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HEALTH POLICY BRIEF

AGEING AND TECHNOLOGY

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Or. Eng.

FOREWORD

OECD countries are rapidly ageing. Together with falling birth and mortality rates, life expectancy across OECD countries has significantly increased over the past 30 years and today's new-born can expect to live 80 years. How do these expanding cohorts of elderly people spend their lives? Is the elderly population becoming any healthier?

Ageing, although a universal biological process, is not a uniform one. Many old people experience good health until time of death while others may suffer from prolonged disabling conditions. In general older people, particularly the very old, use more health care and are responsible for a large share of health and long-term care spending. Per capita expenditure for those aged 65 and over is, on average, two and a half to five times higher than for younger people, with even higher ratios for people age 75 and older.

An essential policy question is then, whether and how morbidity and functional limitations or disability can be postponed and restricted into a briefer final phase of the human life span.

Technology offers many possibilities of preventing disease and promoting health, improving mobility of elderly people, and supporting them in their own homes. Yet there is relatively little knowledge about intensity and appropriateness of use of technology specific to the elderly for both health and long-term care. Some technologies might not be effectively exploited and could contribute immediately to continued improvement of health. For example, treatments for arthritis, dementia or urinary incontinence may lead to much greater reduction in functional limitation than decreasing morbidity from any other conditions, and some new diagnostic technologies, derived from biotechnologies, could be applied, for example, as an aid to prevent or delay the onset of chronic conditions in the elderly.

In addition to this, attempts to quantify the connection between technology and rising health-care expenditure have suffered from the lack of reliable data. The majority of studies to date address technology as a "residual", attributing to technology the portion of increase in health spending not accounted for by more easily identifiable factors (e.g. rising incomes). Furthermore, data on health-care expenditures for the elderly does not include the assessment of, for example, the impact of policies such as the rationing of medical high technology, nor of other factors limiting the adoption and use of available high technology.

Thus, "Ageing and Technology" is largely an uncharted domain, but one which the OECD is seeking to address in the context of its work on health and new and emerging technologies, particularly biotechnologies, under the Committee for Scientific and Technological Policy (CSTP) and as a contribution to a multi-phase study to consolidate and analyse the policy implications of ageing populations.

This report is a first exploration of these issues. It provides a review of the available knowledge on the relationship between technology and the elderly. It also reviews the important research projects and centres dealing with the subject at the time of this report. Finally, it addresses the intensity and appropriateness of the use of technology in the elderly and suggests areas where further work is most needed.

This report was researched and drafted by Dr. David Banta in close consultation with Dr. Elettra Ronchi, co-ordinator of health and biotechnology activities in the Directorate for Science, Technology and Industry. It is published on the responsibility of the Secretary-General of the OECD.

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SUMMARY OF MAIN POINTS

The mortality rate of the elderly has fallen dramatically in recent decades, mainly because of reductions in mortality from cardiovascular disease. Technology has contributed greatly to these reductions. Further decreases can be expected and could even be stimulated.

An essential policy question is, what is the result of these declining rates? Is the elderly population any healthier? Or is there an increasing number of dependent, chronically ill, and disabled people which may cause increasing costs of health care? The answer to this question is not clear.

According to a popular argument raised in the early 80s[1], the human natural life span is of about 100 years, and falling mortality rates are bringing humans closer to that span – "rectangularization" of the survival curve. In other words, due to the compression of morbidity and mortality into the latest years of life, people will increasingly lead a longer and healthier life.

Indeed there is some evidence that morbidity among the elderly is falling but less rapidly than mortality. Consequently, healthy life expectancy has been extended, but total life expectancy has been extended even further, leaving a longer period of dependency.

Simulations[2] based on the US National Long Term Care Survey of 1982 and the 1985 National Nursing Home Survey seem to indicate that even in an optimistic scenario, the numbers of disabled elderly people will continue to rise rather rapidly.

These models may need to be revisited in light of the fact that disability rates[3] are steadily declining in the US elderly population. More importantly, this decline is accelerating. Such a trend may indicate an important change in the health status of the elderly for the years to come and should be re-examined in an OECD context.

Given these facts, an essential policy issue is "... *whether and how morbidity and functional limitations or disability can be postponed and restricted into a briefer final phase of the ... human life span"* (House *et al*., 1990).

This report argues that reimbursement mechanisms designed to encourage technologies and services that maintain functional independence and avoid hospitalisation are the most important policy change that could be made concerning the elderly.

Technology offers many possibilities of preventing disease and promoting health, improving mobility of elderly people, and supporting them in their own homes. Yet there is relatively little knowledge about intensity of use or appropriateness of use of technology specific to the elderly. Some technologies are not effectively exploited and could contribute immediately to continued improvement of health. For example, treatments for senile dementia, arthritis or migraine, may lead to much greater reduction in functional limitation than decreasing morbidity from other conditions. Furthermore, older persons who maintain or adopt a lifestyle with increased moderate physical activity gain numerous health benefits and also increase the range of activities that they can perform. This is an indication that targeted medical and social interventions can increase the independence of elderly people.

There are also some technologies that are overused in the elderly in such a way that the probability of harm is greater than the probability of benefit. For example, multiple pathology is so common in the elderly that it often leads to multiple prescribing or "poly-pharmacy", which may be particularly hazardous.

With increasing health-care costs, an issue often debated is whether technology should be used sparingly in the elderly. The ethical principle involved is that investments in younger people might be considered more cost effective. Although most countries deny explicit rationing on the basis of age, it is acknowledged that it is common as an informal practice.

However, hospital care for the elderly, although expensive, seems to be only a relatively small part of overall health-care costs for the elderly. Only withholding routine medical care from the elderly would be an effective mechanism for controlling costs. In fact, there is evidence that no substantial age differences exists in outcomes for many interventions, including survival after cardiopulmonary resuscitation (CPR), coronary artery bypass surgery, liver and kidney transplantation, other types of surgery, chemotherapy and renal dialysis.

In summary, and in the context of this report, the most important conclusion is that *it does not appear inevitable that longer life leads to higher costs*. The health system is largely oriented to preventing death; better attention needs to be paid to morbidity and disability, targeting the development of technology and services to the prevention of diseases that are incapacitating and to extend and maintain functional independence of the elderly.

Introduction

The issue of the ageing of the population in OECD countries has now become quite familiar (OECD, 1996*a*; OECD, 1996*b*). The essence of the issue is that more and more people are living to old age and the average age of the population is rising. The number of people 65 years and older in Europe is expected to rise from 57 million in 1995 to 81 million in 2025. In terms of health, this may mean an increasing number of dependent, chronically ill, and disabled people which may cause increasing costs of health care and put heavy strains on the health-care system, as well as related systems of care, such as social security.

Technology, defined broadly, both contributes to and offers some possible solutions for these problems. For the purposes of this report, technology is defined as the drugs (pharmaceuticals and vaccines), medical equipment, health-care procedures, supportive systems, and the administrative systems that can tie all these disparate elements together. Thus, technology includes, but is not limited to, physical technologies such as biotechnically-produced pharmaceuticals or medical equipment. Technology has a "software" component concerned with knowledge and skills as well as a "hardware" component.

Technology has certainly contributed greatly to keeping people alive and functional into old age (Gray, 1985). In addition, technology is used with increasing intensity, especially with chronically ill older people, and thus can add to costs. When technology is used inappropriately, it can increase costs and cause harm. Finally, technology offers possibilities of promoting a healthier elderly population, as well as the possibilities of supporting elderly people in their own home environments, both improving their quality of life and possibly reducing costs of care.

Changes in mortality are already well known. Changes in morbidity and possible ways to deal with these are not so familiar and will be emphasized in this report, along with possibilities for dealing with the ageing population without greatly increasing costs.

This report is an exploration of the issues involved in the relationships between technology and the elderly. This issue has received little attention up to the present. The report should be a contribution to other activities dealing with ageing in the OECD.

Section 1: The ageing population and technology

During the last half of the 20th century, there have been great gains in life expectancy (Suzman *et al.*, 1992). Earlier in the century and up until a decade or two ago, most of the gain was attributable to improvements in mortality of new-borns and infants. However, infant mortality has reached quite low levels in almost all OECD countries, and much of the current gain is attributable to improvements in mortality in the aged. The greatest gains have been in some of the most common causes of death, especially heart disease, which accounts for 25-50 per cent of deaths, and stroke, which accounts for 10-25 per cent of deaths (Brody *et al.*, 1992*).* Cancer is a greater contributor to death rates than stroke, but despite massive investments in cancer research, especially aimed at discovering new therapies, age-specific death rates from cancer have changed little during the last decades.

Although mortality has fallen dramatically, morbidity has not fallen to the same extent even though there are indications of decline in some chronic conditions (Manton *et al.*, 1995). If long life comes because sick persons are saved from death, the duration of time with illness may increase (Crimmins, 1996). In short, the "average" health of the population does not necessarily improve with longer life.

This chapter of the report will examine these issues in some detail.

Changes in mortality over time

All developed countries have seen falling mortality rates and increasing life expectancy among their populations, including the elderly. Between 1960 and 1990, life expectancy in western Europe, based on an average of experience of 18 countries, increased 6.3 years (OECD, 1993 p. 48). In Europe during the period 1960 to 1990, the life span of women aged 60 increased by 3.5 years and among men 1.7 years. Today, life expectancy at birth approaches 80 years of age and life expectancy of 80 year olds approaches 10 years in some countries (Manton and Vaupel, 1995).

Men have a higher mortality rate and a lower life expectancy than women in all OECD countries. The full reason for the mortality difference is not understood, although such causes as biological/genetic differences, alcoholism, psycho-social stresses, poor adaptation to working conditions, and early compulsory retirement have all been suspected. There is wide agreement that the cause is multi-factorial.

Since the late 1960s, there has been a dramatic decline in mortality among the very old aged. The result is a rapidly growing number of people in their eighties and nineties. The ageing of the population has also led to changes in mortality patterns. For example, in the Netherlands the conditions that have had the greatest increases in causes of mortality in the elderly are chronic obstructive pulmonary disease in men and senile dementia in women (Nusselder and Mackenbach, 1997).

Explanations for the fall in mortality

As mentioned earlier, the greatest contributor to decreased mortality and increased life expectancy has been the great decline in all cardiovascular diseases and in cardiovascular death rates in OECD countries during the last three decades or so (Stern, 1979; Nusselder and Mackenbach, 1997). The decline began in the United States around 1968 and has continued to the present (Goldman and Cook, 1984; Hunink *et al.*, 1997). During this period, incidence of coronary heart disease (CHD) has declined 1 per cent annually, while CHD mortality has declined 2-4 per cent per year. This decline has been seen in most of the world, beginning slightly later in Europe. Essentially all OECD countries showed declines in CHD mortality by the early 1970s (MONICA, 1987).

Changes in personal habits have made a great impact on the incidence of the disease. These changes include falling rates of smoking cigarettes, changing diet to reduce fat intake, with a resulting decreased serum cholesterol level, and falling blood pressure from treatment (Burke *et al.*, 1989). Investigators have not found decreases in obesity, however Burke *et al.* (1989) reported increasing body mass over time. The situation with regard to exercise is not clear, but there is no clear evidence that exercise is increasing. Gronback *et al.* (1995) have suggested that wine drinking may have contributed to the decline in Europe, since drinking wine results in a lower CHD mortality and in Europe, wine drinking rose from 17.5 per cent of alcoholic intake in 1975 to 32.2 per cent in 1992. Renaud and de Lorgeril (1992) have pointed to the "French paradox", referring to the low rate of CHD mortality in France despite a high intake of fats and serum lipid levels similar to those of the United Kingdom and the United States. They have suggested that the lower rate in France is due to drinking wine.

While early changes in mortality were not associated with public health efforts to convince people to change their behaviour, recent years have seen a great development in community education and prevention programmes aimed at this end. More recently, elevated blood fats are being actively treated, first by diet, and if diet fails, with drugs. This treatment has been shown to reduce mortality and morbidity in people with coronary artery disease (Johannesson *et al.*, 1997). Long-term intake of aspirin in those with vascular disease has also been shown to reduce the incidence of myocardial infarction (Yusuf

et al., 1988). For those who do get the disease, many advances have contributed to lowered mortality. These include drug treatment of those with suspected acute myocardial infarction with aspirin and/or fibrinolytic therapy (Collins *et al.*, 1997), coronary artery bypass grafts and balloon angioplasty for those with advanced disease, and coronary intensive care units for those with acute myocardial infarction.

Stroke death rates have also declined dramatically. The decline began in the United States in the 1940s, mainly due to an improved population risk profile (McGovern *et al.*, 1992). In the Netherlands, for example, there has been an annual decline in stroke mortality of 3-4 per cent (Niessen *et al.*, 1993). In this case, too, falling cholesterol levels, prevalence of smoking, and hypertension have all played a part (McGovern *et al.*, 1992). While this decline has also been from a number of causes, it is widely agreed that better treatment for hypertension since 1973 has made a great difference in the incidence and mortality of stroke (Stern, 1979). In recent years, the mortality and morbidity rates from stroke have been on a plateau, but further declines are considered possible (McGovern *et al.*, 1992).

On the other hand, as mentioned above, overall age-adjusted mortality from cancer has changed little. In the United States, overall age-adjusted mortality from all cancers has remained essentially unchanged since 1970, although there was a slight decrease during the period 1991 to 1994 (Bailar and Gornik, 1997). Some cancers do show a fall in mortality. These include colorectal cancer, stomach cancer, and cervical and uterine cancer. In none of these cases, though, has improved therapy had a discernible effect on mortality. The causes are either reduced incidence for largely unknown reasons or earlier detection and treatment, as seems clear in the case of cervical and uterine cancer. This is probably also the case with colorectal cancer.

Excess mortality

The concept of "excess mortality" refers to population mortality that occurs in excess of what might be expected. Expected mortality can be defined in several ways. OECD estimates that the fatal outcome of diseases for which an effective treatment is available declined by half in all OECD countries (OECD, 1993, p. 48).

