The Cost-Effectiveness of Lifesaving Interventions in Japan
Do the variations found suggest irrational resource allocation?

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Abstract

In this paper, information on the cost-effectiveness of life-saving interventions in Japan from the health, safety and environmental literature are collected and compared. More than 50 lifesaving interventions are analyzed. We define cost-effectiveness as the cost per life-year saved, and discuss the impact of including benefits other than survival, such as non-fatal injuries and diseases, and ecological risks.

1. Introduction

The idea that environmental health risks should be controlled using risk/benefit analysis has recently become increasingly influential. This leads to basing decision making on "cost-effectiveness analysis". That is, cost per unit health risk reduced is calculated and the priority is given to policies with the lowest values. The purpose of this study is to collect information on the cost-effectiveness of life-saving interventions in Japan and to discuss some questions concerning the choice of endpoints.

2. Cost per Life-Year Saved

2.1 *Method*

We have gathered information on the cost-effectiveness of life-saving interventions in Japan from the health, safety and environmental literature. We also performed some original case studies. 85 life-saving interventions are analyzed. We define cost-effectiveness as the cost per life-year saved (CPLYS). Although we did not recalculate this using a common criteria for standardization, due to the lack of information of basic data set, analyses included in this study meet the following criteria; They should contain information on life-saving interventions in Japan; and they should report cost per life-year saved, or sufficient information to calculate this. Ideally, costs would be expressed in some standard year yen, but they are not, since the studies are limited to those published within a decade.

2.2 *Results*

The mean CPLYS is ¥ 200 million and the median CPLYS is ¥ 3.3 million. CPLYSs have been classified into four categories of life-saving: safety control, environmental control, health care (prevention), health care (treatment). The number of observations and mean and median CPLYSs for these categories are shown in Table 1. The distribution of CPLYS estimates are shown in Figure 1, ranging from those that save more resources than they consume, to those costing more than ¥ 10 billion per life-year saved. Those categories are classified into two study types: retrospective and prospective. A 'retrospective study' deals with life-saving interventions that are actually in use, while a 'prospective study' deals with alternative or hypothetical life-saving interventions. Figure 2 shows the categorization of the studies in terms of prevention stage.

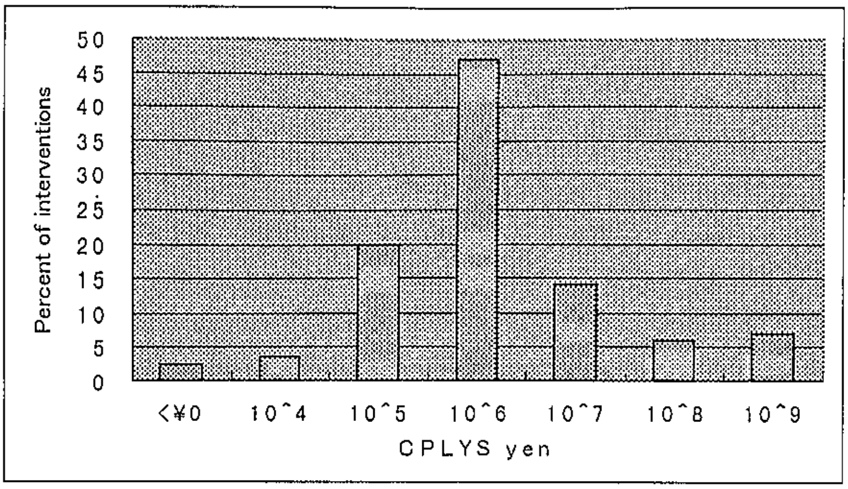
Table 1. Number of Observations and Mean and Median Cost per Life-Year Saved

Category		n	Mean	Median
Safety control	retrospective	3	23,000	27,000
	prospective	2	75,000	75,000
	all	5	44,000	30,000
Environmental control	retrospective	14	740,000	190,000
	prospective	2	3,200,000	3,200,000
	all	16	1,100,000	320,000
Health care (prevention)	retrospective	19	4,200	3,100
	prospective	18	3,500	2,100
	all	37	3,900	2,400
Health care (treatment)	retrospective	22	2,200	610
	prospective	5	4,300	6,200
	all	27	2,700	760
All	retrospective	58	180,000	4,100
	prospective	27	250,000	3,300
	all	85	200,000	3,300

* all costs are expressed in thousand yen, "n" indicates the number of observations

The table shows that the cost-effectiveness of risk-reduction policies varies enormously both within and between different sectors, in the same manner as the findings of similar analyses in the United States and Sweden (Tengs et al. 1995, Ramsberg and Sjoberg 1997). Cost-effectiveness for all life-saving interventions appears in Table 2.

