

Fraction of normal remaining life span: a new method for expressing survival in cancer

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Conventionally, the time between diagnosis and date of last follow up or death is used to plot survival curves for patients with cancer. This ignores the patient's expected life span had the patient been healthy at the time of diagnosis. In human terms the impact of a projected prognosis of 10 year survival on a woman diagnosed as having breast cancer, for example, may be different depending on whether she is aged 30 or 70. Furthermore, oncologists have no answer to the question: "What is my chance of cure?" For this reason, we believe that survival is better expressed as a fraction of normal remaining life span expected at the time of diagnosis. We propose a new method which takes account of age at diagnosis in calculating survival.

The new method

To illustrate this concept we used a database of 1134 patients with breast cancer from Bombay who were operated on at Tata Memorial Hospital between 1974 and 1988. The patients were divided into three groups on the basis of the number of involved axillary lymph nodes (0, 1-4, and >4). The survival curves were plotted in two different ways: by the conventional method (fig 1) and by a new way that we call the real life expectancy method (fig 2). The difference in the two methods is not in the statistical handling of data but in the way period of survival is expressed. Both curves were plotted with the computer program SUREAL by the actuarial method.¹

To plot real life expectancy curves we used data from the Life Insurance Corporation of India to estimate the normal life expectancy of each patient at the age of diagnosis had she not had breast cancer (Life Insurance Corporation of India, personal communication). At the time of survival analysis each patient's age at diagnosis was subtracted from her normal life expectancy at that age to obtain what we call normal remaining life (NRL). The time from diagnosis to the date of last follow up or death was then calculated and divided by the normal remaining life to obtain the percentage of normal remaining life that had been lived by the patient. For example, in India, a healthy woman of 40 woman has a normal life expectancy of 72 years and a normal remaining life (NRL) of 32 years (72-40). If at 40 she were diagnosed as having breast cancer and she lived for 10 years her survival is expressed as 31% of her normal remaining life (10/32 × 100). On the other hand, a patient who is

Summary points

Conventional survival curves for cancer use the time between diagnosis and last follow up or death to denote survival time

This ignores a person's normally expected life span at the age of diagnosis and estimates survival in terms of a fixed number of years

Our new method proposes that each patient's age at diagnosis is subtracted from the average life expectancy for that age to obtain the patient's normal remaining life (NRL)

At analysis the percentage of normal remaining life that has been lived by the patient is calculated and used in place of survival time to plot actuarial survival curves

An estimate of survival time, which will vary with age at diagnosis, can then be calculated for each individual patient

Survival expressed as a probability of living a fraction of normal life span gives a better idea than conventional methods of the impact of a disease such as cancer on an individual patient's life

Oncologists can now answer the unanswerable: "What is the chance of my 'cure'?"

diagnosed as having breast cancer at 60 would have a normal life expectancy of 75 years and normal remaining life (NRL) of 15 years (75-60). If she lives for 10 years after diagnosis her survival is expressed as 67% (10/15 × 100) of her normal remaining life. To plot the real life expectancy curves we used these percentage figures instead of actual number of years. The mathematical procedure and statistical considerations are exactly the same as that used for plotting conventional actuarial survival curves. The difference is that survival time, instead of being expressed as years from diagnosis, is expressed as percentage of the remaining life which the woman would have lived had she been healthy. Thus, to plot real life expectancy curves we convert the years from diagnosis to percent-

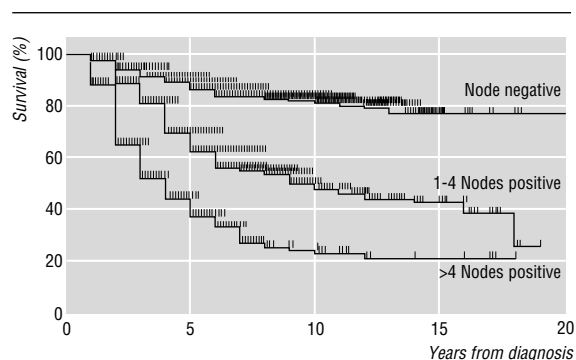


Fig 1 Conventional actuarial survival curves, with x axis indicating number of years from diagnosis and y axis indicating cumulative percentage surviving

