CHAPTER V

EVALUATING ANIMAL RESEARCH

A. THE VALUE OF ANIMAL RESEARCH

For much of the last thirty years of debate over the use of laboratory animals, the scientific community* has kept a low profile, appearing to hope that the protests against animal research were just a passing fad. Mark Hatfield, Executive Director of the Research Defence Society in England, commented on this approach, stating that:

The ignorance of the public on scientific and medical matters is indeed abysmal and a large chunk of the blame must surely go to the scientists themselves for failing to communicate their subject in an intelligible and balanced manner (Mittwoch, 1990).

Since 1985, (in the wake of the head trauma laboratory case at the University of Pennsylvania and then-Secretary of Health Margaret Heckler’s concessions to animal activists) the scientific community has begun to develop a much more active and public profile supporting the use of animals in research. For example, public interest advertisements have been developed and widely distributed, high-profile spokespersons (e.g. former Secretary of Health Dr. Louis Sullivan and former Surgeon-General, Dr. C. Everett Koop) have been recruited to present the message that animal research is necessary, justified and beneficial to both humans and other animals, and speakers who are more knowledgeable in the issues and arguments have appeared. Some of the arguments put forward to support the use of laboratory animals are summarized below.

* “Scientific community,” like “humane movement,” implies a uniformity of opinions and tactics that neither of these categorizations really reflects. The terms are used here only as convenient approximations.
1. HUMAN BENEFIT

Spokespersons for the scientific community assert that the majority of medical advances leading to the cure and treatment of disease are based directly or indirectly on animal research. It has been argued that 90% of the medical knowledge developed in the past 100 years can be traced directly to research involving the use of animals (Hamm, 1985). This implication that nearly all knowledge is derived from animal research is, however, an exaggeration that the critics have no difficulty in undermining.

Sir William Paton (1993) is not as all-encompassing in his claims for animal research and he recognizes the important role played by other investigative approaches. However, he does argue that no area of biological or medical knowledge would be unaffected if animal research had been forbidden. This claim (of the indirect and direct influence of animal research) is not as easy to undermine. In fact, in general terms, the real influence of animal research on medical and biological knowledge is very difficult to quantify. Most advocates and critics rely mainly on specific examples that focus on a tiny element of scientific knowledge for a finite time, not infrequently based on a selective use of source material.

The influence of animal research extends into the development of knowledge of infections and their control, of anesthesia and its refinement, of disturbances in nutrition and dietary deficiencies, and in the development of new drugs and their continued refinement (Paton, 1993). The Foundation for Biomedical Research in their Portraits (1990) booklet states (with little fear of effective contradiction) that “these discoveries and treatments touch every human life in some way from the moment of birth.”
THE JOHN OREM STORY

On July 4, 1988, the laboratory of Dr. John Orem, a professor of physiology at Texas Tech University, was broken into and vandalized. Seventy thousand dollars of damage was done and research animals as well as documents were stolen. The day following the break-in, People for the Ethical Treatment of Animals (PETA) distributed a news release announcing the break-in and two days later held a news conference accusing Orem of "cruelty, incompetence, and greed" in his research and in his treatment of his laboratory animals. PETA and the Animal Liberation Front (ALF), who claimed responsibility for the break-in, objected to Orem's treatment of his laboratory cats who were surgically prepared so that electrodes could be inserted into their brains to monitor neural activity.

The target of these attacks, John Orem, had been supported for twelve years by the National Institutes of Health (NIH) and had recently received a five-year grant from NIH to continue research into the neurophysiology of the control of breathing and the alterations in these controls during sleep. Clinically, it appears that these alterations induced during sleep in normal people cause no problems but patients with certain types of lung disease and infants are another matter. Sudden Infant Death Syndrome (SIDS), the most common cause of death in infants, is now thought to be due to problems in breathing control during sleep.

Following the break-in and charges by PETA, the press took up the story and state-wide demonstrations occurred along with a massive write-in campaign to the NIH. The result was an investigation of Orem's activities by both the Office for the Protection from Research Risks (OPRR) and the National Heart, Lung and Blood Institute (NHLBI) of the NIH. However, following investigation, both OPRR and the NHLBI reported that they found the charges unfounded.