Figure 1. Distribution of CPLYS estimates (n=85)



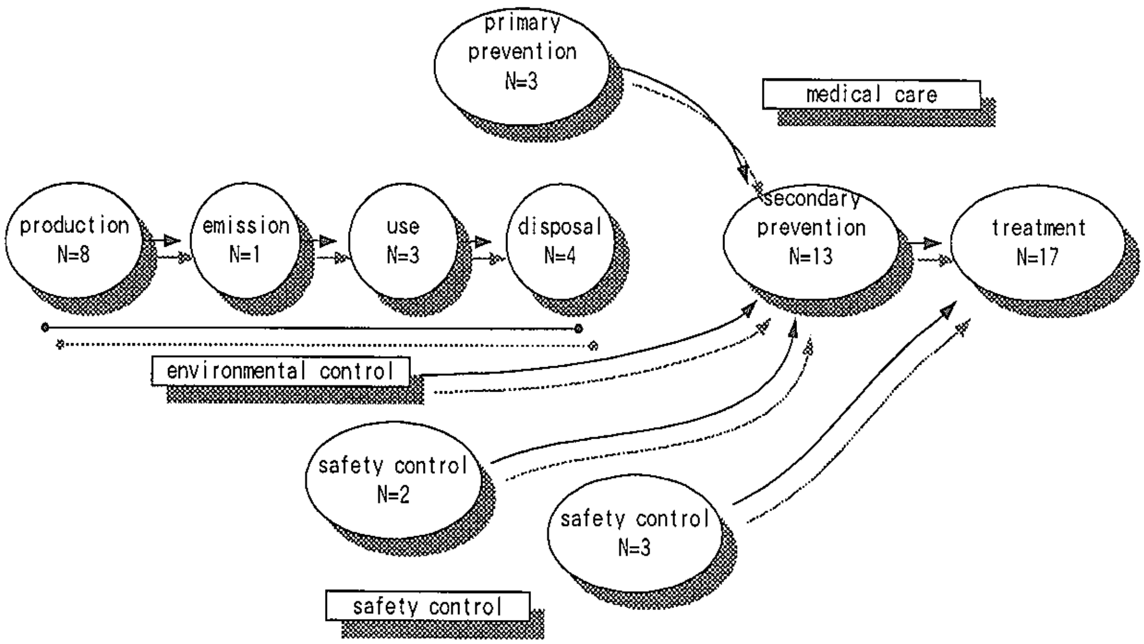


Figure 2. Categorization in terms of prevention stage
Note: "N" indicates the number of studies.