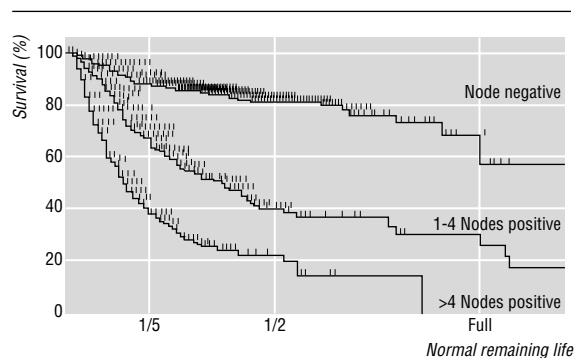


Fig 2 Real life expectancy curves, with x axis indicating fraction of normal remaining life and y axis indicating cumulative percentage surviving

age of normal remaining life, and to use these curves to calculate survival for an individual patient we convert the percentage figure back into number of years, calculated according to each patient's normal life expectancy (see below). The percentage figures may be used to compare different groups of patients.

Comparison between conventional and real life expectancy method

According to the conventional survival curves given in figure 1, the 5 year survival of node negative, 1-4 node positive, >4 node positive patients is 88%, 66%, and 40% respectively. According to the real life expectancy curves given in figure 2, one fifth normal remaining life survival of these three groups of patients is 89%, 65%, and 38% respectively. Just as survival estimates for any number of years can be read off from the conventional curves survival estimates for any fraction of normal remaining life can be read off from real life expectancy curves. Instead of the conventional 5 year or 10 year survival we say survival for a fifth or half of normal remaining life (1/5 NRL or 1/2 NRL), or even for full normal remaining life (cure). As normal remaining life changes with age, an individual patient's survival estimate (in years from diagnosis) will also change with age.

On the basis of conventional life table curves shown in figure 1, a node negative woman has an 82% chance of living for 10 years. With the real life expectancy curves (fig 2) she has a 81% chance of living half of her normal remaining life. As the normal life

expectancy of a 40 year old Indian woman is 72 years and that of a 60 year old woman 75 years, this would work out to a 81% chance of living for 16 years $((72 - 40)/2)$ for a woman of 40 and an 81% chance of living for 7.5 years $((75 - 60)/2)$ for a woman of 60. With these new curves, we could even say that a node negative woman has a 68% chance of living her full normal remaining life, which is 32 years $(72 - 40)$ for a 40 year old woman and 15 years $(75 - 60)$ for a 60 year old woman. A similar difference in the estimates by the conventional and real life expectancy curves is seen for the two other lymph node groups (table 1).

Fundamental change in perspective

Living all of normal remaining life is equivalent to cure. It could be said that node negative women have a 68% chance of being cured of breast cancer. The importance of the facility to express survival in terms of cure, especially for a disease such as cancer, is profound. This might help to resolve the controversy about whether some chronic diseases such as breast cancer are ever cured.²

Once adulthood is attained life expectancy does not change greatly with age. For example, for an Indian population it is 71 years for those aged 15-30, 72 years for those aged 31-45, 75 for those aged 57-60, and 80 for those aged 71-72, and so on. What does change with age, however, is the remaining life expected to be lived (normal remaining life) and, consequently, the percentage of remaining life actually lived by the patient. For a 40 year old woman normal remaining life is 32 years $(72 - 40)$, whereas for a 60 year old woman it is 15 years $(75 - 60)$. Since the average life expectancy changes little once adulthood is attained and since we express survival in terms of fractions of normal remaining life rather than in absolute number of years, a substantial interclass (social) or intercountry variation should not occur in our estimates of survival. Of course, the study population should be reasonably similar to the population whose normal life expectancy is used for the calculations.

