Chapter 11

Economic Considerations

It would not be reasonable to make decisions on alternatives to animal use without having some idea of the consequences to the health and welfare of the public.

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Chapter 11

Economic Considerations

Economic considerations play an important role in decisions on the use of animals in research, testing, and, to a lesser extent, education. It is demonstrable that many valuable techniques, pharmaceuticals, pesticides, and other products have been developed or tested using animals. Yet animal use is often very expensive and time-consuming. A new pesticide, for example, may require $5 million worth of testing with animals before it can be registered. Even higher animal costs may be incurred in developing a new drug. Large incentives thus exist to find alternatives that reduce the cost and time involved in animal research and testing while maintaining the ability to improve human health, assess and manage the risks of toxic substances, and acquire fundamental new biomedical knowledge. Considerable investments are required to develop and validate such alternatives before they can be implemented with confidence.

This chapter examines costs and benefits surrounding animal use and the development, validation, and implementation of alternatives in research and testing. Data are provided for biomedical research as it relates to human health and disease, but a precise determination of costs and economic benefits of animal use within biomedical research is elusive. Several aspects of using animals in toxicological testing are examined, including the development of pesticides, the economic incentives to develop and validate nonanimal tests, and the extent of liability a manufacturer might incur for insufficient product testing.

In education, it is hard to put a price tag on the use of animals. At the college and graduate levels, benefits of animal use include the training of biologists, psychologists, toxicologists, physicians, and veterinarians. Education involving animals contributes indirectly to research and testing by training those who eventually carry out this work. The benefits of using animals in primary and secondary education include increasing students familiarity with animal behavior and care (see ch. 9).

HOW MUCH DOES ANIMAL USE COST?

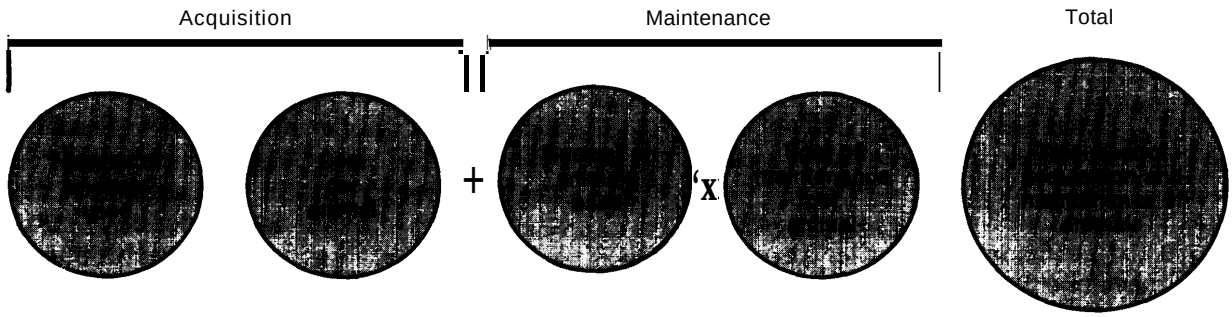
In either research or testing, the principal cost associated with animal use is that of human labor. Animals must be fed, watered, and have their cages cleaned. They require attendant veterinary care and are housed in facilities needing labor-intensive sanitation. Such labor costs are the major component of both the expense of producing animals in breeding facilities and the cost of maintaining them in laboratory facilities prior to and during research and testing.

The total cost of animal use is the sum of the cost of acquisition of the animals and that of maintaining the animals prior to and during their use. Acquisition expenses vary widely among species. Mice, for example, cost on average about $2 apiece, hamsters about $5, and guinea pigs about $19. Dogs range in price from $5 for a pound animal to several hundred dollars for a purpose-bred animal. Primates can cost from $400 to more than $2,000. The actual cost for a particular species varies with the sex, strain, weight, age, quantity ordered, method of shipping, and distance shipped.

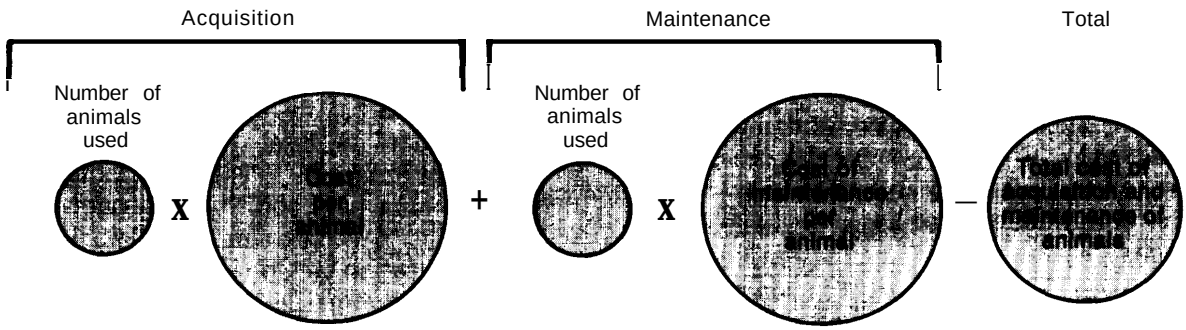
Maintenance costs also vary. Maintaining a mouse, for example, costs about 5 cents per day, a hamster about 11 cents per day, and a guinea pig about 40 cents per day. The actual cost varies among different laboratory facilities, depending, for example, on accounting practices and local labor costs. The total maintenance cost of an animal is directly related to its length of stay in the laboratory. It is important to note that maintenance expenses can quickly exceed and even dwarf acquisition costs. A 2-month-old hamster costing $5, for example, used in research until the age of 10 months costs $26 to maintain.

