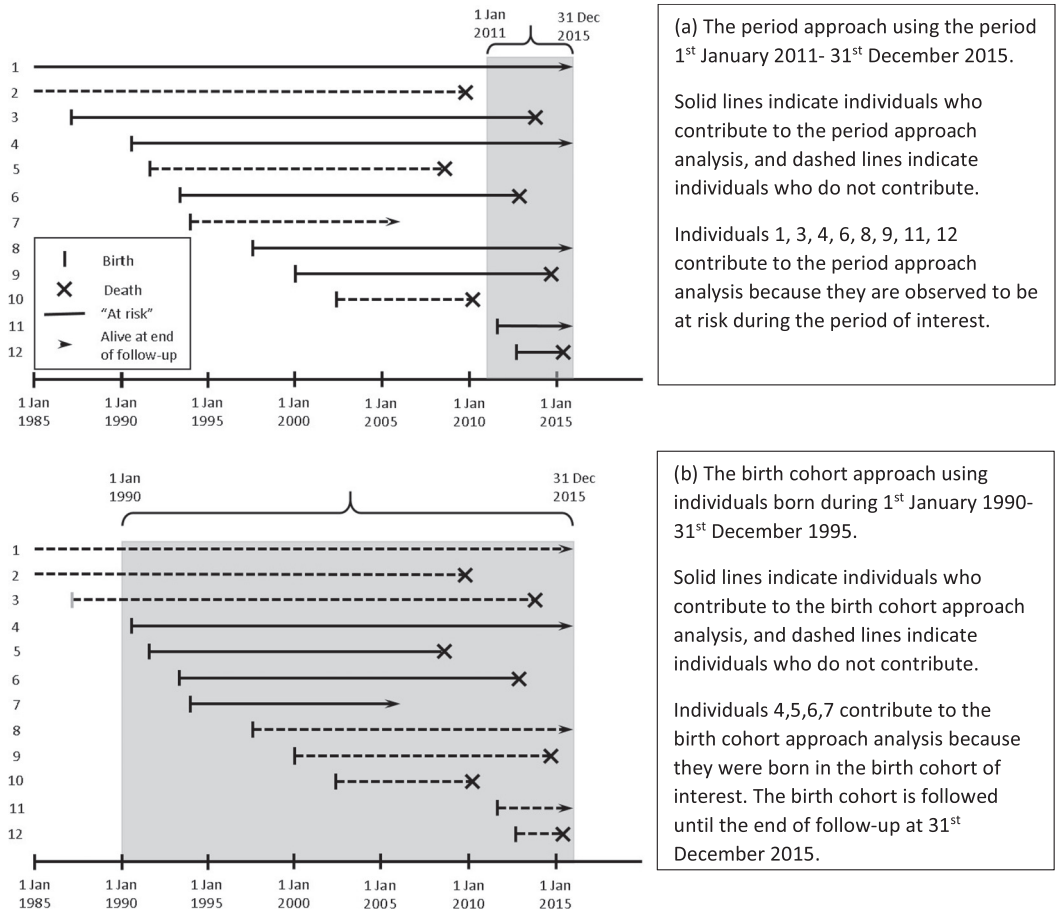

Fig. 1. Illustrations contrasting the period approach and the birth cohort approach. Lines represent 12 individuals followed-up during 1st January 1985–31st December 2015. Individuals 1 and 2 were born prior to 1985 and individuals 1, 4, 8 and 11 were known to be alive at the end of follow-up. Individual 7 was lost-to-follow-up. Individuals 2 and 10 do not contribute to either analysis.

different sets of individuals in the analysis, and are used to answer different questions. The period approach provides the most relevant information about predicted survival for babies being born with CF today, while the birth cohort approach is appropriate for comparing trends in survival in successive birth cohorts.

2.2. The period approach

This approach [7,8], most often used by CF Registries, estimates a survivor curve using mortality rates at each age for people observed in the registry in a recent time period – usually the most recent 5-year period (e.g. 1st January 2011–31st December 2015). The mortality rate at each age is estimated by the number of people alive at that age during the 5-year period who died before their next birthday, divided by the total number of people alive at that age during the 5-year period. Most individuals advance through several ages during this period and hence contribute to the estimated mortality rate at several ages. Individuals do not contribute to estimated mortality rates for their ages before the 5-year period. The 5-year period is used to balance using data on a sufficient number of deaths for reliable estimates of age-specific mortality rates, and obtaining estimates that reflect current standards of care. The resulting estimated median survival age has the following interpretation:

> *The estimated median survival age is the age beyond which we expect 50% of babies with CF born today to live, under the assumption that recent age-specific mortality rates will hold for the rest of their lives.*

Although period estimates of the survivor curve are obtained using people born at different times, we emphasize that the resulting survival statistics refer to a hypothetical cohort of babies born in the present day with CF and subject for the rest of their lives to current (2011–2015) age-specific mortality rates. The resulting estimates are based on an assumption that current mortality rates will apply in the future. This may be reasonable at younger ages, but less reasonable at older ages. For example, it assumes that the current mortality rate at age 30 will still apply 30 years from now, when babies born today would reach age 30. The estimates therefore do not account for potential impacts of future improvements in treatment.

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