Survival of patients with various diseases may be compared with that of the normal population by other methods.³⁻⁸ Unlike our method, these methods usually require cumbersome calculations. Typically, they compare two survival curves, one for the general and the other for the diseased population, and they may include 95% confidence limits.² This does not lend

Table 1 Comparison of survival estimates by conventional and real life expectancy methods

Conventional method		Real life expectancy method	
Node negative			
88% Survive 5 years		89% Survive a fifth of normal remaining life (6.4 years at age 40, 3 years at age 60)	
82% Survive 10 years		81% Survive half normal remaining life (16 years at 40, 7.5 years at 60)	
		68% Survive full normal remaining life (cure) (32 years at 40, 15 years at 60)	
1-4 Nodes positive			
66% Survive 5 years		65% Survive a fifth normal remaining life (6.4 years at 40, 3 years at 60)	
48% Survive 10 years		38% Survive half normal remaining life (16 years at 40, 7.5 years at 60)	
		28% Survive full normal remaining life (cure) (32 years at 40, 15 years at 60)	
>4 Nodes positive			
40% Survive 5 years		38% Survive a fifth normal remaining life (6.4 years at 40, 3 years at 60)	
22% Survive 10 years		20% Survive a half normal remaining life (16 years at 40, 7.5 years at 60)	
		None survive full normal remaining life (cure)	

itself to easy translation in terms of individual estimates of life span or cure rates, especially by someone with little statistical knowledge such as a clinician or patient. The advantage of our method is that the comparison between the normal population and patients with disease is integrated in a single curve that is similar to the conventional survival curves except for the label given in the x axis. Our method is not intended to replace the expression of survival as a yearly probability relative to the general population⁶ as this has a different purpose of elucidating the temporal biology of the disease.

There are two additional steps in our method. Firstly, the calculations use actuarial life tables for normal life expectancy. This can be easily integrated as a simple arithmetic formula in the database. Secondly, to translate the fraction of normal remaining life to actual number of years for an individual patient requires the use of life expectancy tables. This is facilitated by using a table such as table 1.

Our new method is not a new statistical procedure but introduces a subtle change in the perspective of the standard method. When survival is expressed in the manner we describe, the impact of a potentially lethal disease on an individual patient's life, especially when the disease is prevalent across a broad range of ages, is more meaningfully defined. We believe that it is kinder to a patient with breast cancer, for example, to estimate

her survival in terms of the whole life span rather than to limit it to five or 10 years. We believe that by individualising survival estimates according to age and expressing survival in terms of cure rates the new method that we have proposed makes survival estimates more meaningful, relevant, and human.

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Nomenclature

What is your name?

For a couple of decades obstetricians and midwives have been preaching that women having babies were usually normal; they and their offspring were only occasionally subject to pathological processes and most proceeded physiologically. Following this realisation came the problem of what to call the recipients of obstetric care. If they were not ill they were not patients yet they sought medical help to keep them on the straight and narrow of normal childbirth. The more direct minded professional attendants called them women. Confusion expanded when the social scientists christened the women clients, presumably a part of the psychobabble endeavouring to hint at control over the professionals helping them. Most women did not much like this name. Then the Department of Health stepped in and started calling them consumers. This governmentspeak was used in official documents which were so densely written that no one read them and so the name never really took on except in administrators' offices. Other names have been tried since then, ranging from simple users through parturants to the made up word maternants.

At last someone has taken the trouble to ask the women what they think. In Batra and Lilford's study the opinions of women attending the antenatal clinic were obtained qualitatively and semiquantitatively.¹ The women were shown four sentences each of which contained a blank space which could be completed with: client, consumer, maternant, mother-to-be, pregnant woman, or patient. They inserted the word they thought best described women in each situation and were then asked to fill in their strengths of preference on a one to ten linear scale for each of their four choices.

Mother to be had the highest mean mark (85%) in the information brochures for women having babies,

while pregnant women scored 82% if the context was in a medical journal; patient scored highest (61%) when the woman was referring to herself. Consumer and client scored respectively the lowest and next lowest marks, often being given a score of zero in each context.