Figure 11-1 illustrates the relation between the number of animals used in research and testing

Figure 11-1.—Relation Between Number of Animals Used and Cost of Animal Use



The total cost of animal acquisition and maintenance equals the sum of the acquisition cost and the maintenance cost. (The maintenance cost depends-on the animal's length of stay in the animal facility.)



Using fewer animals will yield a decrease in the total cost of animal acquisition and maintenance, but the proportionate savings 'will be less than the decrease in the number of animals used. Both the price of each animal and the cost of maintenance per animal can be expected to increase to support the operating costs of breeding facilities and animal facilities.

SOURCE: Office of Technology Assessment.

and the total cost of animal use. Although the numbers and species of animals used (see ch. 3) and the price per animal can be estimated, it is currently impossible to estimate with any accuracy the laboratory lifetime-and hence the total maintenance costs-of animals used in the United States. Therefore no actual dollar figure can be affixed to the cost of animal acquisition and maintenance in research and testing. Beginning in 1986, the Public Health Service (PHS) will require reports on the average daily census of all species housed in PHS-funded facilities (see app. C). These data may permit an estimate of the total cost of animal use in a sizable portion of animal research—namely, that conducted in PHS-funded facilities.

The relationship shown in figure 11-1 emphasizes several aspects of the economics of animal use. If the number of animals used is reduced, the total cost of animal acquisition and maintenance will decline. But the proportional decrease in total cost will not match the proportional decrease in the number of animals used. Reducing animal use by 15 percent, for example, will not effect a cost savings of 15 percent; the savings will be somewhat less, for two reasons, First, if the number of animals used decreases, the cost of acquiring each animal can be expected to increase somewhat. (A temporary drop in price for some species that are in immediate oversupply may occur, but this would last only through the laboratory-useful lifespan of animals already on

hand and ready for sale.) With reduced demand, vendors would have to raise prices to cover their overhead. Second, if the number of animals used decreases, the expense of maintaining each remaining animal in a laboratory facility can be expected to increase. Laboratory-animal facilities would have to spread the cost of operation over fewer animals. In both breeding and laboratory maintenance of animals, there are economies of scale such that breeding and maintenance of marginally fewer animals does not yield a corresponding decrease in costs.

COSTS AND BENEFITS IN RESEARCH

The many important economic contributions of research with animals are difficult to characterize. First, research does not lend itself to such analysis. Normally, one experiment will draw from many others and contribute to future research, making allocation of costs and benefits to a particular activity virtually impossible. Second, the outcome of each experiment is uncertain, and the experiences in one program would not necessarily apply to others. Third, the delay between research and commercialization is long, reaching a decade or more, with payoff taking even longer. Thus, it is not possible to evaluate with any reasonable confidence the costs and benefits of current or even recent animal and nonanimal research practices,

Biomedical Research

This section discusses biomedical research in general, which unavoidably averages many diverse research experiences. Biomedical research is of interest because it is a major user of animals, because it affects human health, and because it affects an important sector of the economy—the health care industry. As with most areas of research, many of the contributions are indirect and many are not easily quantified in economic terms (see ch. 5). Most benefits are realized in the health care industry, which in 1983 accounted for $355.4 billion (10.8 percent) of the gross national product (9). Drugs, which require both biomedical research and toxicological testing in their development, have annual sales of about $30 billion and contribute about 20,000 jobs to the economy (29).

The first medical discovery that was largely a result of research with animals was diphtheria antitoxin at the end of the 19th century. Its use reduced the likelihood of death for those contracting diphtheria from 40 to 10 percent (28). Animals eventually came to be used in all phases of biomedical research and in the development of medical products such as drugs and devices and of services such as surgery and diagnostic techniques.

Research with animals that leads to practical applications can last from a few days to many years. It may involve inexpensive equipment or hundreds of thousands of dollars' worth of instrumentation, may be performed by a laboratory technician with little supervision or by a team of highly educated scientists, and may be done with fruit flies or with primates. The costs will vary accordingly.

The benefits and rates of return on a given experiment vary widely. The rate of return for a given research program can only be determined reliably many years after commercialization. In the case of products with high research and testing costs and long lead times to commercialization, which applies to many of the products of biomedical research, the lag can be several decades.

A 1972 study on the rates of return for six large pharmaceutical companies for research they conducted in 1954 through 1961, when animals were widely used, estimated the pretax private rate of return to be 25 to 30 percent (2). The social rate of return—the benefits to the public, was estimated to be at least twice as high (20).