Table 2 "Cost per Life-Year Saved (CPLYS)" in Japan

Interventions	"CPLYS" thousand yen	Sources	type of studies
<Safety control>			
Road traffic			
Traffic safety facilities for pedestrians	27,000	Murayama(1991)	retrospective
Traffic safety facilities for pedestrians	5,000	Kishimoto(1997)	retrospective
Traffic safety facilities for Gifu city	30,000	Akiyama and Suzuki(1997)	prospective
Asbestos control			
Abatement measure for sprayed-on asbestos	*120,000*	*Murayama(1991)*	*prospective*
Abatement measure for sprayed-on asbestos	36,000	Kishimoto(1997)	retrospective
<Environmental control>			
Mercury control			
Prohibition of the mercury electrode process in caustic soda production	570,000	Nakanishi et al. (1998)	retrospective
Removal of mercury in dry batteries	22,000	Nakanishi(1995)	retrospective
Benzene control			
Control of benzene in gasoline	250,000	Kajihara et al. (1998)	retrospective
Control of trihalomethane(THM)			
High-level treatment of water supply			
groundwater pollutant aerator	*12,000*	*Akashi and Yasuda(1994)*	retrospective
THM removal facility: treatment plant A	3,700,000	Akashi and Yasuda(1994)	retrospective
THM removal facility: treatment plant B	1,800,000	Akashi and Yasuda(1994)	retrospective
THM removal facility: treatment plant C	1,200,000	Akashi and Yasuda(1994)	retrospective
THM removal facility: treatment plant D	2,200,000	Akashi and Yasuda(1994)	retrospective
Water purifier for home			
in place of treatment plant A	4,500,000	Akashi and Yasuda(1994)	prospective
in place of treatment plant B	1,900,000	Akashi and Yasuda(1994)	prospective
Ozone layer protection			
Recovery of chlorofluorocarbons			
Fukui prefecture	40,000	Oka(1997)	retrospective
Gifu prefecture	68,000	Oka(1997)	retrospective
Hyogo prefecture	130,000	Oka(1997)	retrospective
Tokyo prefecture	390,000	Oka(1997)	retrospective
Prohibition of chlordane	45,000	Oka et al.(1997)	retrospective
Dioxin control			
Urgent countermeasures at municipal incinerators	*56,000*	*authors' calculation*	*retrospective*
<Health care: prevention>			
Cancer screening			
Mass screening for gastric cancer			
males	610	Tsuji et al.(1991a)	retrospective
females	1,500	Tsuji et al.(1991a)	retrospective
male, 40s	6,400	Babazono and Hillman(1995)	retrospective
male, 50s	2,100	Babazono and Hillman(1995)	retrospective
male, 60s	1,200	Babazono and Hillman(1995)	retrospective
male, 70s	800	Babazono and Hillman(1995)	retrospective
female, 40s	5,100	Babazono and Hillman(1995)	retrospective
female, 50s	4,100	Babazono and Hillman(1995)	retrospective
female, 60s	3,100	Babazono and Hillman(1995)	retrospective
female, 70s	2,400	Babazono and Hillman(1995)	retrospective
all (1984-1992)	860	Kishimoto(1997)	retrospective
Kagoshima prefecture(1985-1994)	3,200	Kusano et al. (1997)	retrospective
Kagoshima prefecture(annual participation)	*21,000*	*Kusano et al. (1997)*	*retrospective*
Mass screening for lung cancer			
all (1987-1992)	8,700	Kishimoto(1997)	retrospective
Mass screening for breast cancer			
physical examination(PE) alone	7,500	Okubo et al.(1991)	retrospective
mammography(MG)	2,100	Okubo et al.(1991)	prospective
PE followed by MG if PE findings were abnormal	6,100	Okubo et al.(1991)	prospective
PE combined with MG for all screened women	2,700	Okubo et al.(1991)	prospective
all (1987-1992)	3,200	Kishimoto(1997)	retrospective
Mass screening for cervical cancer	4,900	Matsunaga et al.(1997)	retrospective
Mass screening for colorectal cancer			
two day method of screening program: male	4,100	Tsuji et al.(1991b)	prospective
two day method of screening program: female	5,100	Tsuji et al.(1991b)	prospective
total colonoscopy for workup strategy: male	3,300	Tsuji et al.(1991b)	prospective
total colonoscopy for workup strategy: female	4,100	Tsuji et al.(1991b)	prospective