Schaapveld *et al.* (1995) have carried out a useful review of variations in health between the 12 countries of the European Union. It is clear that it is difficult to make overall conclusions on outcomes of care. Data on outcomes are only generally available for mortality. Standardised mortality rates do not vary greatly in western Europe. Disease-specific mortality is interesting, but difficult to interpret. For example, cardiovascular mortality varies greatly from country to country, with a rate twice as high in Ireland as in France, but no clear pattern. The rate of cancer deaths varies greatly as well, with higher rates in northern Europe than in southern Europe.

An approach called "avoidable mortality" or "mortality amenable to medical intervention" (causes of death that could have been prevented with existing medical technology or changes in behaviour) has been used to analyse the experience of different countries in Europe. Holland (1988) has published a large set of cross-national comparisons, and the OECD now routinely publishes disease-specific years of life lost (OECD, 1993). Perhaps the best review of this subject was carried out by Mackenbach *et al.* (1989), who critically examined 11 aggregate data studies from the literature, mostly dealing with European countries in the period 1950 to 1984. The levels of mortality from "amenable causes" was generally low and death rates from the causes had declined rapidly. This was felt to reflect an increased effectiveness in health care services. Similar findings were reported by Charlton and Velez (1986) for six countries.

Hahn *et al.* (1990) defined excess mortality from nine conditions by examining the experience of different states of the United States. The nine conditions were coronary heart disease, stroke, chronic obstructive pulmonary disease, lung cancer, cervical cancer, breast cancer, colorectal cancer, cirrhosis, and diabetes. They examined nine risk factors and attempted to explain the incidence of deaths by the risk factors. Six of the nine are strongly associated with cigarette smoking, and obesity and no regular exercise are associated with three. Table 1 shows the associations between coronary heart disease and stroke and selected risk factors, estimating proportions of deaths attributable to risk factors.

McGinnis and Foege (1993) have carried out a similar analysis, showing that of the 2 000 000 or so deaths in the United States every year, tobacco accounts for about 400 000 of them, diet for 300 000, alcohol for 100 000, infectious diseases for 90 000, and toxins for 60 000 deaths. They also point to poverty and restricted access to care as important factors in mortality.

Table 1. **Proportions of deaths (%) from coronary artery disease and stroke attributable to selected risk factors**

Risk factor	Coronary heart disease	Stroke
Current/former smoker	25.1	25.1
Elevated cholesterol	42.7	
Hypertension	28.9	31.8
Obesity	32.1	45.9
No regular exercise	34.6	28.9
Diabetes	13.1	4.7

Note: Numbers add to more than 100% because of multiple factors in many people.

Source: Hahn *et al.*, 1990.

Models examining causes of the fall in coronary heart disease mortality

Two serious attempts to analyse the reasons for the fall in coronary heart disease mortality have been carried out; only one has involved the development of a formal model.

Goldman and Cook (1984) examined possible reasons for the decline in CHD mortality in the United States based on known changes in risk factors and proven effective interventions. They observed that diet had changed, leading to changes in serum lipids, and that cigarette smoking had decreased. They found that there had been no overall reduction in weight and the situation with exercise over time not entirely clear. Based on randomised clinical trials (RCTs) and other evidence of the effects of specific interventions, they assigned the following percentages of effect to specific technologies over a ten year period from the late 1960s to the late 1970s:

- Coronary intensive care unit - about 5 per cent decline in hospital mortality.
- Pre-hospital resuscitation and care - about 4 per cent decline in mortality.
- Coronary artery bypass grafting - 3-5 per cent of decline in mortality.
- Medical treatment (mainly drugs) - 10 per cent of decline in mortality.
- Treatment of high blood pressure - 7.5 per cent of decline in mortality.

Hunink *et al.* (1997) developed a formal model based on US data to explain the changes in CHD mortality. They found that 25 per cent of the decline was due to primary prevention (changes in behaviour) and 71 per cent was due to improvements in treatment. Overall, 29 per cent was due to risk factor reductions in the population with CHD, 50 per cent was due to risk factor reductions in the entire population, and 43 per cent was due to improvements in treatment of those with the disease (numbers do not add to 100 per cent because of multiple causes). They concluded that most of the decline in mortality was due to management of those with CHD, through risk factor reduction and improvements in treatment. Among risk factors, one third of the benefit was from changes in serum lipids, due to diet changes, medication, or both. The model also indicated that patients with CHD were living longer, leading to a more chronic form of the disease and thus to increased prevalence.

Mortality and socio-economic status

The lower socio-economic classes, and the elderly, have a higher mortality excess or preventable morbidity and functional limitations than the rest of the population (Hudson, 1993; Jefferys, 1996; Suzman *et al*., 1992; Taylor, 1992). While this difference is most publicised in the United States, the same situation exists in Europe (Mackenbach *et al*., 1997). Mortality is related to level of education and occupational class. Self-reported morbidity is also related to class differences. All countries have inequalities, and these are similar in size in different countries studied.

Lower socio-economic groups are disadvantaged in all risk factors, including health behaviour, risks at work, social and work stresses, and social relationships. Studies have shown that they have worse health, worse psychological functioning, and less confidence (Taylor, 1992). Yet socio-economic differences among the aged population are surprisingly neglected (House *et al*., 1990).

A number of possibilities for further reductions in mortality and morbidity are available and will be briefly reviewed later in this report. These strategies might be selectively applied to elderly people in the lower socio-economic classes. In addition, House *et al.* (1990) feel that a reduction of socio-economic differentials in health in middle and old age is an essential component of any effort to postpone morbidity and disability.

Health technology and outcomes

Perhaps one can approach the question of outcomes from the side of the interventions, that is, the "technology" of health care. Again, this raises serious problems. There is relatively little information on the value of health care for improving health outcomes. It has been estimated that only 15-20 per cent of medical interventions have been tested by clinical trials (Office of Technology Assessment, 1978; Black, 1992). There are a number of reasons for this lack of information, including the historical "newness" of evaluation, the relative lack of interest in scientific evaluation among clinicians and policy makers, and the lack of systematic reviews of available information. These problems are gradually being addressed, but the fragmented information presently available makes it difficult to reach conclusions.

Another problem is that technology is generally evaluated in terms of *efficacy*, or benefit under the ideal conditions of a study. It is often observed, however, that benefits in actual use fall short of this maximum conceivable benefit. The term *effectiveness* is used to denote the benefits achieved under actual conditions of routine clinical practice, as measured against the potential for accomplishment (Banta and Luce, 1993).

The difference between efficacy and effectiveness could be said to be due to errors of commission and errors of omission.

Although aspirin has been clearly shown in well-designed clinical trials to reduce mortality by about 20 per cent following an acute myocardial infarction (AMI), only about 50 per cent of the elderly in the United States are given this drug following an AMI. In Europe, more than one third of those with an AMI are not given aspirin (Collins *et al*., 1997).

On the other hand, there are also indications that a great deal of ineffective technology is in use in health care. Information is still fragmentary, but systematic reviews have demonstrated that commonly used interventions in different areas are either definitely ineffective or probably ineffective. For example, a comprehensive review of obstetrical practice has been carried out by a group of obstetric investigators, based on a database of randomised clinical trials developed by the National Perinatal Epidemiology Unit in Oxford, United Kingdom (Chalmers *et al*., 1989). The investigators have produced tables of more than 100 interventions that have been demonstrated to be useless or harmful or that are unlikely to be beneficial. The Cochrane Collaboration of individuals and groups is reviewing such evidence in many areas of health and medical care, including some in ageing. For example, the Collaboration presently supports review groups concerned with stroke, musculoskeletal diseases, and dementia (Dickinson *et al*., 1995).

Another type of evidence worth examining is variations in use. Twenty years of investigations have revealed remarkable variations in use of common interventions between small areas, regions of countries, and countries themselves. The variations cannot be completely explained. They are thought, however, to be partially attributable to the lack of information on effectiveness and the resulting controversy among clinicians. Table 2 shows rates of selected procedures in the Medicare population in the United States. Such differences have been found all over the world. Factors of 5-7 times between different areas of one country or between different countries are common. Variations in use have been attributed to such causes as lack of knowledge on appropriate use, or lack of access to such information; financial and organisational incentives; excessive faith in technology; professional factors, including opinions of colleagues; and a differing "culture" of medical practice in different sites.

The problem of variations in use has led to direct investigations of inappropriate use. Information was first developed by the RAND programme in the United States to demonstrate the extent of inappropriate use in the extent of overuse of efficacious technology. The programme uses systematic literature review of indications of use for a selected technology, followed by judgements of appropriateness of specific indications by expert panels based on the scientific information and their own experience, to arrive at standards of appropriateness of use by indication. It is then possible to review appropriateness of utilisation. A considerable amount of data from the United States has shown dramatic overuse of selected technologies. Table 3 shows some examples of this work, indicating clearly inappropriate use in up to 30 per cent of cases, with possibly inappropriate use making up as much as 50 per cent of utilisation and more. Some of the work has been replicated in the United Kingdom, which has shown similar patterns of overuse (see Table 4). In the Netherlands, too, results are similar, although rates of inappropriateness are lower. In Sweden, rates of inappropriateness seem to be low, less than 10 per cent for coronary bypass grafting (Bengtson *et al*., 1994).

Another problem that typifies modern health care is over-investment in expensive technology of limited benefit, with under-investment in other technologies that could be of great benefit. A partial list of technologies that may be under-provided is given in Table 5.

A limited conclusion can be stated: it is certainly possible for all health systems to do better.

Table 2. **Rates of use of selected procedures in 13 sites by Medicare beneficiaries 65 years old or older during 1981, per 10 000 beneficiaries**

	RATE OF USE		HIGHEST/LOWEST RATE RATIO
	High	Low	
Injection of haemorrhoids	17	0.7	26.0
Hip arthroplasty	18	2	11.4
Destruction of benign skin lesions	750	94	8.0
Arthrocentesis	1100	120	8.8
Skin biopsy	190	41	4.8
Humeral fracture repair	21	3	7.9
Total knee replacement	20	3	6.0
Lumbar sympathectomy	4	0.9	4.0
Coronary-artery bypass surgery	23	7	3.1

Source: Chassin *et al.*, 1986.

Table 3. **Rates (%) of three procedures judged appropriate, United States**

	Appropriate	Equivocal	Inappropriate
Coronary angiography	74.0	8.5	17.4
Carotid endarterectomy	35.3	32.3	32.4
UGI endoscopy	72.0	10.8	17.2

Source: Chassin *et al.,* 1987.

Table 4. **Rates (%) of coronary angiography and bypass surgery judged inappropriate, Trent Region, United Kingdom, 1988**

	Appropriate	Equivocal	Inappropriate
Coronary angiography	49.0	30.0	21.0
Coronary bypass surgery	58.0	26.0	16.0

Source: Gray *et al.*, 1990.

Table 5. **Some underused technologies (US experience)**

Thrombolytic therapy for acute myocardial infarction
Drug treatment for secondary prevention of myocardial infarction
Prevention, diagnosis and treatment of venous thrombosis and pulmonary embolism
Screening/diagnosis and treatment of hypertension
Antibiotic therapy for duodenal ulcer
Drug palliation for cancer pain
Mammography for women 50 or over
Screening for diabetic retinopathy
Screening/diagnosis and treatment of depression
Organ transplantation
Prenatal care
Childhood vaccines
Hepatitis-B vaccine
Influenza vaccine
Pneumococcal vaccine
Ambulation aids (e.g. canes, crutches, walkers)
Diagnosis and treatment of incontinence
Condoms

Source: Goodman, 1994.

What are health problems?

The issue of mortality has received a great deal of attention. However, health problems and impairments in function have received less attention and will therefore be discussed in somewhat more detail.

Risk factors lead to diseases and health conditions. Having a health problem includes having diseases, conditions, impairments, functional losses, and disabilities. The concept of disease is familiar. A condition might be a congenital problem such as near-sightedness or having one leg shorter than the other. Diseases and conditions can cause impairments in functioning, but depending on the circumstances of the person and the surrounding social environment, functioning may be quite normal. Diseases and conditions may also cause functional losses, such as for example losing some ability to walk. If such functional losses cause problems in daily living, they are disabilities.

As indicated above, if a person survives to old age, it can be expected that he or she will develop certain diseases or conditions or a worsening of already existing diseases or conditions.

Intervention can be carried out at any stage of the development of a health problem with hope of success. Intervening when there is only a risk factor is a method of prevention of disease. Early treatment is often successful. It could be that the most critical point for elderly people is when functional limitations begin to develop. For example, it has been found that the frequency of walking a mile is the most consistent predictor of the development of disability in the elderly (Lawrence and Jette, 1996). Old people who do not have consistent exercise such as walking every day are more likely to develop disability.

Aside from mortality, little comparative information is available from country to country, region to region, or hospital to hospital. Health care has important implications for morbidity (symptoms) and quality of life, but essentially no data are available that allows comparison between and among countries. OECD has begun to collect data on “life expectancy in good health”, but relatively few countries report such data and methods are not standardised, so it is difficult to reach conclusions.

Morbidity in old age

As mentioned above, morbidity generally increases with age. Such problems as diseases of the circulatory system, endocrine and metabolic diseases (such as diabetes mellitus), hypertension, musculoskeletal disease, and mental disorders are seen with increasing frequency (Bourliere and Vallery-Masson, 1985). Chronic diseases are common in the population. Table 6 shows the prevalence of some chronic diseases in the entire population of the Netherlands (age 16 and over).

Table 6. **Prevalence of chronic diseases in the Netherlands, population 16 years of age and older, 1987-88, percentages**

	Men	Women
Arthritis/back complaints	15.8	17.7
Chronic non-specific lung disease	7.5	6.0
Heart disease	6.7	6.0
Migraine/severe headache	6.5	13.4
Diabetes mellitus	1.7	2.8
Other neurological conditions	1.3	1.2
Cancer	0.4	1.6

Source: Nusselder *et al.*, 1996.