Most people would agree that far too much of pregnancy and labour is traditionally described in a nomenclature based on the pathological; the more thoughtful use of simple words can remove much anxiety and annoyance. A good example is the substitution of the term miscarriage for abortion catalysed by Beard *et al.*² Abortion in the lay mind so often meant active termination of pregnancy, often illegal; the word miscarriage was a more rounded English word. Other terms commonly used might be taken to imply ineffectiveness of the woman such as the failure of labour to progress or an inadequate luteal phase of the menstrual cycle. In the highly charged psychology of reproduction such terms can irritate or even produce a stronger reaction. We owe it to women to pay attention to their ideas, they seem to prefer the softer terms and not those of the shopping mall or market place. In view of the study performed by Batra and Lilford perhaps we could drop consumers and clients as descriptive terms and use pregnant woman or mother to be as softer but equally effective and acceptable descriptive terms.

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Health in China

The one child family policy: the good, the bad, and the ugly

Therese Hesketh, Wei Xing Zhu

Summary

Rapid population growth in China during the 1950s and '60s led to the "late, long, few" policy of the 1970s and a dramatic reduction in the total fertility rate. However, population growth remained too high for the economic targets of Deng Xiao Ping's reforms, so the one child family policy was introduced in 1979 and has remained in force ever since. The strategy is different in urban and rural areas, and implementation varies from place to place depending on local conditions. The policy has been beneficial in terms of curbing population growth, aiding economic growth, and improving the health and welfare of women and children. On the negative side there are concerns about demographic and sex imbalance and the psychological effects for a generation of only children in the cities. The atrocities often associated with the policy, such as female infanticide, occur rarely now. China may relax the policy in the near future, probably allowing two children for everyone.

"Late, long, few"

Mao Ze Dong said there could never be too many Chinese: human resources would be China's greatest defence in the widely predicted third world war. So the population of China rose from 540 million in 1950 to over 850 million by 1970 (fig 1). This rapid increase led to the "late, long, few" policy in the mid-'70s. This policy called for later child bearing, longer spacing, and fewer children and was a largely conventional family planning programme.¹ As a result the average number of children born to each woman dropped from 5.93 in 1970 to 2.66 in 1979. But this was still too high; the baby boomers of the 1950s and '60s were entering their reproductive years, and by 1979 around two thirds of the population were under 30.

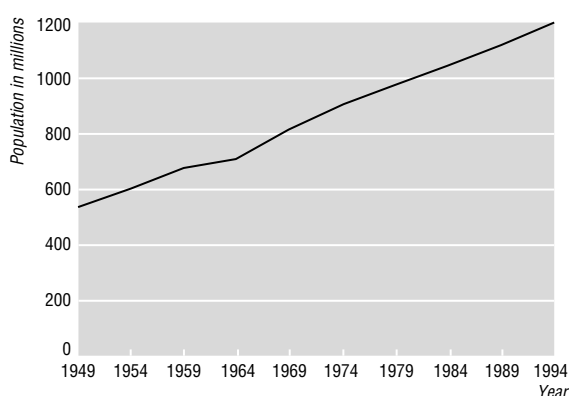


Fig 1 Population growth in China

One family, one child

Population projections worried Deng Xiao Ping, who was launching his economic reform programme. He regarded the curbing of population growth as essential for economic expansion and improved living standards, so the one child family policy was introduced in 1979. The boldness of the policy is all the more remarkable in view of the Chinese traditional love of children, the dependence of parents on their children in old age, and of course the thorny problem of the traditional preference for boys.

By 1984 the fertility rate was reported to have dropped to 1.94. The apparent demographic success of the policy together with its unpopularity, especially in the countryside, led to some relaxation. (It was later discovered that there was considerable underregistration of births in rural areas and the actual fertility rate was probably closer to 2.5.) Since 1984 there have been alternate relaxations and tightenings according to population projections, but the policy has never returned to the stringency of the early 1980s

How does it work?