The most interesting aspect of this case is how both animal activists and research advocacy groups have presented their arguments about the worth of Dr. Orem's work to the press. Following the break-in, spokespersons for biomedical research argued that Orem's research was leading to a better understanding of the causes of SIDS (and sleep apnea) and they claimed that the attack on Orem's laboratory could seriously set back the development of a cure for SIDS. However, animal activists rebutted this claim and noted that, of the twenty-one articles by Orem, only two mention SIDS while a review of a 1988 volume that is devoted entirely to SIDS and that includes over 1,000 references cites Orem only once (Kaufman, 1991).
Orem responded to the third-party defenses of his research in an interesting way. In 1990, in a commentary published in the *Chronicle of Higher Education* (Orem, 1990), he noted that he found himself almost as upset by those defending his research as by the vandalizing of his research laboratory. After careful self-examination, he decided that he was particularly disturbed that research advocates seemed to find it necessary to emphasize the potential “usefulness” of his work. Although people constantly wanted to know about the potential application of his research, he stated that he was simply trying to generate a better understanding of the sleep control center in the mammalian brain and he specifically denied trying to develop therapy for SIDS. While applied research could be judged by its utility, he argued that basic research should be judged simply on whether or not it produces new knowledge based on creative science, rigorous testing, and self-critical interpretation of data.

Despite Orem’s own personal disavowal of the immediate utility of his research and his call for more support for basic research, the debate over the “Orem Incident” still features supporters referring to SIDS and critics pointing out the lack of relevance of Orem’s research to SIDS (Kaufman, 1991).

Orem’s statements about basic research lead to some very important and complex questions. Are the levels of scientific creativity, rigor and interpretation sufficient criteria to determine the value of the knowledge being sought? Why does some knowledge seem more valuable than other knowledge? How can valuable knowledge be distinguished from useless knowledge? How does one provide an appropriate public endorsement that the knowledge being sought is indeed valuable? Should basic research that causes moderate to severe animal suffering be permitted and, if so, should the public demand a higher standard of justification for the data retrieved from basic research that involves moderate to severe animal suffering than from research, basic or applied, that causes little or no animal suffering?

There are no easy answers to the above questions which may explain why there has been so little serious attention given to them in the debate over animal research.
The role of animals in the discovery, production and testing of insulin is one specific example of a narrative that "proves" how important animal research is and it has been widely used by supporters of the standard approach to biomedical research. In 1889, Minkowski and von Mering demonstrated that a pancreatectomized dog developed diabetes. This led to a flurry of activity to isolate the active principle in the pancreas but the results were, at best, inconsistent. The development of better techniques for measuring blood glucose after the First World War then led to the successful isolation of insulin from the pancreas of dogs in 1921. This discovery by Banting and Best is the event that is usually cited as proof of the importance of animal research (although Bliss [1982] questions its actual importance in his masterful history of the discovery and development of insulin therapy).

Procedures then had to be worked out for the purification of insulin from pork and beef pancreases (animal assays played a vital role in tracking insulin activity in the purification fractions). When large-scale purification was in place, each new batch of "purified" insulin then had to be standardized and once again animal assays were crucial.

Collip (one of the four Toronto scientists involved in the discovery) developed a rabbit hypoglycemic convulsion test to track and measure insulin activity (later mice were used). This use of animals in the bioassay of insulin is usually not cited as evidence of the importance of animals in research but it is arguably just as, if not more, important than Banting and Best's work with dogs. Over the years, the need to use mice in the bioassay has declined dramatically due to technical improvements (Trethewey, 1989). Today, in addition to pork and beef insulin, human insulin is also available thanks to the new biotechnology techniques applied to bacteria.
Millions of dogs, rabbits, rats and other species have been and continue to be used in research on diabetes that is aimed at improving therapy, understanding more about diabetes as a disease, and eventually the development of an artificial pancreas that will eliminate further need for insulin injections. Dogs are used to study the problems associated with pancreatic transplants and the ocular and vascular complications associated with diabetes. Charles Best (cited by Rowan, 1984b, p. 182), one of the original discoverers of insulin, estimated that by 1934, 130 million diabetics had had their lives prolonged due to insulin.

