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# WHAT'S DIFFERENT ABOUT HEALTH? HUMAN REPAIR AND CAR REPAIR IN NATIONAL ACCOUNTS

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# What's Different About Health?

## Human Repair And Car Repair In National Accounts

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> The American patient is likely to. . .regard doctors as technicians who are periodically called on to repair his physical machinery.
>
> Aaron and Schwartz (1983, page 17).

Measuring the output of services industries has long been considered hard. "The conceptual problem arises because in many service sectors it is not exactly clear what is being transacted, what is the output, and what services correspond to the payments made to their providers" (Griliches, 1992, page 7). Among the hard-to-measure services, no task has been perceived as more difficult than measuring the output of the health care sector.

Why is measuring health care output so hard? The medical economics literature contains a long list of intimidating and discouraging difficulties. In this paper, I propose to cut through this mostly defeatist list by posing what at first might seem a narrowly-focussed question: Why is health care different from any other analogous service, such as car repair?

Comparing measurement issues in human repair and car repair is instructive. It is not merely the straightforward analogies: Replacing a shock absorber and replacing a hip are both repairs to a suspension system, diagnostic activity is a crucial part of both production processes,

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the frequency of costly diagnostic errors is a concern in both types of repairs, and the outputs of both repair industries are enhanced by new technologies for diagnosis, for installation of the part, and also embodied in the part installed. And, as Vaupel (1997) suggests, the subjects of both repair industries are complicated systems, which is why human and automobile mortality functions look remarkably similar.

More importantly, asking why health is different facilitates asking how health is similar. What can we learn from the way we measure the output of car repair that can be applied to the measurement of human repair, and can simplify the health care measurement problem? Health care *is* "different;" but is it so different that we have to start over with a new paradigm?

I contend that health is not *that* different: The paradigm we use for car repair can be applied, with suitable modification, to health care. Emphasizing the similarities in human repair and car repair paradigms makes it easier to design operational measurement strategies. The similarities may also make it easier for national income accountants and users of economic statistics to understand and accept the sometimes controversial extensions to the paradigm that are necessary because health is indeed, in some respects, different.

## I. Background

Although one might expect that measuring health care output would entail in some manner measuring "health," most prior economic measurement in health care has been conducted without explicit reference to medical care outcomes. Because output measures in the national accounts of most countries are typically produced through deflation--that is, by dividing health expenditures by a price index--medical care price index methodology has determined the concepts embodied in medical care output measures (except of course for health output in national accounts for countries where medical care is part of the public sector).

Historically in the U.S., the Consumer Price Index (CPI) component for medical care has been used for deflating medical expenditures. This CPI medical care index was until recently constructed from a sample of medical care transactions: a hospital room rate, the price for administering a frequently-prescribed medicine, or the charge for a visit to a doctor's office (see Berndt, Cutler, Frank, Griliches, Newhouse, and Triplett, 1998). Such transactions, which are effectively medical inputs, are sufficiently standardized that the same transaction can be observed repeatedly, which is required for a monthly price index.

The health outcomes of those CPI transactions were never considered explicitly. It is, of course, true that when a consumer paid for an influenza shot, the consumer wanted to reduce the probability of contracting influenza. And if an influenza shot that was more effective in preventing influenza became available, a "quality adjustment" would in principle be made in the CPI to allow for the value of the improvement.

In practice, however, such quality adjustments were seldom carried out in the medical care price indexes, for lack of the required information. A quality adjustment in the CPI requires more than just a measure of health care "quality," which may itself be difficult to obtain. The CPI quality adjustment requires valuation, an estimate of "willingness to pay"--what would a consumer be willing to pay for the improved influenza shot, relative to the unimproved one? For health care, the willingness-to-pay question was hard to answer.

Thus, for two reasons, health outcome measures were ignored. First, the primary focus in constructing the price index was on collecting information on transactions, not on medical outcomes, and a collection system that focusses on transactions prices for medical inputs does not routinely yield medical outcomes. Second, when improved medical outcomes did come into the picture (in the form of a CPI quality adjustment), it was not the outcome itself but the consumer's willingness to pay that was relevant.