Based on such factors as importance in death and disability and availability of technology relevant to correction of or compensation for the condition, the United States Office of Technology Assessment (1984) concluded that five chronic conditions were of particular importance: dementia, urinary incontinence, hearing impairment, osteoporosis, and osteoarthritis.

Some years ago, Fries (1980; 1989) posited the "rectangularisation" of the mortality curve and compression of morbidity. Fries argued that there is a natural life span of about 100 years, and that falling mortality rates were bringing humans closer to that span. At the same time, he felt that morbidity rates were falling and that increasingly with time people would remain healthy up until death. While there are different reasons for the improvement, medical advances and technology are an important contributor to such changes. This idea is of some relevance for predictions of the future burden of disease and disability in society; since, if proven correct, increasing life span would be accompanied by an increased period of active life and no increased burden to society. Whether this scenario is being realised continues to be a topic of debate in scientific literature.

Table 7 shows the prevalence of different morbidity-causing conditions among the community-dwelling elderly in the United States (Manton *et al*., 1995). It can readily be seen that the causes of morbidity are generally quite different from the main causes of mortality. It is also interesting that the prevalence of morbidity in the elderly in the United States has generally fallen during the 1980s.

In the Netherlands, a model was developed to examine the impact of falling mortality from ischemic heart disease on morbidity (Bonneux *et al*., 1994). The model shows that both mortality and morbidity have fallen, but because mortality has fallen faster than morbidity, the number of elderly people with morbidity from ischemic heart disease has risen. In other words, healthy life expectancy has been extended, but total life expectancy has been extended even further, leaving a longer period of dependency.

In the United Kingdom, a longitudinal study of the population of Melton Mowbray, Leicestershire has shown a decline in the prevalence of disability in those aged 75 or older, as well as a reduction in the proportion of older people who are dependent. However, this same population reports less good health.

Table 7. **Morbidity prevalence in Medicare-eligible US residents living in the community, 1982 and 1989, percentages**

	1982	1989
Arthritis	68.8	63.1
Hypertension	44.5	39.5
Circulation	40.7	32.1
Arteriosclerosis	20.7	14.9
Other heart	19.5	22.9
Diabetes	11.0	12.4
Bronchitis	9.5	12.1
Emphysema	8.6	6.4

Source: Manton *et al.*, 1995.

Thus, the evidence concerning the question as to whether morbidity is increasing or decreasing is conflicting. Elderly people surveyed in recent years generally report worse health than those surveyed in earlier years. However, Waidman *et al*. (1995) state that it is plausible to believe that morbidity is not worsening, but that the perception that health is worse is due to a combination of social forces affecting how individuals perceive their own health and report it. Spiers *et al.* (1996) also believe that the results are affected by different developments in health care and attitudes toward ageing and health. For example Japanese investigators have shown that preventive services reduce the demand for health care among elderly people in Japan (Nakanishi *et al*., 1996).

It is certain, nonetheless, that disability and dependence is common in old age. Approximately 10-20 per cent of those aged 65-74 have a serious disability, while the figure rises to 35-50 per cent over the age of 75 (Akhtar *et al*., 1973). The figure is higher for women than for men.

Most recently, Manton *et al.* (1997) reported declines in disability prevalence in the elderly population. Interestingly the decline accelerated from 0.27 per cent per year from 1982 to 1989 to 0.34 per cent per year from 1989 to 1994. This decline would be consistent with the Fries hypothesis.[4]

However, a most interesting study by Kunkel and Applebaum (1992), who used the National Long Term Care Survey of 1982 and the 1985 National Nursing Home Survey to generate baseline rates of disability seems to indicate that even in an optimistic scenario, the numbers of disabled elderly people will rise rather rapidly. Estimates for longevity were taken from the US Bureau of the Census. Four scenarios were developed for disability. The first assumed a middle ground of mortality and current rates of disability. The second assumed rapid improvement in mortality rates and a lower disability rate. The third assumed rapid improvement in mortality rates and an increase in disability rates. And the last used an assumption of moderately longer life and moderately higher disability. All models show relatively dramatic rises in the disabled population. For example, the severely disabled elderly population was found to rise from about 3 million in 1995 to 7.6 to 12.0 million in 2040. (See Figure 1)[5].

Active life expectancy

The term active life expectancy (or disability-free life expectancy) has come into increasing use to describe the period of life lived without chronic disability. Although women have a longer life span, they are less healthy, both in terms of disability and in terms of self-rated health. Important factors in increasing active life expectancy include diet (low calorie, low fat), physical exercise (Sherman *et al*., 1994), and limiting stress (Bourliere and Vallery-Masson, 1985).

A considerable portion of the life span of elderly people is spent in an inactive life due to chronic problems. Table 8, taken from the Longitudinal Study of Ageing in the United States, shows the life expectancy of men and women at different ages. As can be seen, a woman age 70 can expect to spend about 20 per cent of her life in an inactive state, while the figure for a man of 70 is 13.6 per cent. The percentage rises with increasing age. Those living an inactive life may be unable to live independently or take care of themselves.

Table 8. **Expected active and inactive life, US non-institutionalised elderly adults**

Age		Total expected life	Expected active life	Expected inactive life
Females	70	13.9	11.1	2.8
	80	8.4	5.5	2.9
	90	4.8	1.8	2.9
Males	70	10.3	8.9	1.4
	80	6.0	4.4	1.6
	90	3.3	1.6	1.8

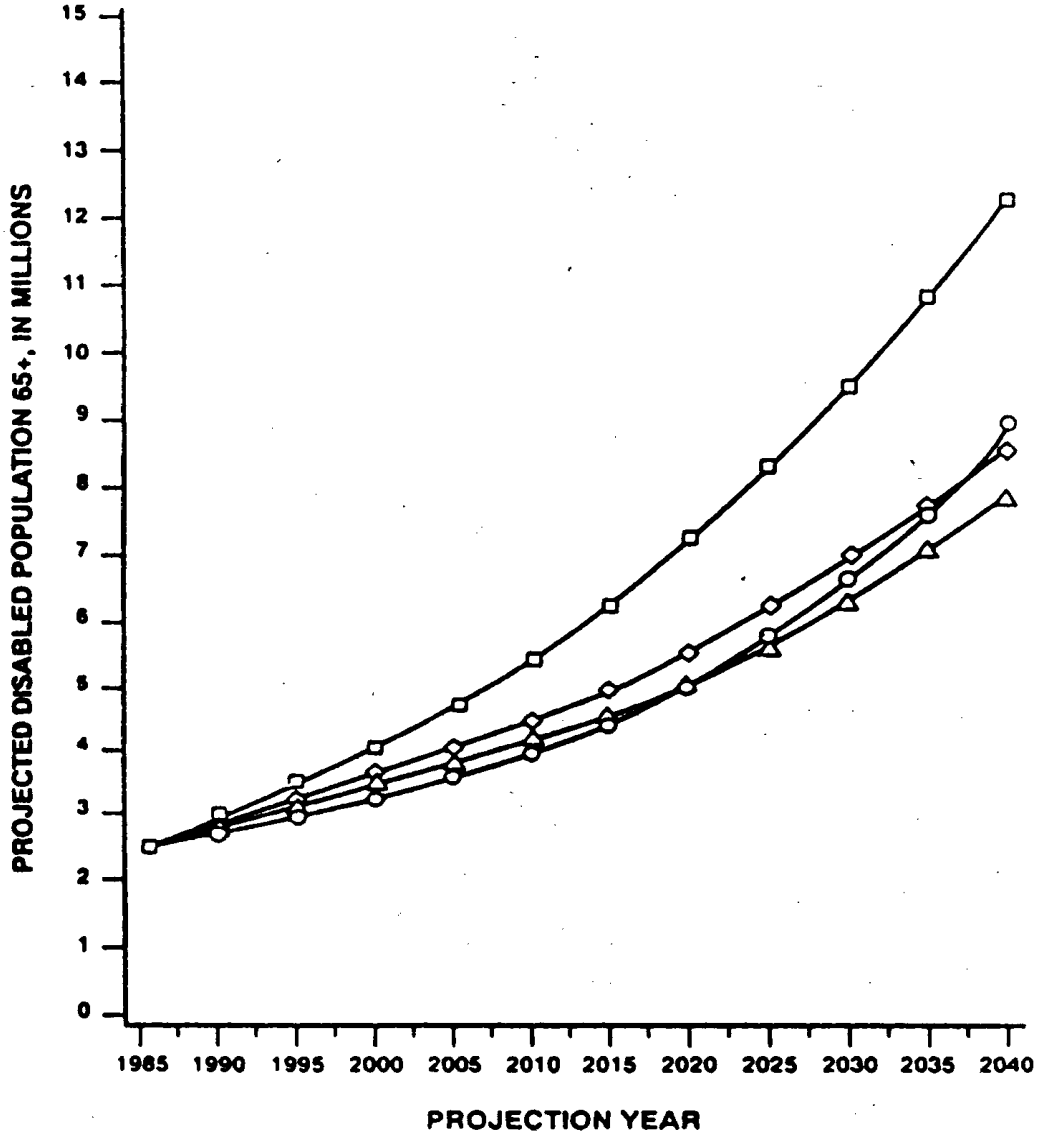
Source: Crimmins *et al.*, 1996.

Table 9 shows the specific functions that may be difficult for elderly people. Difficulties carrying out these functions leads to the need for assistance. In the United States, about 70 per cent of those 65 years of age and older who are living at home receive assistance from others (Kincade *et al*., 1995). Other elderly persons will need to be institutionalised because of difficulties in coping at home.

Obviously providing institutionalisation or supportive services can be very expensive. It is also of concern that active life expectancy seems to have fallen since the mid-1970s (Suzman *et al*., 1992).

Elderly people cope with disabilities in differing ways. The most common is to change behaviour, e.g. to do things less often and more slowly. Devices and equipment such as wheelchairs and orthotics, can help. In the United States, 43 per cent of the elderly use equipment for this purpose; the percentage increases dramatically with age and is increasing rapidly over time (Manton *et al*., 1993). Changing the environment to make it easier to live in, such as having non-skid floors, no stairs, and low thresholds for wheelchairs to cross, is a strategy used by 31 per cent of elderly. Still, overall, 69 per cent of elderly in the United States living in the community receive help from others. Therefore, it is only an illusion to believe that elderly people will not continue to need assistance. Self-care and assistance are complementary (Kincade *et al*., 1995).

Figure 1. **Total projected population 65 and older with severe disability (in millions) 1986 to 2040**



Notes: Key to different mortality and disability assumptions: Δ Constant; ○ Longer life, less disability; □ Longer life, higher disability; ◊ Moderately longer life, moderately higher disability.

Source: Kunkel and Applebaum, 1992.

Table 9. **Functional difficulties of the US population living in the community, 1990, age 65 and older, percentages**

Function	No difficulty
Basic Activities of Daily Living	
Eating	97.8
Dressing	92.7
Bathing	89.2
Maintaining continence	75.1
Mobility Activities of Daily Living	
Getting to toilet	95.1
Transferring	88.7
Getting outside	91.5
Walking	73.7
Instrumental Activities of Daily Living	
Using a telephone	93.5
Managing money	92.9
Preparing meals	90.7
Doing light housework	87.4
Shopping	85.6
Doing heavy housework	64.6

Source: Kincade *et al.*, 1995.

Kincade *et al*. (1995) believe that the load of disabled elderly people can only be dealt with by increasing the attitudinal readiness and technical capability of older adults to assume greater responsibility for their own self-maintenance. While this may be true, a number of investigators have found that institutionalisation of elderly people is related to many factors in addition to health status, including wealth, marital status, and region of residence (Carriere and Pelletier, 1995). This finding suggests that active policies to reduce institutionalisation can be successful. In fact, a number of countries, including Denmark and Sweden (Cates, 1993) and the Netherlands (van den Berg Jeths and Thorslund, 1994), have reduced institutionalisation significantly, mainly by increasing home care and housing for the elderly with services and adaptations (Cates, 1993). Further evidence of this point is given in the next section.

The cost of care

Health care costs for the elderly can be expected to increase greatly unless major improvements in their health care be made. Medical spending per capita for those limited in activity because of two or more chronic conditions was found to be five times that of persons not limited in activity in the United States (Cassel *et al*., 1992).

Several investigators have examined different conditions for their contribution to increasing morbidity and functional limitation. It has been shown that decreasing morbidity from arthritis would lead to a much greater reduction in functional limitation than decreasing morbidity from any other condition (Boult *et al*., 1996). Furthermore, in the Netherlands it was found that eliminating some chronic diseases would increase disability, because of increased longevity and development or progression of other chronic diseases (Nusselder *et al*., 1996). However, eliminating arthritis and back pain results in an increase in disability-free life expectancy. The same result was found for migraine and other severe headache.

This finding has implications for research and R&D policies. These will be mentioned again in the fourth section of this report.

Little information is available as to actual changes in cost. Finnish investigators (Kiiskinen *et al*., 1997) have examined the experience of the last 30 years, which have seen a 50 per cent fall in age-standardised cardiovascular diseases mortality. Overall, direct costs of health care were increased moderately. However, indirect costs, mainly those associated with employment and support for the disabled, fell more rapidly, compensating for the change in direct costs. Overall, there was a 4 per cent decrease in costs. However, this study cannot be generalised to the elderly, who are mostly not productive economically, being already retired. Thus, the Finnish study gives some weak evidence that costs in the elderly population have been increasing with the falling mortality rate.

Another Finnish study (Hakkinen and Luoma, 1995) examined observed differences in costs of health services and care of the elderly. They found that differences were related to need for care, such as morbidity levels, but they were also related to the income level of the local population, the generosity of central government support for such services, the mix of care between institutional and non-institutional care, and efficiency of the service providers. Their conclusion was that expenditures on health services and care of the elderly can be reduced considerably by means available to providers, such as shifting resources to outpatient care and increasing productivity.