2. ANIMAL BENEFIT

The scientific community argues that human beings are not the only group benefitting from animal research. Many of the procedures performed on lab animals have led, directly or indirectly, to clinical applications that have proved helpful in the treatment of animals, especially companion animals. New chemotherapies were developed for humans but proved to be equally effective on animal diseases, and improvements in surgery, imaging and treatment of animals have come to veterinary clinics from research to improve human medicine via human hospitals (Loew, 1988; Foundation for Biomedical Research, 1993).

A recent example of the benefits that some animals derive from increased biomedical knowledge is the rapid development of a vaccine for parvovirus after the virus suddenly appeared in 1978, killing tens of thousands of dogs (Pollock, 1982).

3. KNOWLEDGE

The examples of medical advances mentioned above are largely the result of applied research that is directed toward a specific objective, such as the development of a new drug, therapy or surgical procedure. Such research involves building on existing knowl-
edge, some of which is gained through basic research on a specific biomedical problem (American Medical Association, 1989). For example, the study of retroviruses was begun well before HIV appeared because it was an interesting research problem. How did the retrovirus replicate itself and produce daughter viruses? By the time AIDS was identified as being caused by a retrovirus, there was already substantial knowledge about the basic biology of such entities and scientists were able to make relatively rapid advances in approaching specific therapeutic options.

The value of knowledge has proved to be difficult to assess prospectively. If a particular set of data can be generalized to other situations, then it tends to be more valuable than narrowly applicable data, but it is difficult to say more than this. Perhaps, as a result, biomedical researchers have always had some difficulty persuading the public to support "basic" research and thus tend to focus on specific medical advances instead (see for example, the Orem case, page 35).

However, one famous study conducted by Comroe and Dripps (1976) attempted to identify the relative importance of basic research in the overall process of advancing health care. They evaluated the knowledge required to lead to the top ten developments in cardiovascular and pulmonary medicine at the time and found that approximately 41% of the key publications (as determined by polling a large group of experts in the field) could be classified as basic (as opposed to therapy-oriented) research. On the basis of this study, they argued that society should continue to support basic research. Their study was a retrospective look at the field and nobody has yet performed a prospective analysis because of the obvious difficulties. In general, it is neither possible to predict how, nor if, a particular basic research project will provide a significant contribution to medical advancement.

According to NIH analyses of their granting
patterns, about 35-40% of research funding is allocated to studies using animals, ranging from studies that simply require blood or tissues to conducting brain surgery. Some portion of those studies will fall into the basic research category as opposed to research with a specific applied goal in mind. Therefore, animal research has played a role in developing our current body of scientific knowledge. While there are those who claim that it is wrong to use animals in research with no specific health-therapy objective, the scientific community argues that basic knowledge should be pursued.

B. CRITICISMS OF ANIMAL RESEARCH

1. IT IS IMMORAL

The moral arguments against the use of animals in all or some research are complex and detailed. One needs to understand the philosophical arguments and themes, at least in outline, and recognize the differences between the utilitarian and rights-based approaches at a minimum.

Many of those who oppose animal research believe that animals, in and of themselves, have inherent moral value and should not be used as a mere means to human ends. They argue that treating animals as disposable tools because they are animals and not humans is a form of prejudice that they label “speciesism” and that it is as morally reprehensible as using, say, women or Jews* for experimental purposes. “Speciesism is a prejudice or attitude of bias in favor of the interests of members of one’s own species and against those of members of other species” (Singer, 1990).

Singer’s basic approach is utilitarian and he does not argue that all humans are equal to each other nor that animals are necessarily equal to humans. However,

*Though women or Jews, in this example, are not a separate biological species.
he places great weight on the capacity to suffer and holds that animals and humans share similar capacities to suffer. He then argues that most animal research causes great suffering for relatively trivial benefit and hence is not morally justified. (Note: Singer is not arguing that animals and humans are the same or deserve the same consideration in toto. Only where they share the same morally significant characteristics would they deserve the same consideration.)

Regan takes another approach, arguing that certain animals that have beliefs and desires are "subjects of a life" and have inherent rights that would proscribe their being used as a means to a human end. Thus, according to Regan, mammals (and perhaps birds and other vertebrates) should not be used in research, even if it were to produce useful results. Other philosophers who espouse rights for animals may use different grounds for their argument and may not demand the complete abolition of animal research that Regan does. However, all rights-based philosophies require that those who justify the use of animals in research do so by reference to some greater "right" that overrides the rights of the animals, rather than by pointing to the research's utility.