starting age of screening: 40	1,800	Shimbo et al. (1994)	prospective
starting age of screening: 50	1,700	Shimbo et al. (1994)	prospective
starting age of screening: 60	2,100	Shimbo et al. (1994)	prospective
Mass screening for prostatic cancer			
age 55-59	200	Nakagawa et al. (1997)	prospective
age 60-69	<0	Nakagawa et al. (1997)	prospective
age 70-79	<0	Nakagawa et al. (1997)	prospective
Smoke cessation			
Smoke cessation with Nicotine TTS	18	Fujino et al. (1994)	prospective
Mass screening of unruptured intracranial aneurysms			
Using MR angiography			
male	1,600	Iinuma et al. (1994)	retrospective
female	1,300	Iinuma et al. (1994)	retrospective
Human immunodeficiency virus infection(HIV) prevention			
HIV screening for the population with 1% prevalence	2,100	Rahman et al. (1995)	prospective
Partner notification program	590	Rahman et al. (1998)	prospective
Cardiovascular disease control			
Prevention of coronary heart disease			
HMG-CoA reductase inhibitor (age 35)	75-6,500	Fujino et al. (1989)	prospective
HMG-CoA reductase inhibitor (age 45)	150-47,000	Fujino et al. (1989)	prospective
<Health care: treatment>			
Cancer treatment			
Lung cancer treatment (male, 60)	1,200	Koinuma(1997)	retrospective(QALY)
Colorectal cancer treatment (male, 60)	400	Koinuma(1997)	retrospective(QALY)
Gastric cancer treatment (male, 60)	300	Koinuma(1997)	retrospective(QALY)
Prostatic cancer treatment (male, 60)	300	Koinuma(1997)	retrospective(QALY)
Lung cancer treatment (female, 60)	1,000	Koinuma(1997)	retrospective(QALY)
Colorectal cancer treatment (female, 60)	400	Koinuma(1997)	retrospective(QALY)
Cervical cancer treatment (female, 60)	400	Koinuma(1997)	retrospective(QALY)
Breast cancer treatment (female, 60)	300	Koinuma(1997)	retrospective(QALY)
Gastric cancer treatment (female, 60)	300	Koinuma(1997)	retrospective(QALY)
Conserving treatment in place of mastectomy (female 4(	95	Hisashige(1997)	retrospective
Conserving treatment in place of mastectomy (female 5(	100	Hisashige(1997)	retrospective
Organ transplant			
Liver transplant	3600-8700	Miyasaka and Ohi (1994)	prospective
Heart transplant	4700-9300	Miyasaka and Ohi (1994)	prospective
Liver transplant			
6 years followup	4,600	Hisashige et al. (1997)	retrospective
life-time followup	2,100	Hisashige et al. (1997)	retrospective
Heart transplant	12,000	Ohta et al. (1996)	retrospective
Acute lymphocytic leukemia treatment			
Chemotherapy (5 years followup)	4,500	Ohta et al. (1996)	retrospective
Chemotherapy (life-time followup)	760	Ohta et al. (1996)	retrospective
Bone marrow transplantation (5 years followup)	3,300	Ohta et al. (1996)	retrospective
Bone marrow transplantation (life-time followup)	150	Ohta et al. (1996)	retrospective
Bone marrow transplantation in place of chemotherapy			
5 years followup	4,100	Ohta et al. (1996)	retrospective
life-time followup	450	Ohta et al. (1996)	retrospective
Obesity treatment			
Diet therapy	37	Fujino et al. (1992)	prospective
Mazindol therapy	17	Fujino et al. (1992)	prospective
Cardiovascular disease control			
Hypertensive care			
male	5,100	Hisamichi(1995)	retrospective
female	7,000	Hisamichi(1995)	retrospective
Coronary artery bypass grafting(CABG) in place of percutaneous transluminal coronary angioplasty(PTCA) for exertional angina pectoris (double vessel disease)	8,400	Hisamichi(1995)	prospective(QALY)

2.3 *Interpretations and Limitations*

Before drawing any conclusions, several caveats need to be noted in interpreting these results. First, as shown in Table 1, it is found that more than half of the interventions come from the health care field and those are much cost effective than safety and environmental interventions studied here. One of the reasons for this is that health care researchers have more incentives to demonstrate that their interventions should be adopted widely and be covered by the national medical insurance. There may be downward bias in the estimates of CPLYS in the medical field, such as the so-called publication bias.

Second, these interventions are classified into retrospective and prospective, as presented in Table 1. There is no significant difference between them in CPLYS estimates. Two factors may have some role. For one, those interventions which have already been adopted are more cost effective, since cost effective measures are preferred and followed by less cost effective ones. For another, prospective studies may tend to take those interventions which are less expensive than those already done.

Third, as Tengs et al. (1995) pointed out, there are some limitations in this kind of studies, such as the accuracy of the data and assumptions upon which the original analyses were based and the representativeness of them as a random sample of all life-saving interventions. However, above all, the question which we must consider first is that many of these interventions have benefits other than life-year saved, that is, reduction of non-fatal health effect and ecological impact, which are referred in next section.