It was widely noted, even 35 years ago, that the CPI methodology did not adequately account for improvements in medical care. As the influenza shot example suggests, an improvement in medical procedures that raised the cost of treatment but also improved efficacy frequently showed up as an increase in the CPI. When this CPI was used as a deflator, the improved medical care procedure was thereby inappropriately deflated out of the medical output measure.

Two alternatives to CPI methodology surfaced in the 1960's. The first was the idea of pricing the "cost of a cure," estimating the cost of a medical procedure (the treatment of appendicitis, for example).[2] This contrasted with the CPI's focus on hospital billing elements for a medical procedure, such as the hospital room rate and the administration of a pain medication.

Scitovsky (1964, 1967) estimated cost trends for treating selected medical conditions, including appendicitis and otitis media. She reported that the cost of treating illnesses increased faster than the CPI, a result that most economists found puzzling (because the CPI error that it implied went in the opposite direction from what was expected). Scitovsky also suggested that the CPI had understated the rate of medical inflation in the 1950's and 1960's because actual charges had advanced relative to the "customary" charges that presumably went into the CPI.[3]

Scitovsky raised some problems with the cost of illness approach that had not previously been considered: What should be done about potential adverse side effects of a new treatment that

[2] For example, George Stigler, in testimony on the "Stigler Committee Report" remarked: "...we were impressed by some of the preliminary work that has been done...on problems such as the changing cost of the treatment of a specific medical ailment.... We think it would be possible...to take account of things such as the much more rapid recovery and the much shorter hospital stay...." U.S. Congress, Hearings (1961), page 533.

[3] In recent years, it has been asserted that the error from "list" prices goes the other way; see Newhouse (1989).

was better in some respects (or for some care recipients), but worse in others (or for other recipients)? Her example was a new drug treatment for appendicitis that lowerd average hospital stay, reduced recovery time, and was far less painful, but increased the chance of a ruptured appendix, with potentially fatal consequences. Though it was not recognized at the time, the Scitovsky study showed that all the outcomes of a medical procedure must be considered, not just a single one, or just the principal or primary outcome measure. Put another way, it said that looking only at the cost of a unidimensional "cure" (appendicitis treatment), without considering the multidimensional attributes or characteristics of a medical procedure, could produce its own bias. Though this problem was intractable with the analytic tools that were available in the 1960's, it has been addressed in the cost-effectiveness research of the past 10-15 years (see the discussion below).

It is a bit perplexing that, in intervening years since Scitovsky's work, few other estimates of the cost of treating an illness have been made. Cutler, McClellan, Newhouse, and Remler (1996), Shapiro and Wilcox (1996), and Frank, Berndt, and Busch (1996) followed Scitovsky by three decades.

As a second alternative to the CPI medical care price index, Reder (1969, page 98) proposed to by-pass the medical pricing problem altogether by pricing medical insurance: "If medical care is that which can be purchased by means of medical care insurance, then its 'price' varies proportionately with the price of such insurance." Barzel (1969) estimated an insurance measure of medical price inflation, using Blue Cross-Blue Shield plans.

The medical insurance alternative has not been without critics. Feldstein (1969, page 141) objected that the cost of insurance approach "is almost certain to be biased upward" because "average premiums will rise through time in reflection of the trend toward more comprehensive coverage" and because the insurance plans will purchase "more services or services of higher quality." Moreover, if an epidemic occurred which raised the cost of insurance, it would inappropriately show up as an increase in the cost of medical care, and therefore not an increase in its quantity, unless the medical premium were calculated net of utilization rates. Thus, implementing the insurance alternative requires solving two quality adjustment problems--adjusting for changes in the quality of medical care and of the quality of insurance plans. Additionally, measuring the output of insurance is also hard conceptually (see Sherwood, 1998).

Little empirical work on medical insurance has followed Barzel in the intervening thirty years. Pauly (forthcoming) has recently revived the proposal. He argues that improved methods for measuring willingness to pay makes the medical insurance alternative a more attractive option now than it was in the past. In principle, Pauly contends, one could ask how much one would be willing to pay for an insurance policy that covered an expensive medical innovation, compared with one that did not. Weisbrod (forthcoming), noted that no "constant-technology" health insurance contracts exist, no plans promise to pay for yesterday's technology at today's prices, which in itself suggests that the improved technology was worth the increased cost to insurance buyers. Even if the logic of Pauly's proposal suggests an empirical approach, no empirical work exists, so its applicability to measuring medical price and output has not been tested.