Opponents of animal research do not restrict themselves to philosophical arguments. They have also criticized animal research on technical grounds as well. This criticism is relatively new and was not a major feature of the 19th century debate against animal research. In the late 20th century, the authority of science in modern industrial societies is considerable. Therefore, it is not surprising that critics of animal research should have turned to scientific themes to support their arguments. However, scientific authority is based on more than the mere listing of a series of academic citations at the end of a paper, a point that is not always remembered by either side in this contentious debate.

The various technical criticisms of animal re-
search may be classified into the following two broad themes: first, the practice is unnecessary and second, the practice produces too little benefit to balance the harm done to the animals.

2. ANIMAL RESEARCH IS UNNECESSARY

Some critics of animal research argue that animal research is not necessary because:

a. better use of preventive medicine will eliminate the diseases that require animal research;

b. greater use of and reliance on public health measures will eliminate the need for animal research;

c. clinical approaches provide all the clues we need while animal research merely dramatizes clinical discoveries; and

d. the development of alternatives eliminates the need to use animals.

Prevention and public health

Opponents of animal experimentation propose that the prevention of disease is the only truly effective way to insure universally good health. Sharpe (1988, p.49) states that since, "... treatment has little impact and often comes too late, real improvements can only come by preventing the disease in the first place." But a healthful diet, regular exercise, and avoidance of harmful substances is not always sufficient to keep people free of disease nor even alive in the modern world. Risk of injury and disease cannot be eliminated and life involves making constant compromises between conflicting risks.

The first two approaches to avoiding animal research (preventive strategies and public health initia-
tives) tend to overlap and are vulnerable to the same
general rebuttal - namely, that both are heavily influ-
enced by the growth of knowledge (our ideas about
infectious disease are, for better or worse, very different
today than they were 100 years ago), a considerable
amount of which is generated via the use of animals.

Thus, it is true that the prevalence of many of the
major diseases was declining steadily before the advent
of antibiotics, vaccines and other drugs (McKeown,
1979) but the development of clean water supplies,
better hygiene, improved food supply and nutrition
and other measures that have been identified as contrib-
uting substantially to the decline in infectious-disease
mortality occurred as the germ theory was being con-
firmed, as our knowledge of pathogenic organisms
exploded and as other advances in biomedical knowl-
dge were being made. It would be very surprising if
one could isolate such advances from changing societal
attitudes about hygiene and disease.

The history of medicine is full of examples of
clever detective stories suggesting potentially impor-
tant therapies that were not aggressively applied (or
were even ignored or suppressed - e.g. the story of
Semmelweiss and puerperal sepsis) until the mecha-
nism of the disease was more thoroughly understood.
The connection between lung cancer and cigarettes is a
more recent example of the linked role of epidemiology,
pathology and laboratory research in supporting (all
too little and too late) appropriate public health mea-
sures. (It is also an example of how powerful interests
can use research data and "scientific" authority - whether
derived from animal studies or other approaches - to
their own advantage.)

McKeown (1976) demonstrates quite convinc-
ingly that antibiotics and other landmark medical thera-
pies derived from the research enterprise made only a
small contribution to the decline in overall mortality
due to infectious diseases during the period from the
1850s to 1970. However, his analysis does not take into account the effect of the new medicines on morbidity. A case of non-fatal pneumonia in the early 1900s would have caused several weeks of high anxiety among all family members, several weeks of severe illness in the patient, and many weeks of recuperation. In the late 1900s, pneumonia causes little anxiety and little more distress than a cold thanks to antibiotics.

There are numerous other similar examples. For example, while tuberculosis (TB) mortality rates had declined very significantly before the advent of antibiotics, there were still a substantial number of cases of the disease when isoniazid and streptomycin became available to treat TB (e.g. there were 50,000 people in the United Kingdom with the disease) and no significant mention is made by McKeown or those who cite him of the effect of the antibiotics on morbidity. As Paton (1993) reports, these two drugs produced a marked improvement in the outcomes of those with TB.