In the United States, a study of the Medicare population shows that the cost to Medicare for each additional year of life decreases for people who die at older ages. They suggest that once people reach 65 years of age, the length of their subsequent survival does not appear to have a major effect on costs (Lubitz *et al*., 1995).

Several studies have predicted rising costs of long-term care in the United States, in particular for the older cohorts. For example, Rivlin *et al*. (1988) developed a model to address this issue assuming that disability rates would remain constant over the period of the model, although there was a sensitive analysis to examine the effects of higher or lower disability.

Another study in the United States showed that community long-term care services can substitute for more expensive nursing home care (Greene *et al*., 1993). The investigators developed a formal model that showed that 41 per cent of frail elderly people had potential for net long-term cost reduction through community services.

Some important technological possibilities in care for the elderly

Present and future technology offer many possibilities of improving the health and functioning of elderly people. A number of reports have reviewed such possibilities (Sarunummi, 1996; Hutton and Persson, 1995; Rathenau, 1997*a*; Rathenau, 1997*b*; Rathenau, 1997*c*; Office of Technology Assessment, 1982 and 1984). Technologies now being deployed may allow better care to be furnished without increasing cost and many evolving and future technologies can change the present situation dramatically. However some present technologies are not effectively used and could contribute immediately to continued improvement of health; and there may be some technologies that are overused in such a way that the probability of harm may be greater than the probability of benefit (this appears to be the case with some pharmaceuticals). This section will briefly review some of these possibilities.

In the United States, mortality objectives for the year 2000 have been published by the Department of Health and Human Services. The objectives are based on available technology and proven outcomes.

Dramatic reductions in mortality are feasible. A life table analysis has demonstrated that (with the exception of chronic obstructive pulmonary disease) the following percentage reductions on the prevalence of specific conditions might be expected during the period 1987-2000 (Rockett and Pollard, 1995):

Conditions	(1987-2000) Percentage reductions
CHD Mortality	26
Cancer	3
Stroke	34
Chronic obstructive pulmonary disease (expected to rise)	32
Cirrhosis	35
Diabetes mellitus	10
Pneumonia/influenza	20

Source: Rockett and Pollard, 1995.

Vaccines

Vaccination of the elderly has not received a great deal of attention until fairly recently. The main vaccines useful for elderly people are influenza vaccine and pneumococcal vaccine. The first prevents viral influenza and its complications, which include pneumonia, and the second prevents pneumococcal pneumonia, which is the most common pneumonia.

Pneumonia is one of the most common conditions leading to mortality and disability in the elderly. A number of analyses have shown that these vaccines are highly cost-effective in the elderly population (Office of Technology Assessment, 1978 and 1981). Yet they are seriously underused. Influenza vaccine has been covered by the Medicare Programme in the United States for some years, but in 1993, only 35 per cent of Medicare beneficiaries received the influenza vaccine. More alarming, the figure was 17 per cent in blacks, and very low in those over the age of 85. For example, the rate of immunisation in women 85 years or older was only 30 per cent, lower by eight percentage points than in younger women (MMWR, 1995). The vaccines are also underused in Europe.

The National Vaccine Advisory Committee of the United States has observed that 50 000 to 70 000 adults die in the United States every year from flu and pneumonia (and hepatitis-B). The majority of these deaths are in elderly people (Fedson, 1994). The Committee has recommended a goal of immunising 60 per cent of all elderly and high risk people for influenza and pneumococcal pneumonia.

Screening

Screening refers to a procedure for identifying diseases or disease risk factors early in their course while intervention can be more effective. Screening is a very common procedure in present health care, and is often criticised for its lack of effectiveness. For example, the general physical examination is done periodically and routinely at great cost although there is no evidence that this screening procedure leads to improvements in health. On the other hand, there are a number of efficacious screening procedures that are underused.

Determining which screening procedures should be routine requires careful assessment of the screening procedure itself for accuracy. In addition, assessment requires evaluation of the proposed intervention, since there is little purpose in finding diseases or risk factors when there is no effective intervention.

Common undetected conditions in the elderly include colon cancer, breast cancer, coronary artery disease, urinary incontinence, inappropriate use of medication, impaired social functioning, and nutritional problems (Beers *et al*., 1991). Unfortunately, in many of these cases there is no good screening test, and when there is, intervention has not been shown to be useful.

In recent years, there have been a number of efforts to evaluate screening procedures. The largest has been carried out by the US Prevention Services Task Force (1996). Building on these efforts, a group of professionals interested in ageing have made recommendations for screening of the elderly (Beers *et al*., 1991). The procedures recommended for a routine screen include:

- vision testing for refraction error;
- inspection of skin for cancer, fungi, xerosis, and drug eruptions;
- history of xerosis (very dry skin);
- audimetric testing for hearing loss;
- otoscopic inspection for impacted cerumen (wax);
- dental examination for caries;
- checking blood pressure for hypertension;
- breast examination and mammography for cancer.

The frequency at which most of these procedures is carried out in elderly people is unknown, but it is assumed that it is less than desirable. In the case of mammography, it is known that women up to the age of 69, which is the age group that can gain the most benefit, underutilise the procedure (US Prevention Services Task Force, 1996). In the United States, for example, only 40 per cent of elderly women have had a mammogram within the last two years (German *et al*., 1995).

It is worth noting that a number of screening procedures in widespread use or growing in use are not recommended based on presently available evidence. A prominent example is prostate cancer screening in men, since there is no evidence that intervention changes the ultimate course of the disease (US Prevention Services Task Force, 1996).

Primary prevention of important diseases

Although knowledge of how to prevent diseases is often lacking, available knowledge is not well deployed. The one most important change would be to reduce rates of cigarette smoking. Cigarette smoking is associated with a number of important causes of mortality in OECD countries, including cardiovascular disease, lung cancer, emphysema and chronic obstructive pulmonary disease.

Changes in diet could also affect causes of mortality (Connor and Connor, 1997). A low fat, high carbohydrate diet is being recommended. Changes in the mortality of such important diseases as cardiovascular disease, colon cancer, and diabetes could be seen with such a change.

Exercise is an important preventive measure, yet indications are that the population is actually exercising less over time.

Wine, in moderate amounts, has been shown to reduce onset of acute events and mortality from coronary heart disease (Doll *et al.*, 1994; Gronback *et al*., 1995; Renaud and de Lorgeril, 1992). Apparently no country's public health establishment has yet had the courage to say that moderate consumption of wine improves health.

Intake of low doses of aspirin reduces the development of acute events and mortality in cardiovascular disease.

The importance of genetics

With the genetic revolution, the genetic basis of diseases is being rapidly elucidated. The great majority of diseases is multi-causal. Genetics plays a part in essentially all diseases. At the moment, the genetic basis of such common conditions as cardiovascular disease, Alzheimer's disease, cancer, and arthritis is the subject of active research.

The case of breast cancer will be taken as an example. It has long been known that breast cancer has a genetic component, because it tends to run in families. A gene, BRCA1, has been shown to be linked to the development of breast cancer. A woman with the BRCA1 gene has a lifetime risk of 85 per cent for breast cancer (Easton *et al*., 1995; Stratton *et al*., 1997).

But what can be done if a BRCA1 gene is demonstrated in a woman? Periodic screening appears to be wasteful, since at least nine out of ten screens will be negative (Healey, 1997). Prophylactic removal of the breasts is being done with increasing frequency in such women, but there is no information to show that this practice will prevent the breast cancer (since all breast tissue cannot be removed). Although this genetic test is now commercially available and is being marketed actively to women, the general professional opinion is that it is too early to use it in everyday clinical practice.

As addressed in detail in a recent OECD report (OECD, 1997) it has been proposed that caution should be the attitude toward new genetic tests. An assessment can be carried out, followed by public health policy development (Khoury *et al*., 1996).

In short, genetic testing has extraordinary potential for the prevention and treatment of disease, but that potential will not be fully realised without an active public policy approach to the field.

Prevention of disability

Preventing disability requires focusing on a particular functional limitation for an intervention. There are few effective interventions known for this purpose. The most important predictor of disability is the frequency of walking a mile (Lawrence and Jette, 1996). There is a need for clinical trials of methods aimed at increasing physical activity levels and other changes in behaviour.

Potentials of the new biotechnology for the elderly

The new methods of biotechnology offer the possibility of many new pharmaceutical products, including diagnostic and therapeutical approaches. This area has been comprehensively reviewed by the OECD in a

recent study (OECD, 1997), although the report does not specifically address applications to treat diseases of the elderly.[6]

New treatments and intensified use of older efficacious treatments

As already mentioned, although deaths -- and possibly morbidity -- from cardiovascular disease have already been reduced in many countries, full deployment of presently available technologies could lead to continued, and perhaps even more rapid, falls in mortality in the future. Medical interventions that are not fully or effectively used include use of thrombolytic agents and/or aspirin very early in the onset of acute myocardial infarction; use of long-term aspirin in people with symptomatic coronary artery disease.

In addition, new technologies in development and testing may give new effective possibilities to treat advanced cardiovascular disease (including coronary artery disease) that may replace expensive and invasive procedures such as coronary artery bypass grafting. Examples include new advances in balloon angioplasty, less invasive methods of bypass grafting and, more recently, gene therapy.

Stroke is another condition that can be treated more. Treatment of hypertension is not effectively carried out for the entire population. New evidence indicates that early aspirin use in patients with acute onset of stroke produces small but definite net benefit (CAST, 1997). This practice will surely spread in the future.

Developing better treatments for arthritis is a high priority, given the amount of disability produced by this problem. However, while drug treatments for rheumatoid arthritis have gradually improved, treatment for osteoarthritis, the common form of arthritis in elderly people, has not improved very much in recent years.

Prevention or treatment of dementia

Dementia, including that caused by Alzheimer's disease, accounts for a large amount of dependency, and leads to a great amount of institutionalisation. Presently, there are no effective ways to deal with this condition (Drachman and Leber, 1997). However, rapid developments in the neurosciences and the development of new model systems for research, as indicated at the "OECD workshop Rome '96: Novel Systems for the Study of Human Disease: From Basic Research to Applications" give some promise of improvements during the next decades.

During the last years, there have been intriguing reports of successful pharmacological approaches, especially through the use of nonsteroidal anti-inflammatory drugs (NSAIDs) to Alzheimer's disease (Applegate and Pahor, 1997). Other approaches, such as counselling and social support, also play a role in preventing the progression of Alzheimer's disease (Applegate and Pahor, 1997).

Assistive devices

Assistive devices are available to compensate for some impairments in hearing, vision, walking, and other functions. Various other devices can assist the moderately impaired in preparing food, eating, performing household chores, and managing other activities of daily living. Rehabilitation devices and techniques can also help older people to maintain functioning or to regain normal functioning after a hospitalisation (Office of Technology Assessment, 1984).

Home care and transmural care

Home care, as an alternative to institutional care, has been growing rapidly in recent years as in the case of cancer chemotherapy or long-term antibiotic treatment; but many possibilities still remain to be explored and deployed. A related example is day surgery, in which the patient has a surgical procedure in the out-patient setting and then goes home without a hospitalisation.

Most of the interventions in this area are not new. The main issue is the change in the organisation of care so that it can be delivered in different ways and in different sites.

Recently, the term "transmural care" has been used to denote care that is given without attention to the walls of the hospital, but is tailored to the needs of the individual. In most cases, a hospitalisation is not necessary (Rathenau, 1997*a*). Such transmural care applies equally to diseases and disabling conditions.

In the case of disabling conditions, one of the greatest policy issues at present is long-term care for the elderly, which produces or reinforces dependence and can be quite expensive in relation to alternatives (Defever, 1991; Hudson, 1993). Transmural care may refer to supporting people in their own home environments. A wide range of technologies can contribute to this goal. The broad goal of transmural care for people with disabilities could be said to promote independent, fulfilled lives. Such technologies need to be addressed to the specific needs of disabled people, which include such daily problems in mobility as shopping and dressing. This general subject has been comprehensively reviewed in an OECD publication (OECD, 1996*a*).

The field of telematics (communications and computers) is very important in the development of transmural care. Many innovations, ranging from treatment protocols to home monitoring to alarm systems, can and do support developments in transmural care.

Changing patterns of care

As mentioned above, many elderly people can maintain independence in their homes with modest supports, including both human and technological supports. Technology, in a narrow sense, is not the most important limiting factor. The greatest problem is to have successful patterns of care. There is a need for demonstration projects and evaluations to show how care for the elderly could be organised to encourage self-care while optimising inputs of support.

Section 2: Important research projects and centres dealing with the ageing population

Ageing is a subject of concern in the entire world. Research into ageing is carried out in many sites examining many subjects. As mentioned above, though, few centres were found that concentrate on technology and the ageing. No ongoing population-based research in this subject was found. Therefore, this section is rather general.

Population-based research on the elderly is generally carried out in institutes and faculties of epidemiology or demography. The United States is the leader in this field. The US National Center for Health Statistics (NCHS) carries out a series of ongoing studies and surveys, many of which deal with the elderly in whole or in part. The United States has also developed a network of centres that concentrate on research concerning the elderly. These are funded by the National Institute of Ageing (NIA), part of the National Institutes of Health. Specific population-based studies of ageing are funded by the NIA or the NCHS, often in co-operation with other US government agencies.

In Europe, research into ageing is not very well developed outside of the United Kingdom and the Netherlands (Borst-Eilers, 1995).

Only four centres were found that have shown a strong interest in technology and ageing. Two are in the Netherlands, one is in Sweden and one is in the United States. They are briefly profiled below.

Involvement of international organisations in the subject of ageing

The OECD has become increasingly involved in the issue of ageing (OECD, 1996*a*; OECD, 1996*b*).

The United Nations (UN) publishes a series of reports relating to ageing, such as *World Population Prospects* and *The Sex and Age Distribution of the World Populations*. The UN International Institute on Ageing focuses mainly on training. The UN Economic Commission for Europe, Population Activities Unit is studying the dynamics of population ageing in EEC countries.