The State Family Planning Bureau, which is separate from the Ministry of Public Health, sets overall targets and policy direction. Family planning committees at provincial and county level devise the strategy for implementation, specifying rewards for taking the One Child Pledge and the penalties for failure to comply.² In the cities (where around 25% of the population lives) the policy is strictly applied, with a few exemptions. In the cities in Zhejiang province, for example, a couple is exempt:

- If the first child has a defect (defects which are allowed are specifically defined)
- In the case of remarriage if one partner has no child by the previous marriage
- If they belong to certain groups of workers such as miners
- If both partners are themselves from one child families.

The final exemption, although not yet universally applied, is very important, since it implies that the policy will hold for one generation only.

In the cities young people marry late (the minimum age allowed by family planning policy for marriage is 23 for women and 25 for men). The favoured methods of contraception in the cities are the intrauterine device and the contraceptive pill, which is routinely distributed to married women in many work units. Women who become pregnant for a second time or outside marriage are expected to have an abortion.

What appears to us a draconian policy is accepted with equanimity by many urban Chinese. This is perhaps not so surprising considering the suffocating overcrowding of many Chinese cities, the cramped liv-

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ing conditions, the pressures of child care with two working parents (as is almost always the case), and the high cost of raising children. Compliance is encouraged through the Chinese propaganda machine with its range of slogans: "With two children you can afford a 14 inch TV, with one child you can afford a 21 inch TV"; "The One Child Family Policy can guarantee that children will be better cared for and educated."

In the countryside the picture is rather different. Here the one child family policy is a misnomer. The traditional preference for boys is acknowledged, so in most places a couple is allowed after a five year gap to try for a second child if the first is a girl. In some areas this is permitted irrespective of the sex of the first child. Third and fourth children are still not rare and are officially permitted for ethnic minorities and in underpopulated areas. The 1990 national population census showed that the proportion of third and higher parity births was 19.5%,³ and the total fertility rate was 2.31. This had fallen to 2.1 in 1992.⁴

In the countryside most women use the intrauterine device, which in most places is inserted routinely at the six week postpartum check. Sterilisation is more common in rural areas than in the cities, especially after second or third children. Women may be pressured into having abortions, but physical force seems to be a thing of the past. The penalties for an "illegal" pregnancy carried to term vary, often at the whim of local officials, from no penalty through loss of benefits for the first child, fines, job loss, and seizure of possessions. To avoid coercion and penalties many women now go and deliver elsewhere, where they cannot be tracked down by family planning authorities. The new mobility of the workforce, free to seek work in the cities, has made this much easier.

There are rewards for those who take the One Child Pledge. Urban couples receive a monthly stipend of around 5% of the average worker's wage until the child reaches the age of 14, preferential treatment when applying for housing, increased maternity leave, highest priority in education and health care for the child, and a supplementary pension because of the problem of lack of support in old age. In rural areas the family receives a larger allocation of farming plot.¹



The two child family is the norm in most of rural China

Consequences of "one family, one child"

The good

There is much good about the one child family policy. That China is controlling its population is clearly of benefit for the whole world as natural resources per capita diminish. There have even been calls for a one child world.⁵ China would certainly be heavily criticised if unrestrained population growth was allowed. It is also arguable that for people accustomed to little freedom in many areas of their lives, control over fertility is easier to accept. Impressive evidence is now emerging that couples, even in the rural areas, no longer see large families as an asset. Concerns about division of farmland among children are cited as one important reason.⁶ In 1985, the in depth fertility study, carried out in three rural areas of different socioeconomic level, found that the mean number of children preferred by young married couples was 1.8 in the wealthy Shanghai hinterland, 2.7 in middle income Hebei, and 2.87 in Shaanxi, one of the poorest provinces

And there are direct benefits to children and mothers. Children benefit from the increased resources devoted to them, and girl children benefit particularly, since families place all their investment in them, with no competition from sons. Mothers are freed from the burden of continuous pregnancy and its associated morbidity and mortality. Easy access to safe abortion means that illegal abortion is a rare cause of death.⁷ Mothers also have greater freedom to work outside the home and to acquire skills and training. In more advanced agricultural areas many women are choosing to have only one child because of the economic benefits for their families.¹

The bad

Lack of choice in an area as fundamental as reproduction can never be popular, and coercion cannot be condoned. With the evidence that more couples would opt for a smaller family, though, it is encouraging that the need for coercion at a local level is diminishing. But there are other problems too.