Another approach to gauging costs and benefits involves looking at expenditures from 1900 to 1975 and comparing them with the benefits of medical advances in preventing sickness and death in the work force over the same period (4). All data were adjusted to 1975 conditions. Analogous comparisons were made for 1930 to 1975.

Of course, this approach ignores both the costs of research before 1900 (or 1930) that contributed benefits after those years and any research conducted before 1975 for which the benefits had not fully accrued. The latter is more confounding because much more research was done in the last decade of the study than any other, so the benefits could not be fully counted. Undervalue also occurs because it is impossible to measure the value of not being ill. Yet, other assumptions in the study may overvalue the benefits by neglecting changes in nutrition, lifestyle, and working conditions.

Benefits exceeded costs in this study by factors ranging from 4 to 16, depending on the assumptions made in calculating benefits and whether the time period is from 1900 to 1975 or 1930 to 1975. Expressing the results in another way, the savings in health-related costs due to the increase in knowledge was estimated to be $115 billion to $407 billion (4,20).

Savings were also calculated for various disease categories. As can be seen in table 11-1, research costs in certain areas have exceeded benefits accruing over the same period (as indicated by a minus sign). Table 11-2 provides related information about levels of funding in selected years, showing how funding grew during the same period. The research budget for 1975 corresponded to almost 9 percent of the costs associated with neoplasms (data not shown in tables), whereas all other budget-to-cost ratios were below 1.4 percent (20).

Although economic and financial data such as these are useful in making policy judgments, most decisions about using animals are more complicated and take into account political and technical considerations, as well as economic ones. Monetary costs and benefits must be balanced with factors such as scientists' desire to be certain and society's desire to have animals treated in a humane fashion. Economic analysis focuses on only part of the equation, and cannot be the sole basis for decisions.

one example of the tension between financial and other criteria is exemplified by the question of whether pound animals should be used in laboratory studies. A recent survey indicates that about three times as many dogs and cats are obtained from pounds and dealers (who often purchase from pounds) as are purpose-bred for laboratory use (18). Scientists have argued that

Table 11=1.—Total Savings Attributable to Biomedical Research[a] (in billions)

Disease category	1900-75 simulation			1930-75 simulation		
Total[b]	**$299.37**	**to**	**$479.83**	**$145.65**	**to**	$167.76
Infective and parasitic diseases	*118.35*	to	174,16	63.15	to	69,23
Neoplasms	*–2.66*	to	–3.17	– 1.17	to	– 1.40
Endocrine, nutritional, and metabolic diseases	*0.28*	to	0.95	– 1.57	to	–0.99
Diseases of the blood and blood-forming organs	*0.76*	to	1,27	5.22	to	5.45
Mental disorders	*9.20*	to	21.88	3.73	to	3.72
Diseases of the nervous system and sense organs	*14,76*	to	24.31	–3.32	to	–2.70
Diseases of the circulatory system	*10.68*	to	18.11	–6.42	to	–4.91
Diseases of the respiratory system	*71.75*	to	116.38	23.44	to	27.56
Diseases of the digestive system, oral cavity, salivary glands, and jaws	12.96	to	21.62	23.53	to	26.53
Diseases of the genitourinary system	23.58	to	37.28	9.27	to	10.96
Complications of pregnancy, childbirth, and postpartum	4.59	to	7.88	10.92	to	11.62
Diseases of the skin and subcutaneous tissue	0.93	to	1.76	2.98	to	3.04
Diseases of the musculoskeletal system and connective tissue	6.19	to	14.59	– 11.04	to	– 10.98
Congenital anomalies	7.56	to	10.08	– 1.41	to	–1.11
Certain causes of perinatal morbidity and mortality	2.80	to	3.73	4.38	to	6.58
Svmptoms and ill-defined conditions	14.46	to	19.80	–2.10	to	– 1.67
Accidents, poisonings, and violence	4.08	to	9.39	26.05	to	26.86

[a]Minus signs indicate costs exceeded benefits.
[b]Totals may not add due to rounding.

SOURCES: **1900-75 simulation:** S.J. Mushkin, *Biomedical Research: Costs and Benefits* (Cambridge, MA: Ballinger Publishing Co., 1979); 1930.75 simulation: A. Berk and L.C. Paringer, *Economic Costs of Illness, 1930-1975* (Washington, DC: Public Services Laboratory, Georgetown University, 1977).