The World Health Organization (WHO) publishes a series of reports related to the health of the population and, on occasion, publishes special reports related to ageing. For example, in 1997 the European Regional Office of WHO published *Drugs for the elderly*.

The European Union (EU) has a limited role in health in Europe, although public health is gradually gaining increased attention. The EU does publish relevant statistics (c.f. *The demographic situation in the European Union - 1995)*. In 1993, the European Commission's Framework for Public Health addressed major health problems, including age-related issues (Robinson and Graham, 1997). The Commission defined three areas for action which are crucial for older people:

1. Health promotion, information, education and training.
2. Health monitoring and the establishment of comparable health indicators.
3. Accidents and injuries.

The Health Promotion Programme which runs from 1996-2000 supports studies on the implications of an ageing population and encourages innovative methods of providing health education for older people. However, so far little money has gone into this activity (Robinson and Graham, 1997). An Action Programme was developed in 1990 with the aim of stimulating debate and action in Member States (Jamieson, 1994). A five-year programme to develop a high-quality, policy-oriented health monitoring system in the EU was initiated in 1997 to run to 2001. The programme is intended to measure trends and determinants throughout the EU. How much this will focus on the elderly is not known at present (Robinson and Graham, 1997). In 1996, the Commission published a report, "Ageing and Technology, State-of-the-Art", in which Saranummi (1996) reviews activities of the EU in this area. The EU supports biomedical research, which has allowed collaborative research into many important age-related areas (Robinson and Graham, 1997). Perhaps the most active programme in this area is The Telematics Applications for the Integration of Disabled and Elderly people (TIDE) programme, which funds user-driven applications of information and communication technologies. The Efficiency of Assistive Technologies and Services (EATS) programme, referred to below, is supported by TIDE. Finally, future initiatives have been outlined by the European Commission, including a report on the impact of the ageing of the population on social and health policies; European guidelines on osteoporosis; initiatives in the area of primary care; the creation of a high level advisory committee for health promotion for older people; and a discussion document on the public health aspects of pharmaceuticals (Robinson and Graham, 1997).

The International Federation on Ageing (IFA) is a non-governmental, non-profit organisation with an educational objective, to facilitate the transfer and dissemination of information that has practical application to the problems of the aged.

United States centres are significant in collecting international statistics. The US Census Bureau publishes international statistics. The National Center for Health Statistics has a working group to improve the comparability of international health statistics related to ageing.

Important studies of ageing supported by the US National Center for Health Statistics

- *The National Health and Nutritional Examination Surveys (NHANES).* This survey is carried out periodically and examines the entire US population by sample survey.
- *The National Health Interview Survey, Supplement on Ageing.* The survey is carried out annually.
- *The National Survey of Self-Care and Ageing (NSSCA).*
- *The National Long-Term Care Surveys.*
- *The National Medical Expenditure Survey - Use of Home and Community Services by Persons Age 65 and Older with Functional Difficulties, 1990.*
- *The Longitudinal Study of Ageing*. The study is made up of a sample of 7 527 individuals first identified in 1984. They are followed periodically.
- *The National Survey of Self Care and Ageing, 1990.*

The National Institute of Ageing (NIA) and its demography of ageing centres

NIA is surely the largest supporter of ageing research in the world. The Geriatrics Programme of NIA focuses on several relevant issues, including the development of new interventions and testing them in controlled clinical trials.

NIA funds nine Demography of Ageing Centres. The key activities of the centres are data dissemination, workshops and conferences, pilot project research, and policy briefs and other publications. Three of these centres make data sets available. The data sets are also available through the Internet.

The three centres with data sets are as follows:

1. *Duke University Center on Ageing*. This Centre was probably the first established to concentrate on problems of ageing. The Centre has carried out a large number of studies, including the Duke Longitudinal Studies of Ageing. The Center for Demographic Studies, associated with the Center on Ageing, administers the National Long Term Care Surveys, which are linked to the Medicare payment files.

2. *Center on the Economics and Demography of Ageing, University of California, Berkeley.* The Centre makes the US mortality estimates and projections available through data files. These can be accessed by the Internet.

3. *University of Michigan. Michigan Exploratory Center on the Demographics of Ageing*. The Centre maintains data files on the Health and Retirement Study (HRS), the Panel Study of Income Dynamics (PSID), and Assets and Health Dynamics Among the Oldest Old (AHEAD), all longitudinal studies. The Centre also maintains the National Archive of Computerized Data on Ageing and the Wisconsin Longitudinal Survey. *The Survey Research Center* of the University of Michigan also maintains the American Changing Lives (ACL) Survey.

The other centres are at the University of Chicago, John Hopkins University, the National Bureau of Economic Research, the University of Pennsylvania, Rand, and Syracuse University.

Centres concentrating on technology and ageing

The National Bureau of Economic Research, one of NIA's centres on ageing, has carried out a number of studies related to technology, health, and ageing. This is the only US centre identified that has shown a particular interest in this issue.

A large European organisation carrying out studies of ageing is the Netherlands Organisation for Applied Scientific Research (TNO) in Leiden, whose Institute for Prevention and Health includes a Centre for Ageing Research. The Institute includes programmes dealing with ageing research, prevention research, and health technology and health technology assessment. The main activity related to this project has been policy-related studies and evaluations of technologies used in home care and transmural care. TNO also supports the Dutch Vascular Dementia Study, a longitudinal study.

Another Dutch organisation involved in technology and ageing is the Institute for Medical Technology Assessment (IMTA) at Erasmus University in Rotterdam. Erasmus University also has departments of health policy and epidemiology that have shown considerable interest in ageing, and have co-operated with IMTA in several studies. IMTA administers the Senior People Services project (SENSE), which is a randomised trial of alternative models of community living for the elderly.

The Centre of Medical Technology Assessment (CMT) at Linkoping University in Sweden has carried out a number of studies related to ageing and technology. The most important recent effort has been the EATS, a European study funded by the TIDE programme of the European Commission. TNO and other European centres co-operate in this research, which is aimed at developing better evaluative tools for dealing with technology devoted to the elderly and disabled population.

Other centres involved in longitudinal research on ageing

Other centres around the world that have carried out important longitudinal research on ageing include the following:

The NESTOR programme in the Netherlands, funded by the government, has a co-ordinated programme of research in ageing, carried out by a number of Dutch centres. Longitudinal studies of the Dutch population include the Rotterdam study (Erasmus University Department of Epidemiology and Biostatistics), the Longitudinal Ageing Study Amsterdam (Free University), Living Arrangements and Social Networks of Older Adults (Free University), the Maastricht Ageing Study (University of Limburg), the Groningen Longitudinal Ageing Study on Functional Status and Need for Care (Northern Centre for Health Care Research, University of Groningen), the Dutch Vascular Dementia Study (TNO Prevention and Health), and the Zutphen Elderly Study (the National Institute of Public Health and Environmental

Protection, Bilthoven). The European Research Institute on Health and Ageing of the University of Amsterdam co-ordinates the Cross-European Longitudinal Study of Ageing (EXCELSA).

As noted above, the United Kingdom has a number of centres devoted to the issue of ageing and geriatric care. The Centre for Publication Studies of the London School of Hygiene and Tropical Medicine studies population trends and attempts to modify them. The Department of Epidemiology and Public Health of the University of Leicester has carried out a number of longitudinal studies in the city of Leicester. St. Thomas' Hospital administers the European Community Stroke Project. The Age and Cognitive Performance Research Centre of the University of Manchester supports the Longitudinal Study of Occupational Status and Stability of Cognitive Function in Older Adults. The Institute for the Health of the Elderly, University of Newcastle-upon-Tyne has supported the Longitudinal Study of Cognitive Function and Ageing. Age Concern England is a national charity that aims to promote the well-being of older people by providing help and services in their local communities. Age Concern provides information services, produces an extensive list of publications, and runs a wide range of training courses. The Age Concern Institute of Gerontology, King's College, London has supported a number of relevant studies.

Italy has also supported a network of research centres in ageing, the Italy National Research Centre on Ageing (INRCA) programme. The University Geriatric Unit of St. Louis Hospital, Orbasiano has supported the Longitudinal Study of Ageing in the District of Turin. The Department of International Medicine, University of Padova has supported the Veneto Examination Nutritional Survey in the Elderly.

The Finnish Centre for Interdisciplinary Gerontology at the University of Jyvaskyla co-ordinates the European Longitudinal Study on Ageing, in co-operation with the INRCA Geriatric Department in Florence, the Institute of Gerontology, Kiev, and others. It also co-ordinates NORA, Nordic Research on Ageing, which is studying populations of 75 year old people in Denmark, Finland, and Sweden. The National Public Health Institute and the Department of Community Health and General Practice, University of Kuopio, have co-operated in developing the Finnish Seven Countries Study. The National Research and Development Centre for health in Helsinki has focused on studies of de-institutionalisation.

L'Institut Nationale de Santé et Recherche Médical (INSERM), Paris, the national health research institute in France, has supported a number of studies related to ageing, especially longitudinal studies of the French population. A significant centre supported by INSERM is the Centre Régional de Gériatrie, at the University of Bordeaux, Pessac. INSERM also supports the Centre "Vieillissement cognitif" (Cognitive ageing) in Montpellier.

In Sweden, the Department of Geriatric Medicine, University of Gothenburg has developed the Gothenburg study. The University of Lund has carried out the Lund 80^{+} study.

In Iceland, the Geriatric Department of the University Hospital has carried out the Reykjavik 80^{+} Study.

In Denmark the Department of Internal Medicine, Glostrup Hospital, University of Copenhagen, has carried out the Glostrup Population Studies. The Epidemiology Research Unit of the Rigshospitalet, State University Hospital, Copenhagen, has supported the Copenhagen Male Study. The University of Copenhagen Department of Geriatric Medicine has supported the Survey on European Nutrition and the Elderly, a Concerted Action (SENECA).

The University of Heidelberg Institute of Gerontology has supported the Bonn Longitudinal Study on Ageing.

The National Institute of Public Health, Oslo supports the Lawik Study: a longitudinal study of all those in Lawik, Norway born before 1902. The Institute also co-ordinates the five country International Long-Term Care Study.

The Department of Epidemiology and Preventive Medicine, Collegium Medicum, Jatiellonian University, Kracow, Poland has carried out a number of longitudinal studies including self-evaluation of health, daily living, and mortality and long-term care.

The Chaim Sheban Medical Center, Tel Hashomer, Israel has carried out the Cross-Section and Longitudinal Ageing Study (CALAS).

Other centres in the United States include Yale University, which runs the Yale Health and Ageing Project and the Social Networks and Risk of Functional Disability study and the University of California Los Angeles (UCLA), which carries out the Hospitalized Older Persons Evaluation (HOPE) study.

The Institute for Human Development, Life Course and Aging of the University of Toronto carries out a wide programme in ageing research. The Centre on Ageing, University of Victoria, Canada has carried out a number of studies of social support for elderly people. The Manitoba elderly study has followed a group of elderly people for 12 years.

Other centres

A number of other centres are cited in the literature or have well-known figures in the field working in them. A selection of such centres includes:

- *The Institute of Gerontology, Wayne State University.*
- *Alzheimer Research Center, Washington University, St. Louis.*
- *New England Research Institute, Watertown, Massachusetts.*
- *Gerontology Research Center, Simon Fraser University, Canada.*
- *Center for Studies of Aging, University of Toronto.*
- *Research Group on Aging and the Life Course, Free University of Berlin.*
- *Institute for Longevity Research, Moscow State University.*
- *National Ageing Research Institute, University of Melbourne.*

Section 3: Intensity and appropriateness of use of technology by the elderly

Appropriateness of use

A literature review by Brook *et al.* (1991) found 17 articles that explicitly cited appropriate or inappropriate care involving procedures and 19 articles presenting data on the appropriateness of medication use in the elderly[7]. Virtually every study reported at least double-digit percentages of inappropriate care. Perhaps as much as one-quarter of acute hospital services were used for equivocal or inappropriate reasons, and two-fifths to one-half of the medications studied were overused. Few studies examined underuse, but that was also documented.

A standardised instrument, the Appropriateness Evaluation Protocol, can be used to assess appropriateness of hospital services. In the United States, inappropriate admissions have been found in 10-35 per cent of patients (Restuccia *et al*., 1984; Siu *et al*., 1986). In Italy, health policy changes led to a reduction in hospital beds. At the same time, inappropriate admissions diminished (Pahor *et al*., 1996). Perhaps this is because bed availability tends to promote inappropriate admission (Fisher *et al*., 1994). In Sweden, elderly patients were found to be inappropriately hospitalised in only 1.5 per cent of cases (Lagergren, 1995).

One condition that has been extensively studied is carotid endarterectomy, which is done almost entirely in people over the age of 65. One study found that 35 per cent of patients in the sample had endarterectomy for appropriate reasons, 32 per cent for equivocal reasons, and 32 per cent for inappropriate reasons (Winslow *et al*., 1988).

Pharmaceuticals seem to be often overused by the elderly. In the United States, for example, studies have shown that among people 65 years of age and older, 61 per cent get three or more prescription drugs in a year, 37 per cent get five or more, and 19 per cent get seven or more (Wolfe and Hope, 1993). Of those not in a nursing home or hospital, 65 per cent took a cardiovascular drug, 33 per cent took a psychotropic drug (a tranquilliser, sleeping pill, or anti-depressant), and 24 per cent used a gastrointestinal drug (for ulcers, constipation, colitis). These three categories of drugs are considered to be the most over-prescribed (Wolfe and Hope, 1993). In Ontario, Canada, rising costs in drug benefits were found to be due to physicians prescribing to the elderly more and writing more prescriptions each time they see an elderly patient (Lexchin, 1992). The problem, however, is to determine appropriate use. With each prescription, the physician must judge whether the potential benefits outweigh the possible risks. High prescription rates do not directly constitute proof of inappropriate use.

