Age and severity

In Norwegian health services there is a broad consensus that serious health conditions must be given higher priority than less severe conditions. At the same time, giving emphasis to age when setting priorities is highly controversial. As I see it, it is impossible in practice to emphasise «severity» without imposing «age discrimination», and we must choose between giving relative priority to the young and giving relative priority to the old.

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The Norheim Commission has proposed replacing the current «severity criterion» with a new «health loss» (1), or burden of disease criterion. The proposal has generated debate and has been criticised for representing an age criterion that discriminates against the elderly. In an article in *Aftenposten* 16 June 2015, Bent Høie, Minister of Health and Care Services, stated that the health loss criterion is overly «theoretical and difficult». The article was provocatively entitled *Age will not be the deciding factor for treatment* (2). Personally, I feel that this debate underlines the need for a clarification of the terminology concerning what makes a condition «severe». This should include a review of how alternative severity definitions are affected by age.

What makes a disease severe?

Severity was proposed as a priority setting criterion by the Lønning II Commission, along with the criteria benefit and cost efficiency. The commission claimed that the severity of a condition should be based on the loss of prognosis in the absence of treatment or other interventions, and be assessed in relation to a) the risk of death or loss of function, b) the degree of physical and mental loss of function and c) pain, physical or mental distress (3). Despite the rapid implementation of the principle in laws and regulations, e.g. the Regulation on Priority Setting, the definition has proven difficult to apply consistently in practice. First, it is vague regarding how past and future health should be assessed. While item (a) above obviously applies to future health, items (b) and (c) can apply backwards as well as forwards in time. Second, the degree of loss of prognosis has never been specified, e.g. in terms of how great the risk of loss of function needs to be before a condition is deemed severe.

Severity can be operationalised in seven different ways with the aid of a simple graph, with lifespan on the horizontal axis and health-related quality of life on the vertical axis (Figure 1). Jan Abel Olsen, Professor of health economics, has used a similar framework, but restricted his discussion to four different definitions (4). In the figure, the vertical axis represents health-related quality of life and the horizontal axis shows years of life. The red curve is a fictional example illustrating the health profile of a person who falls ill approximately in mid-life. The area under the curve (the integral) can be referred to as «good years of life», or quality adjusted life years. How severe, then, is this disease in this fictional example? The answer depends on whether the degree of poor health is assessed at the time of diagnosis, in the future (prognosis) or across the lifespan (5, 6).

Level of health at the time of diagnosis

(i) Severity = 1 – Hd (Reduction in the level of health at the time of diagnosis)

This definition is based on the patient's acute need for help by emphasising the degree of present poor health (1 – Hd). It can be justified in terms of the need for emergency help or the «rule-of-rescue» principle. This definition only addresses health-related quality of life, and is perhaps the most common way to refer to «severity» in the literature (4, 7–9). By assessing «severity» at the time of diagnosis, the time dimension is disregarded. This principle is thus the only way to assess severity completely independently of age. At the same time, this is the method's main weakness, since duration will obviously be relevant to the severity of a disease. Painful drilling into a tooth with no anaesthetic will hardly be considered «severe», because it is short-lived. However, enduring the same pain as a chronic condition would literally be insufferable.

Future health (prognosis)

(ii) Severity = Tu – Td (Life expectancy at the time of diagnosis)

The second definition assesses the degree of severity on the basis of remaining life expectancy in the absence of treatment (Tu – Td), and can also be justified in terms of the patient's acute need for help (rule-of-rescue). According to this definition, a short remaining life expectancy is deemed more serious than when the prognosis is longer. British health authorities emphasise such «end-of-life» assessments (10). Both of these first definitions have only one dimension of health and are therefore overly simplistic. For example, 1 – Hd ignores prognosis in relation to survival, while Tu – Td ignores acute need for pain relief.

(iii) Severity = A3 (Quality adjusted life expectancy at time of diagnosis)

A third possibility is to assess the prognosis as a combination of health-related quality of life and remaining life expectancy with no treatment (the area A3). This alternative is perhaps closest to the definition of severity proposed by the Lønning II Commission (3), and it is also recommended in the Directorate of Health's manual for economic evaluation (11). In the literature, «severity» is used to refer to definitions (i), (ii) and (iii) alike (8). In principle, one could argue that Tu – Td is independent of age (4). Often, however, the prognosis will be affected by the patient's age, for example with regard to most forms of cancer (12). At an advanced age, when the life expectancy of a healthy person (T*) is shorter than the expected prognosis of an average patient (T* – Td) < (Tu – Td), the correlation between age and severity is very high.

Two alternative definitions assess the severity of the disease on the basis of future health in a more sophisticated manner:
(iv) Severity = (T* – Tu) / (T* – Td) x 100 % (Relative future loss of years of life)

(v) Severity = B2/(A3+B2) x 100 % (Relative future loss of quality adjusted life years)

These two definitions are concerned with the realisation of the patient's health potential. This is calculated as the fraction of the

health loss with disease over the remaining health in the absence of disease at the time of diagnosis, based either on years of life (iv) or quality adjusted life years (v). According to this definition, severity is an expression of how much of his or her future health the patient loses as a result of the disease, i.e. the proportional shortfall of health (13). Dutch researchers have proposed proportional shortfall as a priority setting criterion (14).