Table 11-2.—Estimated Biomedical Research Outlays, Selected Years, 1900-75 (in millions)

Disease category	1900	1930	1963	1975
Total [a]	$0.1570	$10.0180	$1,561.0	$4,640.0
Infective and parasitic diseases	0.0476	1.0329	17.2	37.6
Neoplasms	0.0195	2.8291	847.6	2,464.8
Endocrine, nutritional, and metabolic diseases	0.0006	0.2775	33.2	109.0
Diseases of the blood and blood-forming organs	0.0003	0.0701	4.5	12.5
Mental disorders	0.0005	0.0461	4.1	22.7
Diseases of the nervous system and sense organs	0.0072	0.2164	14.2	41.3
Diseases of the circulatory system	0.0039	0.9136	252.4	876.0
Diseases of the respiratory system	0.0305	1.0609	96.5	261.7
Diseases of the digestive system, oral cavity, salivary glands, and jaws	0.0060	0.7273	62.3	175.4
Diseases of the genitourinary system	0.0129	0.9338	25.8	66.8
Complications of pregnancy, childbirth, and postpartum	0.0009	0.1142	1.2	0.9
Diseases of the skin and subcutaneous tissue	0.0002	0.0160	1.9	4.6
Diseases of the musculoskeletal system and connective tissue	0.0006	0.0240	3.3	12.1
Congenital anomalies	—	0,1092	18.4	32.0
Certain causes of perinatal morbidity and mortality	0.0085	0.4448	50.0	68.7
Symptoms and ill-defined conditions	0.0096	0.2725	19.4	74.2
Accidents, poisonings, and violence	0.0068	0.9377	109.0	379.6

[a] Totals may not add due to rounding.

SOURCE: Data from S.J. Mushkin, *Biomedical Research: Costs and Benefits* (Cambridge, MA: Ballinger Publishing Co., 1979)

pound animals are much cheaper than purpose-bred ones and that it would be wasteful to destroy them when they could be used. The difference in price between a purpose-bred and a pound dog ranges from $200 to $500 per animal. Estimates of the impact on research of a ban on using pound animals range from a tenfold increase in costs to effectively stopping research in Los Angeles County (25). Others have argued that pound animals are poorly suited to most laboratory work because they are often in poor health and their genetic background is usually uncertain (25).

It may seem ethically desirable to make use of animals that would be killed anyway, but an animal that had been a pet may find laboratory conditions more stressful than a purpose-bred animal would. Other nonpecuniary considerations are that people may hesitate to bring their animals to a pound if they oppose laboratory use of pound animals and that those using pound animals will see them as cheap, disposable experimental tools that need not be conserved (22).

Supporting Patent Claims

Data derived from animal research have proprietary value and are often used to support patent applications for drugs or devices for humans. Patents give the inventor an exclusive right to make and sell the patented invention, thus providing an incentive to invent, which in turn fuels a growing economy. Thus, animal use can have important economic consequences in addition to improvement in health.

To obtain a patent, an inventor must show that the invention is novel and useful and must disclose how to make it and use it. Data from studies with humans are normally obtained to support a patent on an invention to be used by humans, but data on animals can provide evidence of utility as well (12,15). And because they are normally obtained before research is done on humans, such data sometimes play a crucial role in determining the date of an invention, which could determine who gets the patent in the case of two competing inventors.

Utility can be demonstrated with animal studies, but only if the data would convince someone of ordinary skill in the art that the same effect would be observed in humans (14). The character and quantity of evidence needed to show utility depend, in part, on whether the results agree with established beliefs (13). Courts recognize that an animal may respond differently than a human would (16), and in demonstrating the utility of an invention it is not necessary to demonstrate safety (11)17).

In vitro experiments are sometimes sufficient to demonstrate utility for patent purposes. In one recent case (7), in vitro tests showed that the chemical to be patented, an imidazole derivative, inhibited thromboxane synthetase in blood platelets. The activity of thromboxane synthetase was thought to be related to hypertension, pulmonary vasoconstriction, and other cardiovascular diseases, and the demonstration of the chemical's ability to inhibit it was sufficient to show utility. Data showing therapeutic use were not required in showing that an invention had taken place. In another case, the fact that the inventor had given a detailed description of how the substance to be patented would behave was enough to support a showing of utility, thus fixing the date of invention (24).

Although the use of alternatives to support patents is interesting, it does not have much practical effect on the use of animals in developing medical products because safety and efficacy must be demonstrated to satisfy regulatory requirements (see ch. 7). These patent cases might have some application, however, in demonstrating the sufficiency of alternatives in other areas.

COSTS AND BENEFITS IN TESTING

There are several major economic benefits to using animals in toxicological testing. Drugs, food additives, pesticides, and many consumer products are tested for toxicity or other kinds of hazards before they can be marketed and begin to generate income for the manufacturer. This is often done to meet regulatory requirements, but the tests are also done to avoid marketing unsafe products. In addition, testing is done to confirm that a product does in fact confer a benefit.

Testing Pesticides for Toxicity

Over a billion pounds of pesticides are used in the United States annually, corresponding to over $4 billion in sales. About 130 firms produce the active ingredients in pesticides. Thirty of these produce common products in high volume; the others tend to produce specialty pesticides. Most of the pesticides are used in the agricultural sector. About 7 percent are purchased by consumers for home and garden use, while industrial and institutional use account for about 20 percent (31).