Firstly, the policy is resulting in an excess of boys. Data from the in depth fertility survey for 1979-84, when the policy was at its most stringent, put the male: female ratio of reported births at 115:100 in rural Hebei and 116:100 in Shaanxi. This compares with an expected ratio at birth of 106:100 in China.⁸ The reasons for the imbalance related to not reporting female births, female infanticide, sex selective abortion, and unreported adoption of baby girls.⁹ The relative contributions of each are unknown. The relaxation in the policy and strict legislation on infanticide and antenatal sex determination suggests that the ratios are less worrying now. The 1995 population survey reported average ratios of around 108:100 in rural areas and stated that now "about 51.03% of the population is male."¹⁰

A second concern is the issue of support of elderly people, traditionally a responsibility of children, especially in the countryside. (Around 60% of the urban workforce is entitled to a pension.) But the proportion of the population above 65 will rise from a modest 8% now to 18% by the year 2025, about the same as most Western countries today.¹¹

Finally, what of the psychological consequences for all these only children? Much publicity has been given to the "little emperor syndrome," supposedly suffered



Health education material for family planning on display at an advice centre on the street in Zhejiang province

only do individuals risk imprisonment, but health institutions allowing such practices are liable to heavy fines. Abandonment of baby girls and babies with defects persists, but this was common long before the one child policy.

The way forward

China has managed to win large scale acceptance of a relatively drastic birth limitation in less than a decade. However, with the new economic freedom it will not be possible to contain family size through communal pressure and economic disincentives. There needs to be a shift of values towards a "small family culture" reinforced by improved living standards, assured survival of children, and financial security in old age.¹² This is starting to happen in many areas. However, some regulation will be necessary for the time being.

The one child family policy was never intended to be a long term measure, and several options are being considered for the near future. In making a choice several factors must be considered: population size and aging, the family's ability to support elderly members, economic factors, the position of women, and cultural acceptability. One possibility, favoured by demographers, is that everyone should be allowed to have two children—but only two children, and with at least five years between them. It is predicted that this option would give a fertility rate of 1.72 in the years 2000-2025 and would be acceptable to most people.² A number of the alternatives would perform better than the current haphazard system. It will be fascinating to see what route the Chinese decide to take.

by those only children who are the pride and joy of adoring parents and grandparents. Reports about behavioural problems in the so called spoiled generation abound, although they often seem trivial when compared with the behavioural problems of Western children. But there is little hard evidence of causation and in such a rapidly changing society many factors are undoubtedly contributory.

The ugly

The ugliest aspects of the policy have received great attention: female infanticide, forced abortions, and selective abortion of female fetuses. There is no doubt that all of these have occurred, but they have now disappeared completely in many places. This is because people are accepting birth limitation more readily and because of the strict legislation covering these acts. Not

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A memorable case

A not so common case

During my clinical training at medical school one of the aphorisms most frequently quoted by teachers was "never forget, common things are commonest." This was sound advice, for a teaching hospital specialises in uncommon conditions.

Eventually, I became an assistant to a singlehanded rural general practitioner. Here, no doubt, must be where the common things occur. My principal gave me an excellent grounding into the intricacies of a dispensing practice and after some weeks considered me safe to make a solo visiting round.

Armed with a shiny leather bag and a list of three calls, carefully selected by my senior for their simple nature, I knocked at a terraced cottage and was shown directly into the dimly lit

living room. A little girl, about 5 years old, lay on a sofa. I inquired as to the problem. "It's her leg, doctor," exclaimed the mother, who proceeded to pump her child's right leg up and down, causing obvious pain. I examined the leg. Above the knee there was an obvious swelling, hot, red, and tender. In partial disbelief I gave a large dose of intramuscular penicillin and hurried back to inform my colleague. He confirmed the diagnosis and the child made an excellent recovery in hospital.

This was the first and last case of osteomyelitis of the femur that I saw in more than 30 years in general practice.

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