The WHO (1997) has formulated the problem of appropriateness of drug use in this way. Multiple pathology is so common in the elderly that it often leads to multiple prescribing ("poly-pharmacy"). Side effects of drugs are common. The problems this raises will be even greater if drugs are given to treat the side effects of other drugs. Poly-pharmacy is particularly hazardous in older patients, and frequently leads to admission to hospital. "Simplicity is the most important single principle for prescribers to observe". One study showed that the prevalence of side effects was 18 per cent in those using fewer than six drugs and 80 per cent in those using more than six drugs (WHO, 1997).

WHO also gives many examples of drugs that should not be used in the elderly, but many of these drugs are in routine use in elderly patients (WHO, 1997).

Direct studies of pharmaceutical use have shown substantial overuse, as mentioned above. For example, studies of psychoactive drugs showed that between 7 and 51 per cent of sedatives, hypnotics, antidepressants and antipsychotics are overused. Another study found that 22 per cent of emergency room antibiotic prescriptions were inappropriately overused (Brook *et al*., 1991). Ondansetron (an antiemetic) was found to be greatly overused, with only 37.8 per cent of patients satisfying guidelines for both indications for use and dose administered (Vermeulen *et al*., 1994).

Rationing of care to the elderly

With increasing health care costs, there have been proposals for rationing medical and health care. In fact, all health systems ration care (Hunter, 1995). One of the most prominent proposals has been to ration on the basis of age (Callahan, 1993). The ethical principle involved is that investments in younger people

might be considered to be more cost effective. Callahan (1990) feels that citizens should substitute communalism for individualism and accept death at the end of a normal life span.

A related idea is to de-emphasize curative medicine, as proposed by a group of American, Dutch, and Hungarian ethicists in their report, "Care for the Elderly: Goals and Priorities". This group of ethicists have supported less attention to "cure": "It is curing that should, when economic pressure is strong, give way to caring, not the other way around". At the same time, they give strong support for dealing with emerging problems of the elderly, including morbidity (ter Meulen *et al*., 1994).

A number of commentators have objected to this idea of rationing on the basis of age (Levinsky, 1990; Rivlin, 1995). Levinsky (1990) sees it as part of society's devaluation of the old and emphasis on youth. He observes that expensive hospital care for the elderly is a relatively small part of overall health-care costs for the elderly. Only withholding routine medical care from the elderly would be an effective mechanism for controlling costs. A Swedish report has concluded that while services may be withheld from elderly people because of disadvantages outweighing advantages, it is not correct to use chronological age as part of medical decision making (SOU, 1995). A British report from the Royal College of Physicians has stated that patients have a right to equal access to services and should not be discriminated against because of their age (Royal College of Physicians, 1994).

On the other hand, a study of the preferences of the Swedish population showed that people are willing to sacrifice thirty-five 70-year-olds to save one 30-year-old. A measure that would increase life-expectancy by one year, conditional on having survived until the age of 75 years, is given a low weighting by the Swedish population (Johannesson and Johansson, 1996).

A study in one area of Sweden found, in fact, that many elderly people were not receiving the care deemed to be necessary. In fact, 11.5 per cent of the elderly population who were in non-institutional care were felt to need institutionalisation (Lagergren, 1995).

Economic analysis has been advocated with increasing frequency during recent years as a guide to difficult policy decisions. One standard method of economic analysis uses quality-adjusted life years (QALYs) as the outcome measure, putting QALYs in relation to the cost of the intervention. In defining QALYs, no account is taken of the age at which the treatment measure is undertaken. Since younger persons have a longer life expectancy than older persons, the use of QALYs means that lives saved for younger persons will be given a higher weighting than lives saved for older persons. Thus, QALYs as a measure of effectiveness discriminates against older persons, and, if seriously used in policy-making, would tend to lead to rationing on the basis of age (Johannesson and Johansson, 1996).

Proposals for rationing are not based on poor likelihood of achieving medical benefits in older patients or the low quality of medical benefits in older age groups (Jecker and Schneiderman, 1992). In fact, there is evidence that no substantial age differences exist in outcomes for many interventions, including survival after cardiopulmonary resuscitation (CPR) for in-hospital cardiac arrest, coronary artery bypass surgery, liver and kidney transplantation, other types of surgery, chemotherapy, and renal dialysis. Surgery that would not have been done a few years ago in elderly people is now routine (Caron, 1996). Surgeons recognise that many elderly people are very healthy and quite able to withstand complicated surgical procedures, even at a quite advanced age.

It is difficult to determine if elderly people receive fewer services because of rationing on the basis of age. In other words, are effective and beneficial services withheld from elderly people because of scarcity or limited resources? As mentioned above, large variations in use are routinely found, and there has been little attempt to determine if ageing might play a role in such variations.

Furthermore, it is quite appropriate in many cases not to provide services to older people that would be provided to younger people. The standard for health care should be efficacy. In many cases, efficacy does not exist or has not been shown for elderly people. A good example is mammography screening for breast cancer, which has only been proven effective for the age range 50-69 and is usually not provided to women over 70 years of age (US Prevention Services Task Force, 1996; Kerlikowske *et al.*, 1995). At the same time, elderly people are often frail, and procedures may be associated with a higher risk, meaning that the benefit/risk ratio is often different for older people (Kramer, 1995).

Finally, elderly people may refuse effective services, even when they have a good chance of benefit. The oldest patients, given appropriate information, make more conservative decisions concerning life-preserving technology than younger patients (Kramer, 1995).

In the Netherlands, cardiac surgeons and cardiologists did not provide coronary artery interventions such as coronary artery bypass grafting to older people as much as to younger people. The rationale for this practice was that medical outcomes were not satisfactory. However, a study by the Dutch Health Council found that this practice could not be defended on medical grounds, but this was in fact a case of rationing by age. The Dutch government promulgated a regulation stating that the practice of age discrimination in heart surgery was not acceptable.

A much publicised case of rationing of care to the elderly is the provision of renal dialysis for chronic kidney failure. This case is relatively clear-cut, because those with end stage renal disease who do not receive dialysis will generally die. With the initiation of dialysis in Seattle, (Washington) in 1961, adults over the age of 45 were excluded (Rothenberg, 1992). A 1969 survey in the United States showed that 29 per cent of dialysis centre directors always used age in selecting patients for dialysis. Despite the passage of a law to cover dialysis for the entire US population in 1972, studies in the 1980s showed that patients over the age of 65 were only half as likely to receive dialysis as younger patients, and those over age 75 were only one-third as likely. The experience in Sweden was similar in the 1980s. In the United Kingdom, it has been observed for years that there are lower rates of dialysis than in other countries and that this difference is due to a very low rate of dialysis among older people (Stocking, 1982; Rothenberg, 1992). Horina *et al*.(1992), reporting from Germany, have stated that many nephrologists use an age limit for dialysis and that in most places around the world, the elderly have a reduced likelihood of receiving dialysis. Winearls *et al*. (1992) have responded from the United Kingdom that they have no such policy in their dialysis unit, but they acknowledge that referrals of older people are low, leading to low rates of dialysis. Indeed, surveys of British general practitioners and nonrenal consultants have shown a low pattern of referral of older patients for dialysis (Rothenberg, 1992).

Apparently age discrimination is widespread in the United Kingdom. Recently, a 73 year-old man was refused physiotherapy because he was considered too old (Dean, 1994). Twenty per cent of coronary care units surveyed refused to treat patients above a certain age. Forty per cent of these units refused to give thrombolytic drugs to older people even though research has shown that the drugs are more effective in elderly than younger people (Dean, 1994).

Although this situation has not been described fully for other conditions and in other countries, it is probably common. It has been shown that clinical evaluation of elderly patients is less common than in younger patients. Elderly people are less often encouraged to participate in screening programmes for early detection of cancer. Elderly people with cancer are treated in a different way from younger people in the United States, being less likely to receive possibly curative surgery (Farrow *et al.*, 1996; Zagonel *et al.*, 1994). The cases that have surfaced are probably only the "tip of the iceberg". Although most

countries deny explicit rationing on the basis of age, it is acknowledged that it is common as an informal practice (Hanson, 1994).

As Hanson (1994) says, “Ironically, rationing efforts may entail that the elderly receive fewer acute care medical benefits in exchange for better chronic and long-term care services”.

In summary the literature gives little evidence of differential treatment of the elderly compared with the rest of the population. Undoubtedly, as mentioned above, some services are over-provided, and others are under-provided. It would be very difficult to show that one factor in such over provision or under provision was the age of the person.

Section 4: Areas where technological efforts and research are most needed

As mentioned above, there have been few efforts to link the issues of technology and ageing. In fact, despite a great deal of concern about rising health-care costs and the contribution of an ageing population to such rises, few analyses have examined this issue. The literature is indeed very sparse.

Suggestions in this section for changes in research priorities and care activities follow from the discussion above, and are highly selective because of the large number of possibilities.

Possible changing priorities for health research

Biomedical research continues to be largely focused on a biological model of disease and ageing. This research paradigm has led to considerable advances during this century. This report in no way disparages those advances.

At the same time, other areas of health research offer great -- and possibly greater -- potentials for affecting the health of the population. Some of these possibilities are research into disease risk factors, research into interventions to change population and individual behaviour, and research into the efficacy and cost-effectiveness of medical and health-care interventions.

The area of cancer is a high priority for research into risk factors (Bailar and Gornik, 1997). In particular, the dietary components related to cancer and useful dietary changes need research. Genetics as a risk factor for a wide variety of diseases, including cancer, is another important field.

The highest priority for health research is generally cardiovascular and cerebrovascular disease. But diseases that result in long-term disability, including osteoarthritis, osteoporosis, incontinence, dementia, depression, and visual and hearing disorders deserve higher priority (Cassel, 1994).

A large percentage of health changes in this century have come from behavioural changes in the population, and that will undoubtedly continue to do so. Yet little is known about how to convince people to change their behaviour. That people do change is beyond dispute. Cigarette smoking and diet changed well before concerted public health efforts to promote such changes. Research on methods to motivate people to stop smoking and to help them do so is a high priority (Bailar and Gornik, 1997).

The evaluation of efficacy and cost-effectiveness is obviously a high priority. Much information is becoming available, but there are still many old health technologies that have not been evaluated. In addition, technologies related to care and disability have been far less evaluated than clinical technologies. This type of research is a priority in the ageing field as it is in health care as a whole.

Technological developments needed

Clinical technology is changing at a very rapid rate. Investments in this area are large. Many forces promote the acceptance of new clinical technologies. In many cases, this leads to premature acceptance of such technologies.

On the other hand, technologies for supporting elderly and disabled people do not develop nearly so rapidly. Governments have not been very much involved in this field, and industry so far has generally shown little interest in it. In recent years, a number of countries have tried to stimulate such developments. Such efforts need to be expanded.

Possible changes in care

The sections above have presented a number of technologies that are not fully deployed despite good evidence of their efficacy and cost-effectiveness. These technologies range from vaccines to newer drugs for cardiovascular disease. Concerted efforts by policy-makers and medical leaders to assure full use of such under-used technologies could have an immediate impact on health status in OECD countries.

Care should always be based on what is known to be efficacious. Yet many practices are known or suspected to be useless or overused.

In a broad sense, changes to increase use of under-used technologies and to decrease use of overused and obsolete technologies fall within quality assurance activities, which are growing rapidly in OECD countries. Such programmes need to pay more attention to technological dimensions of care.

Health workers pay a great deal of attention to exciting developments in clinical technology. Yet these often have little impact on health status even if they are beneficial in a broad sense. The health system is largely oriented to preventing death. More attention needs to be paid to morbidity and disability. Elderly people often do not need medical treatment, but they may very well need care and support to remain in an independent position in society.

For example, social support has been found to prevent mortality. In addition, a change in social ties to a lower level is associated with a greater mortality risk (Cerhan and Wallace, 1997). Social support also is related to service use, including hospitalisation (Penning, 1995). Other factors have been found that predict success in maintaining high physical and cognitive function and sustained engagement in social and productive activities. Intervention studies are needed to test possible programmes for maintaining functioning in old age (Rowe and Kahn, 1997).

As mentioned above, there is a lack of models for providing care to the elderly, with a goal of promoting their independence. More demonstration projects are needed. It would also be beneficial to develop an inventory of successful models.

Needs for additional information concerning ageing and technology

Information on efficacy and cost-effectiveness is an essential part of any health care decision. Although there is still a long way to go, clinical interventions are being assessed far better now than 10 or 20 years ago. Technologies for non-clinical purposes, however, are poorly assessed, whether these are physical

aids for disabled people or telematic systems for allowing improved transmural care (Hutton and Persson, 1995; Rathenau, 1997*a*).

Perhaps the most important policy-related research that could be done across the OECD is to examine the question of disability and dependence over time in relation to the falls in mortality, replicating also some of the US-based surveys. Countries need to know what to expect in the future. Mortality will continue to decline. Does this mean rising morbidity rates, or increases in the number of people with morbidity and disability? Can falling morbidity rates be stimulated?

Recommendations for OECD research

1. A comprehensive international review of mortality/morbidity experience could be useful to OECD countries. A reasonable volume of research into the demography and health of the ageing population is available. The results are conflicting. The model developed by Kunkel and Applebaum (1992) could be updated and extended to the international context. The importance of such work is to understand better the implications of ageing for OECD countries, as well as possibilities for intervention, addressing priority needs.
2. OECD could suggest new or altered priorities for health research. Possibilities include studies of risk factors of disease, methods of changing behaviour, technology assessment, and evaluations of new models of care for the elderly. It seems clear that present priorities for research often do not pay sufficient attention to ageing, in particular the impact of chronic diseases and disabilities on future health and social care. New technologies could offer important solutions for changing this in the future.
3. OECD could review the possibilities for decreasing morbidity. These are not so clear as the possibilities of lowering mortality in the elderly. A comprehensive review covering all diseases of importance and the possible interventions would be necessary. A particularly interesting point, which has not received a great deal of attention, would be to identify conditions where the development and diffusion of technologies could "compensate" for people's functional limitations; therefore partially or entirely preventing disability. A model of the economic effects of ageing which includes the possibilities of technological intervention and their effects, could give important guidance for the future.
4. Mortality rates in the elderly seem almost certain to continue to fall. Active intervention could accelerate this fall in mortality. Some suggestions are given in this report to promote such an acceleration. OECD could carry out a comprehensive study of strategies to promote a more rapid decline of mortality in the elderly.
5. The strategies suggested in the other recommendations can help lead to changes in care, but they do not address the core issue. The core issue is, how can the health-care system be designed to provide care for sick and disabled elderly people without great increases in costs. Piecemeal approaches cannot deal with such dramatic change. A comprehensive model of care is needed that can prevent mortality and morbidity, promote healthy life styles, provide support in the non-institutionalised setting, and encourage increased self-care. Such a model could aid countries in efforts to reform health care.