In addition, the sense of control over disease that modern advances in health care have provided is not accommodated by McKeown’s analysis at all, but such feelings of control are likely to be very important when measuring quality of life.

Thus, one can make some important arguments about the importance of prevention and public health initiatives in human health and even grant the argument that modern medical research has contributed only a small part directly to extending life expectancy. But one cannot infer that these measures were not influenced by knowledge derived from animal research nor that prevention and public health by themselves are responsible for the considerable ability we now have to control morbidity and suffering. An example is the relief from suffering provided by medications for fever, muscle ache, allergy or of the remarkable achievements of modern dentistry.
At least one critic of animal research argues that he is not advocating that preventive measures replace animal research (Barnard - personal communication, 1993). Instead, he views animal research as not morally justifiable and, in looking for another approach that might be able to pick up the slack if animal research were abolished, he suggests that we can employ preventive and public health approaches instead with little or no loss in health benefits.

For example, he suggests that high intakes of saturated fat are positively correlated with increased rates of breast cancer and heart disease, based on human epidemiological data. However, the link between saturated fat and breast cancer is not as obvious as he implies and there are other plausible explanations including the suggestion that estrogenic chemicals in the environment may be causing the increase in breast cancer rates (Colborn et al, 1993). The critic could no doubt suggest that we should merely reduce both saturated fat intake and the burden of estrogenic chemicals in the environment without trying to decide which is more important but, without good strong evidence, such sweeping public health measures are unlikely to be enacted (viz. cigarette smoking or alcohol consumption).

Clinical studies

The third claim in this category implies that animal research is unnecessary because we can achieve the same or better results by relying on clinical (i.e. human) research. In the United States, a considerable proportion of federal biomedical research funding (around one third) does support clinical research while approximately 40% supports animal research. Thus, the call to support clinical studies is already being addressed. The question is whether the clinic can completely supplant all animal studies. Reines has argued this issue most forcefully, drawing on examples like the discovery of some psychoactive drugs via clinical observation (Reines, 1990) and other case studies. In addition,
Kaufman et al (1989) have produced a critique of animal models which argues that animal models are rarely cited in the clinical literature and are, therefore, not useful in terms of actual clinical medicine.

The case studies cited by Reines draw on instances where astute clinicians (following William Osler's advice) use interesting cases and clues from the clinic to make conceptual or therapeutic leaps into new areas. For example, important psychoactive drugs (e.g. chlorpromazine) were discovered in this way (Reines, 1990). However, this clinical insight then led to a whole range of additional research questions about the mode of action of such drugs and the possibility of developing other drugs with different (improved?) properties that could not all be answered by clinical observation or human experimentation. (Reines does not use "discovery" in its colloquial sense. For him, "discovery" appears to refer to the creative insight. The subsequent research to test the insight appears to be categorized, at least in part, as "dramatization.") In addition, as with public health investigations and conclusions, the clinical insights occur in the context of the then current knowledge base which relies on data from all sorts of laboratory, epidemiological and clinical research.

In the critique of animal models, Kaufman et al (1989) analyze citations to ten randomly chosen models from the animal model files at the Armed Forces Institute of Pathology. Of 693 citations to the 21 core papers describing the animal models, 78 (11.3%) were judged to be clinical with most of these citations (61) referring to only three of the models. The authors note many of these citations appeared to be clinically unimportant and they conclude by questioning the usefulness of these models in understanding and treating human disease.

This study represents an interesting (and to this date the most sophisticated) attempt to undertake an objective analysis of the utility of animal models. However, it is not without significant problems. Citation
analysis has developed into a complex science with many potential pitfalls. For example, it is well known that older papers rapidly disappear from the literature and become subsumed by more recent reviews. Thus, their simple citation analysis tracked the influence of the original papers that first described the animal model but not the influence of the model itself. In addition, errors in citation are fairly frequent and one has to be careful to examine potential variants. Such variants can account for a significant proportion of the total citation record.