Because pesticides are designed to be biological poisons, they are among the most toxic substances commercially available. Most of the hazards result from chronic, low-level exposure. Exposure and the risk of it are widespread. About 2 million commercial farms in the United States use pesticides, some of which remain in or on the food and are eventually consumed. About 40,000 commercial applicators use pesticides to treat structures and facilities. The Environmental Protection Agency (EPA) estimates that 90 percent of all households regularly use or have used pesticides in the home, garden, or yard (31). The results of tests on animals are used by EPA to identify hazards and to develop acceptable exposure levels and safe handling and disposal practices (see ch. 7). Thus, animal testing plays an important role in the protection of virtually the entire U.S. population.

Acute poisonings have been estimated to cost over $15 million annually (1980 dollars), excluding the value of saving lives or avoiding suffering. The estimated cost of each death due to pesticide poisoning is $112,000, whereas the average cost of a nonfatal poisoning is $200 (23,31). The costs of cancer, the most important chronic effect, is over $34 billion in 1980 dollars, with each cancer costing $52,000 (31). One research goal is to find new pesticides that are less toxic and more effective than those now in use, a search that entails animal testing.

There are over 48,000 registered pesticide formulations, with an estimated 1,400 to 1,500 active ingredients (5). There are between 5 and 20 new registrations for active ingredients issued annually, each requiring a complete toxicological evaluation based on animal testing and other data. Another 1,500 to 2,000 new formulations or uses are also registered annually (5,31). These require little additional testing, as a rule, and often rely on data in EPA's files.

Testing costs vary with the product and its uses. Pesticides intended for food crops require much more testing than those for other uses. Some of the required testing depends on results obtained in screening tests. The cost of testing can range from $2 million to $5 million for a new active ingredient. This represents a small fraction of the total developmental expenses, which may approach $100 million (31). Testing costs are incurred primarily in the beginning of the developmental cycle (see fig. 11-2). As the figure illustrates, testing with animals-during testing for toxicity—is an integral part of the development of a new pesticide.

Testing and Product Liability

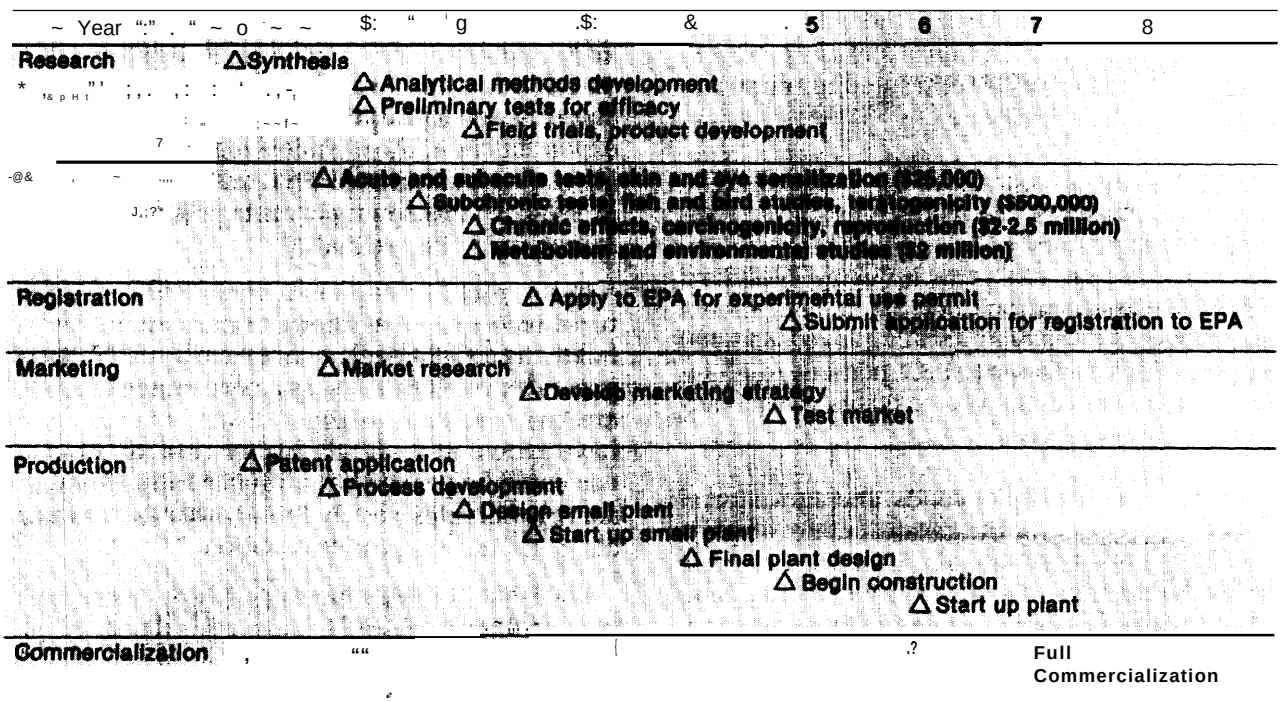
Toxicological testing of consumer products helps keep unsafe products off the market, It also may sometimes allow liability for injuries to be avoided. The cost of product liability litigation can be enormous, and companies are tending to drop risky products, as the current situation with vaccines illustrates.