According to this definition, previous health is seen as irrelevant, and proportional shortfall thus ignores the past disease burden of chronic sufferers, for example. In mathematical terms, proportional shortfall is a ratio, which has been criticised for concealing the magnitude of this health loss (15). A health loss of five days when life expectancy is ten days is deemed just as serious as a health loss of five years when life expectancy is ten years. In the Norwegian debate, it has been argued that proportional shortfall is an age-neutral definition for severity (16). This is incorrect. On the contrary, with this principle «severity» will increase with age, because the area B2 shrinks with age and because B2 is below the fraction bar in (v). While this is a relatively trivial mathematical observation, it has ethical implications that are problematic to many. Using a reference age of 80 years, as proposed by the Norheim Commission, proportional shortfall implies that the loss of a quality adjusted life year for a 78-year-old (e.g. prostate cancer) will be deemed 40 times more «severe» than the loss of a quality adjusted life year for a one-year-old (e.g. childhood cancer) (Table 1). To the extent that the health loss criterion represents «age discrimination», we can therefore say that proportional shortfall is «reverse age discrimination».

Instead of a fixed reference age, we can use remaining life expectancy at different age levels, i.e. based on life expectancy tables (17). This reduces the effects for relative priority at an advanced age, but does not change the fact that the method represents «reverse age discrimination» and that the relative priority increases exponentially with age (Table 2).

Health loss over the lifespan

(vi) Severity = T* – Tu (absolute loss of years of life)
(vii) Severity = B1 + B2 (absolute loss of quality adjusted life years)

These two definitions focus on the patient's absolute health loss or absolute shortfall over their lifespan, either in the form of lost years of life (T* – Tu) or in the form of good years of life (B1 + B2). The latter corresponds to the health loss criterion proposed by the Norheim Commission (1) and is based on Williams' «fair innings» argument (18). According to this definition «severity» is considered as the health loss endured over the entire lifespan, including the time both before and after diagnosis. All other things being equal, long-term illness, according to this definition, is regarded as more severe than short-term illness. In other words, it is health loss (or disease burden) over the lifespan that is relevant for assessing severity (B1 + B2), not age (Td) (19).

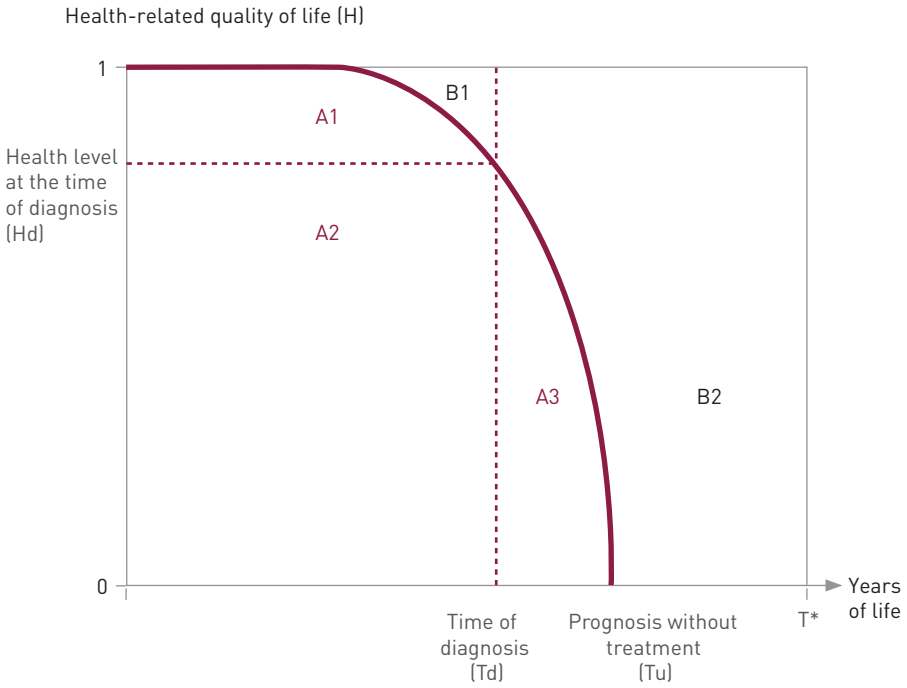

Figure 1 *The value 1 represents the best health imaginable, the value 0 the worst health imaginable (death), while T* is life expectancy without illness. The red curve illustrates the health profile of a person who falls ill approximately in mid-life. The diagnosis is made at the time Td, when the person's health level is at Hd. Without treatment, his or her health will gradually fail, and the person can be expected to live until the time Tu*

This principle has been criticised for being essentially an age criterion, leading to priority decreasing with increasing age (17). This is correct in the sense that a chronic illness which strikes at a young age, by definition lasts longer, resulting in a greater health loss and consequently higher priority than a similar illness developing later in life. The effect is indirect, however, and illness that significantly reduces the quality of life of elderly people may be assessed as more severe than illness that to a lesser extent reduces the quality of life of younger patients. It is also a fact that long-term illness in elderly people may amount to a greater absolute shortfall than shorter-term illness in younger patients. The argument about a direct correlation between severity and age (16) is thus erroneous.