There are other problems aside from the technical difficulties of citation analysis. It is not clear how clinical "value" was judged nor how the citing literature was divided into clinical papers and other types of research. The scientific literature is also notoriously neutral in assigning value to prior literature (e.g. one paper may have been far more influential than others in the bibliography, yet is "counted" as equal to the others in impact) and it is likely to be very difficult to determine how much impact an earlier paper has had on an investigator merely by reading a journal report. The study also does not provide any control comparisons, such as a citation analysis of the clinical studies of the same human diseases which the animals were supposed to be modeling. It may be that the clinical studies appear similarly unimpressive in influencing the later literature.

Alternatives

The best available statistics indicate that the use of laboratory animals worldwide has fallen by 30-50% after peaking between 1975 and 1980. Several reasons have been put forward to explain this decline. First, it is argued that laboratory animals and their care have become increasingly expensive leading to an economic disincentive to use research animals. This is true but there is no data showing that animal research costs have risen

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(From graph in Trethewey, 1989)
any faster than general research costs. In other words, have cost pressures really influenced investigators to switch from animals to cell cultures when the costs of cell culture research have also increased? Second, animal care and breeding standards have improved substantially over the past twenty years and, as a result, investigators can obtain better data from fewer animals.

Third, it has been suggested that animal use has fallen because of economic uncertainty and recessions. During the last fifteen years there have been two recessions and one boom period but animal use fell steadily throughout this period with no evidence that the economic boom had any impact on the rate of decline. For example, Hoffman-La Roche reported that it cut its animal use from 1 million to around 300,000 per annum over ten years but throughout this period it maintained the same number of Investigational New Drugs under study and therefore did not diminish its overall research effort (The Alternatives Report, 1991).

Fourth, it is argued that alternatives have played a major role. This is most likely true but it is not clear how much of the fall has been due to the specific search for and use of alternatives and how much has been due to the development of more efficient and powerful research techniques that also happen to reduce animal use. Thus, cell-culture technology has improved considerably in the last fifteen years as has our knowledge of basic biological mechanisms. Partly as a result, the National Cancer Institute has replaced its use of the mouse cancer model for screening for new chemotherapeutic agents with cultures of human cancer cells at a savings of around 3-4 million mice per annum (Rowan, 1989b). The pharmaceutical industry has also made very good use of new techniques to reduce animal use in screening for potential new drugs.

Even given the progress made in reducing animal use (and in reducing animal distress in research) over the past fifteen years, it is difficult to see how
In determining whether or not animal research is beneficial, Smith and Boyd (1991) recommended that the following steps be followed:

1. Judgements about the benefits should be made by scientists in dialogue with informed public opinion.

2. Scientists should not only seek to advance the public interest when performing animal research but should be seen to be doing so.

3. Any judgement that animal research is necessary should be regarded as subject to possible change as scientific technology advances.

4. The factors and interests taken into account when making such judgements should be well known and widely agreed upon by both scientists and the public.

3. ANIMAL RESEARCH CAUSES TOO MUCH SUFFERING FOR LITTLE OR NO BENEFIT

Another criticism of animal research addresses its utility for humankind. Some suggest that animal research produces a tremendous amount of suffering and little human benefit. For example, Singer (1990) states that he thinks that much animal research "...is of minimal or zero value" while it causes considerable suffering. Others suggest that no animal research is useful but it still causes considerable harm to animals. For example, the Australian Association for Humane Research (1988, p.1) states, "We know of no animal experiments, as such, which ever led to a cure of a human disease."

Finally, others argue that animal experiments are not only useless, but are actually misleading. Sharpe (1988, p.200) states that, "... the real choice is not between dogs and children, it is between good science and bad science; between methods that directly relate to humans and those that do not. By its very nature vivisection is bad science: it tells us about animals, usually under..."
artificial conditions, and not about people." All three criticisms are commonly found in the literature of animal protection groups, sometimes together and sometimes not. All three criticisms focus on refuting the research advocates' argument that animal studies have proved to be very useful at small or no cost in animal suffering.

We have relatively little data on animal suffering in research and testing and what we do have depends heavily on what is perceived to constitute suffering. The authorities in the Netherlands have collected data on the potential pain and suffering experienced by laboratory animals. Their 1990 Annual Report on animal experimentation notes that 53% of the animals experienced minor discomfort, 23% were likely to have experienced moderate discomfort and 24% were likely to have experienced severe discomfort. About one fifth of the animals in this last category were given medication to alleviate pain. Examples of procedures that would place animals in the "severe" category are prolonged deprivation of food or water, some experimental infections, tumor induction, LD50 testing, and immunization in the foot pad or with complete Freund's adjuvant (The Alternatives Report, 1992a). All of the animals are likely to be euthanized so they will also experience the harm of death.