NOTES ON METHODS

The initial research for this study was carried out using Medline, Excerpta Medica, and Current Contents. Searching for "technology and ageing" turned up few useful sources. Searching for "health and ageing" turned up a large number of articles, but few that were useful for the project.

Background on ageing was sought in standard textbooks of geriatric medicine and gerontology. These sources pointed to improvement in health related to technology, but gave few useful references.

Indexes of journals that might be assumed to contain relevant articles were hand-searched from 1992 to 1997. Journals searched included the *American Journal of Public Health*, the *European Journal of Public Health*, the *Bulletin of the World Health Organization*, the *International Journal of Epidemiology*, *Geriatrics*, *Gerontologist* and the *Journal of Gerontology*. Ultimately, the most useful journal by far was the *Journal of Gerontology: SOCIAL SCIENCES*. Editorials, review articles, and original research articles covered many subjects related to the project. Reference lists of relevant articles were carefully reviewed. Ultimately, several hundred articles were scanned.

Three past years of the *New England Journal of Medicine*, *The Lancet*, and the *Journal of the American Medical Association* were hand-searched generally, but also for articles on medical progress that could be applicable to the elderly.

Expert help was sought from the TNO Centre on Ageing, which was particularly helpful with Dutch literature, and the US Centers for Disease Control (CDC), which pointed to very useful references on health status of the elderly over time, especially in relation to preventive activities. In addition, CDC staff identified key articles on falling heart disease mortality.

With specific questions, such as the efficacy of specific interventions, the MEDLINE system was more useful. There was no difficulty in finding articles related to coronary heart disease and proven efficacy from randomised trials, for example.

Part of the contract called for an identification of significant centres carrying out longitudinal surveys relating to ageing, especially to ageing and technologies. The Internet was searched for such centres, and a large number were identified. The OECD library was particularly helpful in this part of the work. The journal *Gerontologist* began publishing a list of Internet sites and Web links in 1996.

The abstracts of the 1995 III European Congress of Gerontology were very helpful for assuring that pertinent research was covered and that all significant centres are listed. Centres were listed if they presented relevant work at that meeting.

No models using international data and examining the relationships between health technology and ageing were found.

ENDNOTES

1. Fries (1980).

2. Kunkel and Applebaum (1992).

3. Manton *et al.* (1997).

4. Addition by the Secretariat.

5. In light of Manton's recent data indicating an acceleration in the decline of disability rates with time, the assumptions made by the authors may have to be revisited. (Note by the Secretariat).

6. An extension of the study to cover this aspect might be of great interest.

7. On the whole, there is relatively little literature on intensity of use or appropriateness of use of technology specific to the elderly.

REFERENCES

AKHTAR, A., G. BROE, and A. CROMBIE *et al*. (1973), "Disability and dependence in the elderly at home", *Age and Ageing* 54, pp 102-111.

APPLEGATE, W. and M. PAHOR (1997), "Geriatric medicine", *Journal of the American Medical Association* 277, pp. 1 863-1 864.

BAILAR, J.C. and H.L. GORNIK (1997), "Cancer undefeated", *New England Journal of Medicine* 336, pp. 1 569-1 574.

BANTA, H.D. and B. LUCE (1993), *Health care technology and its assessment, an international perspective*, Oxford University Press, Oxford.

BEERS, M., A. FINK, and J. BECK (1991), "Screening recommendations for the elderly", *American Journal of Public Health* 81, pp. 1 131-1 140.

BENGTSON, A., J. HARLITZ, and T. KARLSSON *et al*. (1994), "The appropriateness of performing coronary angiography and coronary artery revascularization in a Swedish population", *Journal of the American Medical Association* 271, pp. 1 260-1 265.

BERG JETHS VAN DEN, A. and M. THORSLUND, "Will resources for elder care be scarce?", *Hastings Center Report, September-October* 1994, pp. 6-10.

BLACK, N. (1992), "Research, audit and education", *British Medical Journal* 304, pp. 698-700.

BONNEUX, L., J. BARENREGLT, and K. MEETER *et al*. (1994), "Estimating clinical morbidity due to ischemic heart disease and congestive heart failure: the future rise of heart failure", *American Journal of Public Health* 84, pp. 20-28.

BORST-EILERS, E., *New developments in health care and the application of technical developments in relation to the ageing population* (abstract). III European Congress of Gerontology, 20 August-2 September 1995, Amsterdam.

BOULT, C., M. ALTMANN, and D. GILBERSON *et al*. (1996), "Decreasing disability in the 21st century: the future effects of controlling six fatal and nonfatal conditions", *American Journal of Public Health* 86, pp. 1 388-1 393.

BOURLIERE, F. and J. VALLERY-MASSON (1985), "Epidemiology and ecology of ageing", in J.C. BROCKLEHURST (ed.), TEXTBOOK OF GERIATRIC MEDICINE AND GERONTOLOGY, Churchill-Livingstone, pp. 3-28, London.

BRODY, J.A., S. FRELLS, and T.P. MILES (1992), "Epidemiological issues in the developed world", in J.G. EVANS, T.F. WILLIAMS (eds.), OXFORD TEXTBOOK OF GERIATRIC MEDICINE, Oxford Medical Publications, pp. 14-20, Oxford.

BROOK, R., C. KAMBERG, and A. MAYER-OAKES *et al*. (1991), "Appropriateness of acute medical care for the elderly: an analysis of the literature", Santa Monica, CA, Rand.

BURKE, G.I., J.M. SPRAFKA, and A.R. FOLSOM *et al*. (1989), "Trends in CHD mortality, morbidity, and risk factor levels from 1960 to 1986: the Minnesota Heart Survey", *International Journal of Epidemiology* 18 (suppl I), pp. S73-S81.

CALLAHAN, D. (1987), "Setting limits: medical goals in an ageing society", Simon and Schuster, New York.

CALLAHAN, D. (1993), "Should health care for the elderly be rationed?", *Coronary Artery Disease* 4, pp. 393-394.

CARON, J.L. (1996), "Surgery in the elderly patient: a time for reappraisal", *The Canadian Journal of Surgery* 39, pp. 94-95.

CARRIERE, Y. and L. PELLETIER (1995), "Factors underlying the institutionalization of elderly persons in Canada", *Journal of Gerontology: SOCIAL SCIENCES* 50B, pp. S164-S172.

CASSEL, C., M. RUDBERG, and S.J. OLSHANSKY (1992), "The price of success: health care in an aging society", *Health Affairs* 11, pp. 87-99.

CASSEL, C. (1994), "Researching the health needs of elderly people", *British Medical Journal* 308, pp. 1 655-1 656.

CAST (1997), "Randomized placebo-controlled study of early aspirin use in 20 000 patients with acute ischaemic stroke", *Lancet* 349, pp. 1 641-1 649.

CATES, N. (1993), "Trends in care and services for elderly individuals in Denmark and Sweden", *International Journal of Aging and Human Development* 37, pp. 271-276.

CEC (Commission of the European Communities), (1993), "European networks of innovative projects concerning older people", Brussels.

CERHAN, J. and R. WALLACE (1997), "Change in social ties and subsequent mortality in rural elders", *Epidemiology* 8, pp. 475-481.

CHALMERS, I., M. ENKIN and M. KEIRSE (eds.) (1989), "Effective care in pregnancy and childbirth", Oxford University Press, Oxford.

CHARLTON, J. and R. VELEZ (1986), "Some international comparisons of mortality amenable to medical intervention", *British Medical Journal* 292, pp. 295-301.

CHASSIN, M., R. BROOK, and R. PARK *et al*. (1986), "Variations in the use of medical and surgical services by the Medicare population", *New England Journal of Medicine* 314, pp. 285-290.

CHASSIN, M., J. KOSECOFF, and R. PARK *et al*. (1987), "Does inappropriate use explain geographic variations in the use of health care services?", *Journal of the American Medical Association* 258, pp. 2 533-2 537.

COLLINS, R., R. PETO, C. BAIJENT, and P. SLEIGHT (1997), "Aspirin, heparin, and fibrinolytic therapy in suspected acute myocardial infraction", *New England Journal of Medicine* 336, pp. 847-860.

CONNOR, W. and S. CONNOR (1997), "Should a low-fat, high carbohydrate diet be recommended for everyone?", *New England Journal of Medicine* 337, pp. 562-563.

CRIMMINS, E.M. (1996), "Mixed trends in population health among older adults", *Journal of Gerontology: SOCIAL SCIENCES* 51B, pp. S223-S225.

CRIMMINS, E.M., M.D. HAYWARD, and Y. SAITO (1996), "Differentials in active life expectancy in the older population of the United States", *Journal of Gerontology: SOCIAL SCIENCES* 51B, pp. S111-S120.

DEAN, M. (1994), "Rational care by age deemed unfair", *The Lancet* 343, pp. 1278.

DEFEVER, M. (1991), "Long term care: the case of the elderly", *Health Policy* 19, pp. 1-18.

DICKINSON, E., P. ROCHON, and COCHRANE (1995), "Collaboration in health care of elderly people", *Age and Ageing* 24, pp. 265-266.

DOLL, R., R. PETO, and E. HALL *et al.* (1994), "Mortality in relation to consumption of alcohol: 13 years' observation in male British doctors", *British Medical Journal* 309, pp. 911-918.

DRACHMAN, D.A. and P. LEBER (1997), "Treatment of Alzheimer's disease -- searching for a breakthrough, settling for less", *New England Journal of Medicine* 336, pp. 1 245-1 247.

EASTON, D.F., D. FORD, and D. BISHOP (1995), "Breast and ovarian cancer incidence in BRCA1-mutation carriers", *American Journal of Human Genetics* 56, pp. 265-271.

FARROW, D., W. HUNT, and J. SAMET (1996), "Temporal and regional variability in the surgical treatment of cancer among older people", *Journal of the American Geriatrics Society* 44, pp. 559-564.

FEDSON, D. (1994), "Summary of the National Vaccine Advisory Committee Report", *Journal of the American Medical Association* 272, pp. 1 133-1 137.

FISHER, E., J. WENNBERG, T. STUKEL, and S. SHARP (1994), "Hospital readmission rates for cohorts of Medicare beneficiaries in Boston and New Haven", *New England Journal of Medicine* 331, pp. 989-995.

FRIES, J.F. (1989), "The compression of morbidity: near or far?", *The Millbank Quarterly, Vol. 67, N°2*, pp. 208-227.

FRIES, J.F. (1980), "Ageing, natural death, and the compression of morbidity", *New England Journal of Medicine* 303, pp. 130-136.

GERMAN, P., L. BURTON, and S. SHAPIRO *et al*. (1995), "Extended coverage for preventive services for the elderly: response and results in a demonstration population", *American Journal of Public Health* 85, pp. 379-386.

GOLDMAN, L. and E.F. COOK (1984), "The decline in ischemic heart disease mortality rates", *Annals of Internal Medicine* 101, pp. 825-836.

GOODMAN, C. (1994), Personal Communication.

GRAY, J.A.M. (1985), "Social and community aspects of ageing", in M. PATHY (ed.), PRINCIPLES AND PRACTICE OF GERIATRIC MEDICINE, John Wiley & Sons, pp. 17-55., New York.

GRAY, D., J. HAMPTON, and S. BERNSTEIN *et al*. (1990), "Clinical practice: audit of coronary angiography and bypass surgery", *The Lancet* 335, pp. 1 317-1 320.

GREENE, V., M. LOVELY, and J. ONDRICH (1993), "The cost-effectiveness of community services in a frail elderly population", *The Gerontologist* 33, pp. 177-189.

GRONBACK, M., A. DEIS, and T. SORENSEN *et al*. (1995), "Mortality associated with moderate intakes of wine, beer or spirits", *British Medical Journal* 310, pp. 1 165-1 169.

GURALNIK, J., L. FRIED, and M. SASLIVE (1996), "Disability as a public health outcome in the aging population", *Annual Review of Public Health* 17, pp. 25-46.

HAHN, R., S. TEUTSCH, R. ROTHENBERG, and J. MARKS (1990), "Excess deaths from nine chronic diseases in the United States, 1986", *Journal of the American Medical Association* 264, pp. 2 654-2 659.

HAKKINEN, U. and K. LUOMA (1995), "Determinants of expenditure variation in health care and care of the elderly among Finnish municipalities", *Health Economics* 4, pp. 199-211.

HANSON, M. (1994), "How we treat the elderly", HASTINGS CENTER REPORT, September-October.

HEALEY, B. (1997), "BRCA genes -- bookmaking, fortune telling, and medical care", *New England Journal of Medicine* 336, pp. 1 448-1 449.

HUNINK, M., L. GOLDMAN, and M.C. WEINSTEIN *et al*. (1997), "The recent decline in mortality from coronary heart disease 1980-1990: The effect of circular trends in risk factors and treatment", *Journal of the American Medical Association* 277, pp. 535-542.

HOLLAND, W. (ed.), (1988), "European Community atlas of avoidable death", COMMISSION OF THE EUROPEAN COMMUNITIES HEALTH SERVICES, Research Series Vol. 3, Oxford University Press, Oxford.