Most States have "strict liability, " in that a manufacturer is liable for whatever injuries its products cause. In most jurisdictions, there are exceptions, such as when the technology for determining that a product is unsafe does not exist. There are also exceptions when the product is known to be dangerous but also to confer a great benefit. Such is the case for rabies vaccine. A few jurisdictions merely require that a manufacturer not be negligent (see ch. 7.) Manufacturers are unlikely to adopt alternatives to animal tests until they believe such methods offer a level of assurance of product safety equal to that offered by animal testing.

Testing Costs of Animals and the Alternatives

An estimated 80 percent of the cost of testing, whether whole-animal or in vitro, is for labor (6). Testing costs vary widely with the assay used and somewhat with the facility. The cheapest, such as for eye or skin irritation, can be done for un-

Figure 11 "2.—Development of a Typical Pesticide for Agriculture
(Note the integral role of animal toxicity testing in pesticide development, shown in boldface.)



SOURCE: Off Ice of Technology Assessment, adapted from Haskell Laboratories, El. du Pent de Nemours & Company, Wilmington, DE, 1984.

der $1,000. An LD_{50} test can be performed for less than $2,000. Subchronic toxicity tests can cost under $100,000, and those for long-term toxicity or carcinogenicity for two species can be done for less than $1 million, and perhaps for under $500,000 (10,31). As a rule, the cheaper tests require fewer animals, but more importantly they take far less time at each of three stages—planning, execution, and analysis. Another reason for large variations in testing costs is the species used, with maintenance costs approximating $0.05 per day for a mouse, $4 for a dog, and $11 for a chimpanzee. Most of the cost of maintaining animals is attributable to labor expenses.

Various short-term in vitro tests for mutagenicity have been developed over the past 15 years in an effort to replace the more costly and time-consuming carcinogenicity test (see ch. 8). The most popular mutagenicity test, and one of the first to be introduced, is the ***Salmonella typhimurium*** / microsome plate mutation assay (the Ames test), costing $1,000 to $2,000 (10). This assay has the most extensive database thus far (1). Used alone, it does not appear to be as predictive of human carcinogenicity as are animal tests.

If the Ames test, some yet-to-be developed test, or a battery of tests proves to be more predictive of carcinogenicity than testing with animals, the savings could be enormous. A battery of tests that might indicate carcinogenicity has been suggested by the National Toxicology Program (30) and has shown some promise in preliminary evaluations (see ch. 8). Most testing laboratories could conduct this particular battery of tests for under $50,000, and costs would probably decline as the tests become more commonplace (10).

NATIONAL EXPENDITURES FOR RESEARCH AND TESTING

Research and testing in the United States are financed and conducted in a variety of ways. The sources of research funding are Government and industry. Some Government research funds support Government laboratories, but a larger share support research in academia. Industry research is done primarily at in-house industry laboratories, with some funds contracted to other laboratories and to academia.

Most testing is conducted by industry. The chemical industry is the sector most directly affected by regulatory policies concerning toxicological testing. In 1982, this industry (Standard Industrial Classification Code 28) had shipments worth over $170 billion and employed 866,000 people, which represented 8.7 percent of all industry shipments in the United States and 4.5 percent of the employees.

Drugs, soaps and toilet goods, and agricultural chemicals account for the greatest use of animals in testing, and constitute almost a third of their use by the chemical industry. The rest of the chemical industry, in order to satisfy transportation, disposal, and occupational health requirements, does simple tests such as the LD_{50} for substances for which the potential exposure is high (see ch. 7).

Corporate research and development (R&D) in the chemical industry is large and concentrated in the industrial chemicals and drug sectors. Expenditures by the industry totaled $7.6 billion in 1984 (8), a figure that includes in-house toxicological testing, research involving the use of animals, and many other activities. It has been estimated that the toxicological testing industry accounts for just under 10 percent of the R&D expenditures in the chemical industry (27), making testing an estimated $700 million expenditure in 1984. An unknown percentage is spent on research involving animals.

In the past 10 years, industry's R&D expenditures have grown at about 13 percent per year, following a slight decline in the early 1970s. R&D expenditures for drugs, as a percentage of sales, are twice as high as the industry average, and have grown at a slightly higher rate (8). Animal use could be growing at a similar rate, although survey estimates (see ch. 3) and other factors (see ch. 8) do not support this notion.

The Federal Government also plays a major role in animal research and testing, with almost $6 billion obligated for research in life sciences for 1985. University research in the life sciences, which is funded largely by Government and some-

what by industry, will cost an estimated $2.9 billion (8).

Projections of future expenditures depend on a number of factors, including the growth of the chemical industry and of R&D within it; the areas of R&D (e.g., new substances, new uses for old substances, new processes for making old substances); regulatory policies, both domestic and foreign; the growth of the overall economy; tax policy; and further developments in nonanimal tests.

International developments can have economic repercussions. For example, Swiss voters defeated in 1985a referendum virtually banning all animal testing (see ch. 16). A number of companies have facilities in Switzerland, and such a change could have shifted testing to another country. whether U.S. labs could compete for that business depends on the strength of the dollar.