3. Non-fatal health and ecological effect

Some studies include non-fatal effects in their calculation, but many studies do not. It is implicitly assumed that the ratio of the magnitude of reduced risks of non-fatal outcomes to that of life-years saved is close enough among these interventions, though the validity of this assumption has never been confirmed so far. Table 3 compares non-fatal benefit per life-year saved across some interventions. Non-fatal health effect can be incorporated into cost-effectiveness analyses in two ways. One is to convert them into monetary terms and net out from the cost side. The other is to measure effectiveness in terms of "adjusted" life-years, where non-fatal diseases and injuries are attached some quality-of-life weights.

Some studies include reduction of ecological risks in its calculation only as gains in direct use value, such as those in recreational and commercial fishing, and the reduction of crop damage, though environmental changes may also yield nonuse values. The evidence, based on small number of contingent valuation studies, suggests these values may be significant. Cost-effectiveness analyses can also be applied to the reduction of ecological risks, for example, "cost per species saved", since valuation studies still have many difficulties. Table 3 compares direct use ecological benefit per life-year saved across some interventions.

Table 3. Examples of non-fatal benefit per life-year saved

Examples of risk reduction measures	Non-fatal benefit per life-year saved (thousand yen)	Contents of benefit	Sources
Reduction of pedestrian motor vehicle accident	8,200	non-fatal injuries	U.K. Department of the Environment, Transport and the Regions (1997)
	23,000	non-fatal injuries	U.S. Department of Transportation (1994)
Reduction of exposure to suspended *particulate matter(SPM)*	8,200	non-fatal diseases	Ostro and Chestnut (1998)
Reduction in emissions of SO2 and NOx	1,600	non-fatal diseases	Burtraw et al. (1997)
	280	recreational lake fishing	
	4,100	visibility	
Reduction of exposure to suspended UV-B radiation	330	non-fatal diseases	Hammitt (1997)
	220	commercial fish and crop	

* \$1=¥120, £1=¥200

4. Conclusions

We must choose an endpoint in cost-effectiveness analysis as the event which people think are the most valuable. "Life-year saved" is adopted in this study. The endpoint may change as values of the society change as shown in figure 3.

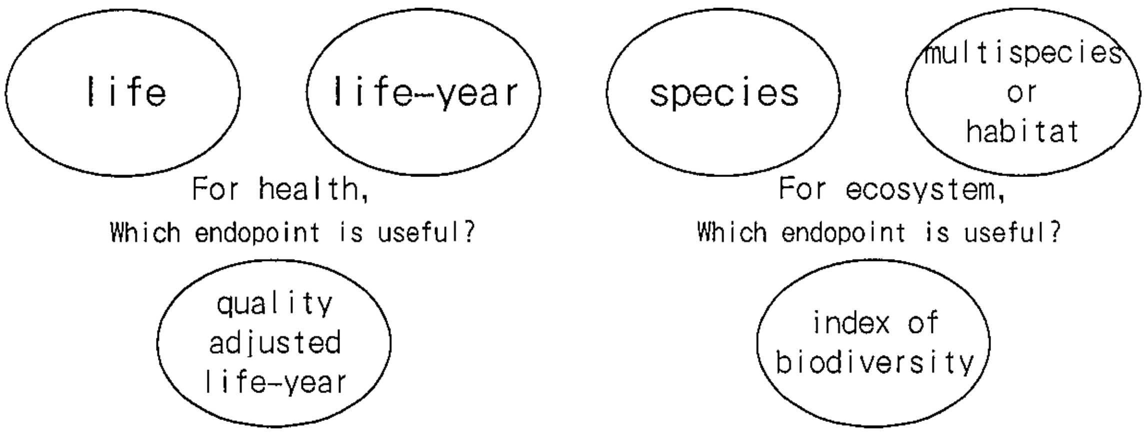


Figure 3. Choice of endpoints

It is shown that the cost-effectiveness of risk-reduction policies varies enormously both within and between different sectors. Considering that decision making concerning risk is mainly based on public demand, this result seems to be a reflection of the disparity between the risk perception of lay people and the risk assessment of experts. It is often discussed that the risk perception of lay people leads to inefficient resource allocation. Nevertheless, before concluding that democratic resource allocation, based on the preferences of lay people, is bound to be inefficient, it is necessary to explore into the way their risk perception differs from risk assessment by experts. The variations may not be so large when we consider some overlooked factors, such as non-fatal injuries, morbidity effect including reproductive effect and ecological risk, which seem to be important parts of the public demand for risk reduction.

5. References

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