In Great Britain, the only indication of pain and distress level in laboratory animals that is available is the recording of anesthesia use. In 1978, 3% of the 5.2 million procedures involved anesthesia for the whole procedure (they were terminal) and 14% involved anesthesia for only part of the procedure. In 1988, 19% of the 3.5 million procedures involved anesthesia for the whole procedure and 17% involved anesthesia for only part of the procedure. It is not clear why anesthesia use doubled from 1978 (at 17% of all animal experiments) to 1988 (at 36%) although the 1986 Act that revised British controls over animal experimentation placed considerable emphasis on the control of pain and distress (The Alternatives Report, 1990). However, it is also possible that
potential pain was being under-assessed prior to the debate over the new act in 1985 and 1986.

According to 1992 USDA statistics (excluding rats and mice), 5.63% of the animals used in research in the U.S. experience pain or distress that is not alleviated by painkillers. However, USDA statistics on pain and distress are not reliable indices of animal pain and distress. Those completing the annual report forms are provided with few guidelines on how to assess pain and distress and there is also direct evidence that the use of post-operative pain relief in the laboratory is lower than reported (Phillips, 1993).

States vary dramatically in the proportion of research that is reported to be painful (from 45% to less than 1%) and for which pain relief is not provided. Some corporations that do toxicity testing report no animals in the category of "pain and distress unrelieved by drugs" and many non-profit institutions are reluctant to report animals in this category for fear they will be targeted by animal activists (who have access to annual reports from institutions). It is very probable that the number of animals experiencing pain and distress in research and testing is under-reported. It is not possible to estimate the degree of under-reporting from current data.

Despite the problems of assessing animal pain and distress (see chapter VII for more discussion of this issue) and the questionable reliability of some of the numbers, the available evidence does not indicate that all, or even a majority of research animals experience severe and unrelieved suffering. Of course, how one judges the total extent of animal suffering (and whether it is excessive) is going to be heavily influenced by one's personal values and interpretation of the data, and by one's assessment of the level of harm caused by the killing of animals and by their housing in the laboratory. Differences in the assessment of the extent of laboratory animal distress accounts for some of the apparently
irreconcilable conflicts between animal research and animal protection advocates.

C. THE COST-BENEFIT BALANCE

An analysis of the literature defending or criticizing animal research proves to be relatively unhelpful in evaluating the cost-benefit balance of animal research. Two separate papers on Nobel Prize winners in medicine for this century come to very different conclusions about the role played by animals. Stephens (1986) argues that alternatives have been honored many times by the Nobel Committee while Leader and Stark (1987) extoll the value of animal models. What is especially interesting about these two papers is that they quite frequently cite the same award in support of their argument. Stephens (1986) is more rigorous in his analysis (he defines his selection criteria more carefully) but the two papers demonstrate that there is considerable room for disagreement on the role played by alternatives or animals in the development of a particular discovery.

Overall, a careful reading of the arguments leaves one with the impression that non-animal models can be more valuable and can reduce reliance on animals more than the animal research advocates care to admit. By the same token, however, animal studies have been more valuable and more productive than the animal research critics are willing to acknowledge. Ultimately, Sir Peter Medawar was probably correct when he stated that:

The use of animals in laboratories to enlarge our understanding of nature is part of a far wider exploratory process, and one cannot assay its value in isolation — as if it were an activity which, if prohibited, would deprive us only of the material benefits that grow directly out of its own use. Any such prohibition of learning or confinement of the understanding would have widespread and damaging consequences; but this does
not imply that we are forevermore, and in increasing numbers, to enlist animals in the scientific service of man. I think that the use of experimental animals on the present scale is a temporary episode in biological and medical history, and that its peak will be reached in ten years time, or perhaps even sooner. In the meantime, we must grapple with the paradox that nothing but research on animals will provide us with the knowledge that will make it possible for us, one day, to dispense with the use of them altogether.

(Medawar, 1972)