Toxicological Testing Services

In 1984, the toxicity testing industry in the United States was estimated to be worth about $650 million per year (27). Sixty-five percent of the testing is done by corporations in-house. The remaining 35 percent (about $225 million annually) is conducted by commercial laboratories, universities, and other organizations. Although there are over 110 U.S. laboratories that sell testing services, most specialize in a small number of assays and are not '(full service. " Hazelton is the largest of the full-service labs, with domestic sales of $36 million in 1983. Except for Hazelton and several other large commercial labs, the industry is a dispersed one, with the many small commercial firms accounting for approximately two-thirds of the value of domestic sales (10).

The industry expanded its facilities in the 1970s in response to Federal regulatory changes and the passage of the Toxic Substances Control Act. Testing did not increase as much as expected, however, and in the early and mid-1980s the industry was operating at 60 to 70 percent capacity (27). This has led to fairly level prices over the past few years and, in some cases, price cutting to maintain market position. Because of this competition, current prices reflect the actual costs of testing. Testing laboratories often do not quote set prices for some testing procedures or for particular batteries of tests, preferring to negotiate on a case-by-case basis.

Government Toxicological Research and Testing

The U.S. Government programs with strong ties to toxicological testing are EPA, the National Center for Toxicological Research in the Food and Drug Administration, the Centers for Disease Control, and the National Institutes of Health (see table 11-3). other programs are not identified with separate budget line items and are dispersed among various agencies and departments.

Table n-3.-Selected Federal Expenditures Reiated to Toxicoiogicai Testing and Research, 1984-86
(in thousands)

	1984	1985a	1986a
Environmental Protection Agency:			
Program expenses	*$327,145*	*$380,341*	*$376,074*
Toxic substances	34,484	39,341	38,660
Pesticides	32,772	37,805	36,948
Research and development	144,903	195,449	212,061
Toxic substances	12,327	14,450	26,358
Pesticides	1,738	5,121	6,938
Interdisciplinary	18,522	22,423	14,876
Food* and *Drug Administration:			
National Center for Toxicological Research	21,132	21,575	22,284
Drug program	138,248	153,112	152,430
Food program	115,541	109,538	113,907
Devices and radiologic products	62,568	67,081	68,368
Centers *for Disease* Control:			
Occupational safety and health research	54,740	54,863	57,645
Research on chronic and environmental disease	25,953	28,568	23,726
National Institutes of Health:			
National Cancer Institute:			
Cause and prevention	276,075	301,655	285,844
Detection and diagnosis	63,182	70,524	66,839
Treatment	340,041	367,940	351,683
National Institute of Environmental and Health Sciences:			
Characterization of environmental hazards	19,152	21,136	21,601
Applied toxicological research and testing	57,781	57,303	56,737
Intramural research	48.643	55.051	52.536

[a]Estimates.

SOURCE: U.S. Executive Office of the President, Office of Management and Budget, *Budget of the United States Government, Fiscal Year 1986* (Washington, DC: U.S. Government Printing Office, 1985),

PROTECTING PROPRIETARY INTERESTS

In commercializing a particular product, animal use may be limited to toxicity testing, but many products rely on animals in the initial research phase as well. These research and testing results have proprietary value that is sometimes protected by secrecy, other times by obtaining a patent. The value of data that lead to a particular product may depend more on the size of the market and its profitability than on the cost of obtaining them, particularly when it takes a long time to generate the data.

Cooperative Research and Testing

Two major competing factors influence the sharing of research and testing costs— the desire to keep information that has proprietary value secret and the desire to share the very large expenses that may be involved in generating it. These business decisions are only slightly influenced by Government policies. Another factor is antitrust law, however, which is greatly affected by such policies.

In considering the role of antitrust law, it is important to recognize that the results of research and testing enable society to use resources efficiently. Antitrust laws help ensure that these efficiencies benefit consumers, by preventing manufacturers, for example, from colluding to maintain high prices. However, these statutes have sometimes been applied in a way that impedes technological development (3) by making it difficult for companies to pool resources for research so expensive that none would undertake it alone.

In recent years, antitrust policies have been changed or clarified so that resources can be pooled more easily (19). One component of this is the National Cooperative Research Act of 1984 (public Law 98-462). The Sherman and Clayton antitrust acts still apply, but damages in private suits are reduced from three times the value of the unfair advantage to the actual value. This will certainly lower the risks involved in collaborating, and probably the likelihood of being sued as well.

Testing costs can be most equitably shared if potential participants can interact before testing begins rather than after it is completed, because a party who has already tested may have an unfair advantage (or disadvantage) in negotiating compensation. It is easiest to identify potential sponsors for a particular chemical when testing is required by a regulatory agency, because it is known that testing will take place and who is required to test. When industry forms testing consortia to share costs, it is most easily done through existing trade associations, such as the Chemical Manufacturers Association. Cooperative testing is also conducted by industry through the Chemical Industry Institute of Toxicology.