HORINA, J., H. HOLZER, and E. REISINGER *et al*. (1992), "Elderly patients and chronic haemodialysis (letter)", *New England Journal of Medicine* 339, p. 183.

HOUSE, J., R. KESSLER, and A.R. HERZOG *et al*. (1990), "Age, socio-economic status and health", *The Milbank Quarterly* 68, pp. 383-411.

HUDSON, R. (1993), "Social contingencies, the aged, and public policy", *The Milbank Quarterly* 71, pp. 253-277.

HUNTER, D. (1995), "Rationing health care: the political perspective", *British Medical Bulletin* 51, pp. 876-884.

HUTTON, J. and J. PERSSON (1995), "Special section: Technology and disability", *International Journal of Technology Assessment in Health Care* 11, N°2, Spring.

JAMIESON, A. (1994), "The role of the European Union in promoting healthy ageing", *Social Science and Medicine* 39, pp. 1 497-1 499.

JECKER, N. and L. SCHNEIDERMAN (1992), "Futility and rationing", *American Journal of Medicine* 92, pp. 189-196.

JEFFERYS, M. (1996), "Social inequalities in health -- do they diminish with age?", *American Journal of Public Health* 86, pp. 474-475.

JOHANNESSON, M. and P.O. JOHANSSON (1996), "The economics of ageing on the attitude of Swedish people to the distribution of health-care resources between the young and the old", *Health Policy* 37, pp. 153-161.

JOHANNESSON, M., B. JONSSON, and J. KIEKSHUS *et al*. (1997), "Cost effectiveness of Simvastin treatment to lower cholesterol levels in patients with coronary heart disease", *New England Journal of Medicine* 336, pp. 3 332-3 336.

KERLIKOWSKE, K., D. GRADY, and S. RUBIN *et al*. (1995), "Efficacy of screening mammography", *Journal of the American Medical Association* 273, pp. 149-158.

KHOURY, M. and the GENETICS WORKING GROUP (1996), "From genes to public health: the applications of genetic technology in disease prevention", *American Journal of Public Health* 86, pp. 1 717-1 722.

KIISKINEN, U., E. VARTIAINEN, M. PEKURINEN, and P. PUSKA (1997), "Does the prevention of cardiovascular diseases lead to decreased cost of illness? Twenty years of experience from Finland", *Preventive Medicine* 26, pp. 220-226.

KINCADE, B., J. NORBURN, S. BERNARD, and T. KONRAD *et al.* (1995), "Self-care and assistance from others in coping with functional status limitations among a national sample of older adults", *Journal of Gerontology: SOCIAL SCIENCES* 50B, pp. S101-S109.

KRAMER, A. (1995), "Health care for elderly persons -- myths and realities", *New England Journal of Medicine* 332, pp. 1 027-1 029.

KUNKEL, S. and R. APPLEBAUM (1992), "Estimating the prevalence of long-term disability for an ageing society", *Journal of Gerontology: SOCIAL SCIENCES* 47, pp. S253-S260.

LAGERGREN, M. (1995), "Determining the appropriate level of care", *Scandinavian Journal of Medicine* 23, pp. 209-215.

LAWRENCE, R. and A. JETTE (1996), "Disentangling the disablement process", *Journal of Gerontology: SOCIAL SCIENCES* 4, pp. S173-S182.

LEVINSKY, N. (1990), "Age as a criterion for rationing health care", *New England Journal of Medicine* 322, pp. 1 813-1 816.

LEXCHIN, J. (1992), "Prescribing and drugs costs in the province of Ontario", *International Journal of Health Services* 22, pp. 471-487.

LUBITZ, J., J. BEEBE, and C. BAKER (1995), "Longevity and Medicare expenditures", *New England Journal of Medicine* 332, pp. 999-1 003.

MACKENBACH, J., A. KUNST, and A. CAVELAARS *et al*. (1997), "Socio-economic inequalities in morbidity and mortality in Western Europe", *The Lancet* 349, pp. 1 655-1 659.

MANTON, K., L. CORDER, and E. STALLARD (1993), "Changes in the use of personal assistance and special equipment from 1982 to 1989: results from the 1982 and 1989 NLTCS", *The Gerontologist* 33, pp. 168-176.

MANTON, K., E. STALLARD, and L. CORDER (1995), "Changes in morbidity and chronic disability in the United States elderly population: evidence from the 1982, 1984, and 1989 National Long Term Care Surveys", *Journal of Gerontology: SOCIAL SCIENCES* 50B, pp. S194-S204.

MANTON, K. and J. VAUPEL (1995), "Survival after the age of 80 in the United States, Sweden, France, England, and Japan", *New England Journal of Medicine* 333, pp. 1 232-1 235.

MANTON, K., L. CORDER, and E. STALLARD (1997), "Chronic disability trends in elderly United States populations: 1982-1994", *Proceedings of the National Academy of Sciences USA Vol. 94*, pp. 2 593-2 598.

McGINNIS, J.M. and W. FOEGE (1993), "Actual causes of death in the United States", *Journal of the American Medical Association* 20, pp. 2 207-2 212.

McGOVERN, P.G., G.I. BURKE, and J.M. SPRAFKA *et al*. (1992), "Trends in mortality, morbidity, and risk factor levels for stroke from 1960 through 1990", *Journal of the American Medical Association* 268 , pp. 753-759.

MEULEN ter R., E. TOPINKOVA, and D. CALLAHAN, *What do we owe the elderly?* The Hastings Center Report, Special Supplement, March-April 1994.

MMWR. (1995), "Race-specific differences in influenza vaccination levels among Medicare beneficiaries -- United States, 1993", *Journal of the American Medical Association* 273, pp. 449-451.

MONICA Group. (1987), "WHO Monica Project: geographic variation in mortality from cardiovascular disease", *World Health Statistics Quarterly* 40, pp. 171-184.

NAKANISHI, N., K. TATARA, and H. FUJIWARA (1996), "Do preventive health services reduce eventual demand for medical care?", *Social Science and Medicine* 43, pp. 999-1 005.

NIESSEN, L., J. BARENDREGT, L. BONNEUX, and P. KOUDSTAEL (1993), "Stroke trends in an ageing population", *Stroke* 24, pp. 931-939.

NUSSELDER, W. and J. MACKENBACH (1997), "Rectangularization of the survival curve in the Netherlands", *Journal of Gerontology: SOCIAL SCIENCES* 52b, pp. S145-S154.

NUSSELDER, W., K. VAN DER VELDEN, and J. VAN SONSBEEK *et al*. (1996), "The elimination of selected chronic conditions in a population: the compression and expansion of morbidity", *American Journal of Public Health* 86, pp. 187-194.

OFFICE OF TECHNOLOGY ASSESSMENT (1978), "Assessing the efficacy and safety of medical technologies", US Government Printing Office, Washington DC.

OFFICE OF TECHNOLOGY ASSESSMENT (1981), "Cost effectiveness of influenza vaccination", US Government Printing Office, Washington DC.

OFFICE OF TECHNOLOGY ASSESSMENT (1982), "Technology and handicapped people", US Government Printing Office, Washington DC.

OFFICE OF TECHNOLOGY ASSESSMENT (1984), "Update of federal activities regarding the use of pneumococcal vaccine", US Government Printing Office, Washington DC.

OFFICE OF TECHNOLOGY ASSESSMENT (1984), "Technology and aging in America", US Government Printing Office, Washington DC.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (1993), *OECD Health Systems, Facts and Trends 1960-1991*, OECD, Paris.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (1996*a*), *Ageing in OECD countries, a critical policy challenge*, Paris.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (1996*b*), *Caring for frail elderly people, policies in evolution*, Paris.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (1997), *The economic aspects of biotechnologies related to human health. Part 1: Biotechnology and medical innovation: socio-economic assessment of the technology, the potential and the products*, Paris.

PAHOR, M., L. CAROSELLA, and C. PEDONE *et al*. (1996), "Trends in the characteristics and appropriateness of admissions to acute geriatric and medical wards in Italy from 1988 through 1993", *European Journal of Epidemiology* 12, pp. 563-571.

PENNING, M. (1995), "Health, social support, and the utilization of health services among older adults", *Journal of Gerontology: SOCIAL SCIENCES* 50B, pp. S330-S339.

RATHENAU INSTITUUT (1997*a*), *Extramurale technologie voor chronisch zieken (Extramurale technology for chronic illness)*, The Hague.

RATHENAU INSTITUUT (1997*b*), *Kansen en benaderingen voor assistive technology (Chances and approaches for assistive technology)*, The Hague.

RATHENAU INSTITUUT (1997*c*), *Zelfstandigheid ondanks beperkingen* (*Independence despite limits*), The Hague.

RENAUD, S. and M. DE LORGERIL (1992), "Wine, alcohol, platelets, and the French paradox for coronary artery disease", *The Lancet* 339, pp. 1 523-1 526.

RESTUCCIA, J., P. GERTMAN, and S. DAYNO *et al*. (1984), "The appropriateness of hospital use", *Health Affairs* 3, pp. 130-138.

RIVLIN, M. (1995), "Protecting elderly people: flaws in ageist arguments", *British Medical Journal* 310, pp. 1 179-1 182.

RIVLIN, M., J. WIENER, R. HANLEY, and D. SPENSE (1988), *Caring for the disabled elderly -- who will pay?,* The Brookings Institution, Washington DC.

ROBINSON, J. and V. GRAHAM (1997), "The European Union's public health policy and older people", *Eurohealth* 3, pp. 23-24.

ROCKETT, I. and J. POLLARD (1995), "Life table analysis of the United States' Year 2000 mortality objectives", *International Journal of Epidemiology* 24, pp. 547-551.

ROTHENBERG, L. (1992), "Withholding and withdrawing dialysis from elderly ESRD patients", *Geriatric Nephrology and Urology 2,* pp. 109-117 and *Geriatric Nephrology and Urology 3*, pp. 23-41 (1993).

ROWE, J. and R. KAHN (1997), "Successful aging", *Gerontologist* 37, pp. 433-440.

ROYAL COLLEGE OF PHYSICIANS OF LONDON (1994), "Ensuring equity and quality of care for elderly people",

SARANUMMI, N. (1996), "Ageing & technology, state-of-the-art", PREPARED FOR PROSPECTIVE TECHNOLOGICAL STUDIES, European Commission.

SCHAAPVELD, K., A. CHORUS, and R. PERENBOOM (1995), "The European health potential: what can we learn from each other?", *Health Policy* 33, pp. 205-217.

SHERMAN, S.E., R. D'AGOSTINO, J. COBB, and W.B. KANNEL (1994), "Does exercise reduce mortality rates in the elderly? Experience from the Framingham Heart Study", *American Heart Journal* 128, pp. 965-972.

SIU, A., F. SONNENBERG, and W. MANNING *et al*. (1986), "Inappropriate use of hospitals in a randomized trial of health insurance plans", *New England Journal of Medicine* 315, pp. 1 259-1 266.

SOU (1995), "Priorities in health care", Final report by the Swedish Parliamentary Priorities Commission, Swedish Government Official Reports, Stockholm.

SPIERS, N., C. JAGGER, and M. CLARKE (1996), "Physical function and perceived health: cohort differences and interrelationships in older people" *Journal of Gerontology: SOCIAL SCIENCES* 51B, pp. S226-S233.

STERN, M. (1979), "The recent decline in ischemic heart disease mortality", *Annals of Internal Medicine* 91, pp. 630-640.

STOCKING, B. (1982), "Management of medical technology in the United Kingdom", in H.D. BANTA and K.B. KEMP (eds.), THE MANAGEMENT OF HEALTH CARE TECHNOLOGY IN NINE COUNTRIES, Springer Publishing Company, pp. 10-28, New York.

STRATTON, J.F., S.A. GAYTHER, and P. RUSSELL *et al*. (1997), "Contribution of BRCA1 mutations to ovarian cancer", *New England Journal of Medicine* 336, pp. 1 125-1 130.

SUZMAN, R., F. KINSELLA, and G. MYERS (1992), "Demography of older populations in developed countries", in J.G. Evans, T.F. Williams (eds.), *Oxford Textbook Of Geriatric Medicine*, Oxford Medical Publications, pp. 3-14, Oxford.

TAYLOR, R.C. (1992), "Social differences in an elderly population", in J.G. EVANS, T.F. WILLIAMS (eds.), OXFORD TEXTBOOK OF GERIATRIC MEDICINE, Oxford Medical Publications, pp. 24-32, Oxford.

US PREVENTION SERVICES TASK FORCE (1996), "Guide to clinical preventive services", Williams & Wilkins, London.

VERMEULEN, L., K. KATUSZEWSKI, and T. RATKO *et al*. (1994), "Evaluation of ondansetron prescribing in US academic medical centers", *Archives of Internal Medicine* 154, pp. 1 733-1 740.

WAIDMAN, T., J. BOUND, M. SCHOENBAUM (1995), "The illusion of failure: trends in the self-reported health of the US elderly", *The Milbank Quarterly* 73, pp. 253-287.

WINEARLS, C., D. OLIVER, and J. AUER (1992), "Age and dialysis (letter)", *New England Journal of Medicine* 339, p. 432.

WINSLOW, C., D. SOLOMON, and M. CHASSIN *et al*. (1988), "The appropriateness of carotid endarterectomy", *New England Journal of Medicine* 318, pp. 721-727.

WOLFE, S. and R. HOPE (1993), "Worst pills, best pills II", Public Citizen's Health Research Group, Washington DC.

WORLD HEALTH ORGANIZATION (1997), "Drugs for the elderly", *WHO Regional Publications, European Series, No. 71*, Copenhagen.

YUSUF, S., J. WITTES, and L. FRIEDMAN (1988), "Overview of results of randomized clinical trials in heart disease", *Journal of the American Medical Association* 260, pp. 2 259-2 263.

ZAGONEL, V., U. TIRELLI, and D. SERRAINO *et al*. (1994), "The aged patient with lung cancer", *Drugs & Ageing* 4, pp. 34-46.