The absolute shortfall criterion as a measure of severity is not entirely unproblematic. Indirectly, the principle takes into account the prognosis without treatment assessed as the product of life expectancy without treatment and the degree of poor health (area A3 in the figure, which changes just as much, although with the sign reversed, as B2 with treatment). However, the principle may be insensitive to highly acute conditions (1 – Hd) in which the duration (Tu – Td) is so short that A3 becomes very small (e.g. anaesthesia for surgery). Such counterintuitive priority setting consequences merit further investigation.

Age before beauty?

Hearings are being held on the Norheim Commission's recommendations, and the Norwegian Storting will later decide how severity should be operationalised and weighted in health priority setting. Olsen has proposed to split the concept of severity into four parts (4), including the alternatives (i), (ii), (iii) and (vii), while I, in this review, also include proportional shortfall in the form of years of life (iv), quality adjusted life years (v) and absolute loss of years of life over the lifespan (vi). These seven alternatives emphasise different aspects of this question, and they vary in how they are sensitive to the patient's age.

Table 1 The relationship between age and severity when the future health loss is one good year of life for all, and when proportional shortfall is used as the definition. The example shows that relative future health loss amounts to «reverse age discrimination» and that the relative priority given to elderly people increases exponentially

Patient (age)	Future good years of life without illness (A3+B2)	Future health loss (B2)	Severity = B2/(A3+B2) (%)	Relative priority
1 year	79	1	1.3	1.0
10 years	70	1	1.4	1.1
40 years	40	1	2.5	2.0
70 years	10	1	10	7.9
78 years	2	1	50	40

Table 2 The relationship between age and severity when future good years of life are based on a life table (17) instead of a fixed reference age

Patient (age)	Future good years of life without illness (A3+B2)	Future health loss (B2)	Severity = B2/(A3+B2) (%)	Relative priority
1 year	80.9	1	1.2	1.0
10 years	71.9	1	1.4	1.1
40 years	42.6	1	2.4	1.9
70 years	16.0	1	6.0	4.9
78 years	10.3	1	10	7.7

Alternatives (i) and (ii) are overly simplistic and both overlook factors that are clearly essential with regard to what makes a condition severe. In my opinion, the same can be said of alternatives (iv) and (vi), since they both disregard health-related quality of life. Thus, we are left with three alternatives that can be assessed more closely, i.e. alternatives (iii), (v) and (vii).

Severity defined as expected quality adjusted life years at the time of diagnosis (iii) is perhaps closest to the current definition formulated by the Lønning II Commission and described in the regulation on priority setting. Obviously, it is possible to specify more clearly how this definition should be applied in practice (9). The principle will nevertheless place great emphasis on the risk of imminent death, i.e. «end-of-life», and consequently, higher priority is placed on illness that strikes elderly compared to younger patients.

Proportional shortfall, alternative (v), will also result in high priority being given to elderly, rather than younger patients. Moreover, it is easy to show that this weighting in favour of the elderly may be exponential. Since both alternatives (iii) and (v) favour the elderly, both will serve to reinforce existing parities in lifetime health between groups of patients. This happens because giving priority to the strongest (in terms of achieved health over the lifespan) implies less priority to the weakest groups of patients.

The health loss criterion, or absolute shortfall (vii), gives relatively higher priority to patient groups with major health loss and long-term illness. Therefore this criterion appeals to those who think that the health services should contribute to reducing inequalities in life time health. The principle also has some empirical support, from the UK, (20), the Netherlands (21) and Norway (10). On its own, however, the principle may be insensitive to certain issues in emergency medicine. The Norheim Commission believes that this concern can be countered by the proposed «health benefit» criterion (1), although applied research should be undertaken to better elucidate whether the sum of such a pluralist perspective agrees with people's preferences and the value basis of the health services.

The relationship between severity and age is a sensitive question and arouses strong opinion. However, the debate on age discrimination has been imprecise, oversimplified and overall more confusing than constructive, as illustrated by the feature in *Aftenposten* on 16 June 2015 (2). Since it is ethically problematic to disregard the duration of illness when assessing severity, we have no appropriate, age-neutral alternatives for operationalising the concept. In my opinion, we have a choice between two alternatives that indirectly favour older people and one alternative that indirectly favours younger patients. The English expression «age before beauty» is generally used in a humorous way to give precedence to elderly people, for example when there are too few vacant seats on a bus. Is this what we want in the Norwegian health services? I scarcely think so.

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The author has completed the ICMJE form and declares the following conflict of interest: He is a colleague of Ole Frithjof Norheim, with whom he has co-authored a number of publications.

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