Many testing consortia have been put together to negotiate agreements in anticipation of required testing under Section 4 of the Toxic Substances Control Act. Such negotiations were ruled invalid in a recent case (2 I). Despite this ruling, testing consortia will continue to have appeal so long as testing is expensive and the results have little or no proprietary value other than in fulfillment of regulatory requirements.

Toxicity Testing Data

Many companies begin making other financial commitments to the commercialization of a product before testing is completed. Plant design and small-scale production may coincide with long-term toxicity testing. The practical costs of fulfilling lengthy testing requirements may greatly exceed the costs of testing. Thus, it is advantageous to be able to use any existing data generated by another laboratory in order to avoid the delays and uncertainties of testing. Conversely, this provides an incentive to prevent data from being made available to competitors.

The protection of pesticide testing data has been the subject of much litigation and several amendments to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The most recent changes provide that data submitted after September 30, 1978, are protected from uncompensated use for 15 years. There are two kinds of protection. One

requires that data be shared as long as compensation is offered. The terms of the compensation are subject to arbitration if the parties cannot agree. The other protection only applies to new pesticides (new active ingredients), not to new formulations of old ingredients. It gives exclusive use of the data to the data owner for 10 years unless the data owner explicitly agrees to sell the right to use the data.

The Supreme Court recently decided in ***Ruckelshaus v. Monsanto (26)*** that these provisions of FIFRA are constitutional. For data submitted before 1972 or after 1978, there is no expectation of a proprietary interest, thus nothing is taken; for data submitted between those years, the compensation and arbitration provision, in combination with the Tucker Act, provides adequate compensation. (See also the Environmental Protection Agency's regulations at 40 CFR 1984 ed. 152; 40 FR 30884.)

Congress has recognized the important business interest in keeping information from competitors, but it also supports the public's '(right to know" and the Federal Government's need to know. An important barrier to the sharing of confidential business information among agencies is the differing standards and procedures for handling it. The ad hoc interagency Toxic Substances Strategy Committee, coordinated by the Council on Environmental Quality, thought it would be necessary to pass legislation permitting the sharing of confidential data between health and environmental agencies (32). Such legislation would establish a need-to-know standard, require uniform security procedures for the data to be shared, impose uniform penalties for disclosure, and provide for notification of the data submitted by the data holder at least 10 days prior to transfer.

SUMMARY AND CONCLUSIONS

The total dollar cost of animal acquisition and maintenance is directly related to the length of time animals stay in the laboratory. With no accurate source of data on various species' length of stay, it is impossible to calculate the total cost of animal use. Analysis of the factors involved in the costs of animal acquisition and maintenance indicates that a reduction in animal use will be accompanied by a reduction in cost—although the proportionate savings will be less than the proportionate decrease in the number of animals used.

Many of the issues involved with using animals in research and testing have economic implications, although they do not lend themselves well to rigorous quantitative economic analysis because many considerations are nonmonetary. A highly contested concern, for example, is the propriety of using unclaimed pound animals in laboratory studies.

An area of animal use that is of major economic importance is biomedical research, which contributes to health care through the development of drugs, medical devices, diagnostic techniques, and surgical procedures. Health care accounts for over 10 percent of the Nation's gross national product, or $355 billion in 1983. The results of research with animals might also reach the public through patented products. Although data on humans may also be required, and although nonanimal or in vitro methods are sometimes sufficient, many such patent applications use animals to show that the invention is useful.

Another use of animals with economic importance is toxicological testing, used to ensure that new products are sufficiently safe. One type of product for which such testing is of major consequence to public health is in the development of pesticides, which affect virtually all Americans through the production and contamination of food. The Environmental Protection Agency has estimated that 90 percent of all households use some pesticide product.

Whole-animal tests can be far more costly than in vitro and nonanimal alternatives, largely because they are labor-intensive. The incentives to find alternatives to the LD_{50} and Draize tests are primarily nonmonetary, however, as these tests can be performed for $1,000 to $2,000. This is

in the price range of the cheaper, currently available in vitro and nonanimal replacements.

Most research and testing in the United States is financed by Government or industry. The chemical industry, including the production of drugs, has annual sales of over $170 billion and spends over $7 billion on research and development. An unknown fraction is spent on research involving animals and about $700 million is spent on toxicity testing.

The Federal Government sponsors much biomedical research and testing involving animals (see ch. 12). An unknown amount leads to the development or use of alternatives. The Government also has many programs related to testing, including the evaluation of testing data generated in other sectors. Agencies with significant budgets for such activities include the Environmental Protection Agency, the Food and Drug Administration, the Centers for Disease Control, and the National Institutes of Health.

The Federal Government also has a special role in the sharing of data derived from animal use, as the data have proprietary value. First, antitrust laws and policies affect industry's ability to share data and the costs of generating it. Such sharing is facilitated by the passage of the National Cooperative Research Act of 1984. It is also facilitated under the Federal Insecticide, Fungicide, and Rodenticide Act and the Toxic Substances Control Act.

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