As these references from the 1960's suggest, the major issues on health care output were joined years ago. Until recently, the debate on the measurement of output in the medical sector largely repeated the arguments of 30 years ago. The empirical work and the data, too, had not advanced that much beyond the mid-1960's (Newhouse, 1989).

Several things have changed recently. First, the Bureau of Labor Statistics, initially in the Producer Price Index and more recently in the CPI, has introduced new medical price indexes that are substantial improvements on what existed before (Catron and Murphy, 1996; BLS, 1997). Second, a major new research initiative on health care price indexes, using new approaches and new sources of data, has been created by a research group centered in the National Bureau of Economic Research (these studies are described below). Third, information on health care outcomes has been enhanced greatly by recent research on “cost-effectiveness analysis” within the medical establishment itself (Gold, Siegel, Russell, and Weinstein, 1996).

A task as yet unexplored is building these new price indexes and health outcome measures into a measure of the output of the medical care sector. The remainder of this paper will develop an approach (which I call the “human repair model”), contrast it with approaches that are used in other parts of economic accounts, and explore the reasons why health care output requires a modification to the measurement conventions used for nonmedical services, such as car repair.

## II. The Conceptual Framework for the Human Repair-Car Repair Model

How do we measure the output of nonmedical services in national accounts? Taking as an example car repair, most countries do something like the following. First, one gathers from some place the total expenditure on car repairs (expenditures on brake jobs, water pump and fuel pump replacements, engine overhauls, and so forth). Next, a government statistical agency takes a sample of car repairs (brake jobs and water pump replacements, say), collects prices for these repairs, and from them constructs a price index for auto repair.[4] When the price index is used as the deflator for automobile repair expenditures, the result is the (real) expenditures on the output of the auto repair industry (see U.S. Bureau of Economic Analysis, 1989).

Thus, we have:

(1) $I_{0t} = \sum_i P_{it} Q_{i0} / \sum_i P_{i0} Q_{i0}$
(2a) $Z_{0t} = \sum_i P_{it} Q_{it} / \sum_i P_{i0} Q_{i0} / I_{0t}$
(2b) $= \sum_i P_{it} Q_{it} / \sum_i P_{it} Q_{i0}$
$=$ real expenditure on car repair

[4] This describes, very generally, the BLS methodology for the “auto repair” component of the CPI. See Bureau of Labor Statistics (1992).

The subscript *i* in these equations refers to individual car repairs. The first term on the right hand side of equation (2a) is the change in expenditure on auto repair, and equation (2b) gives the expression for the change in real output or expenditure on auto repair.[5]

Constructing a measure of health care output can proceed in ways that are in some respects similar to methods used for nonmedical services. However, there are also some necessary differences. The following sections highlight some of those differences.

A. What does the health care sector do?

When a human repair expenditure is incurred, it must in some sense add to the stock of health, just as car repair adds to the stock of functioning cars.[6] But how should we think about that increment?

There is little disagreement that health is produced by many factors, and not solely by the activities of the medical sector. Diet, lifestyles, environmental factors, genetic endowments, and other influences determine an individual's, or a society's, level of health. It might even be true, as sometimes asserted, that nonmedical influences on health are more important than the medical ones (Mokyr, 1997).

Medical and nonmedical influences on the "production" of health can be represented in a very general way as:

(1) health = H(medical, diet, lifestyle, environmental, genetic, etc.)

"Health" is thus the ultimate output of a "production process" in which medical interventions are one of a number of contributing inputs.

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[5] Note that (2a) is a Laspeyres price index number, and (2b) is a Paasche quantity index. The U.S. NIPA now use a Fisher index number system for aggregating over components of GDP, and also for aggregating output in Gross Product Originating by industry data (see: Landefeld and Parker, 1996; Yuscavage, 1997). However, at the lowest level of aggregation in the accounts, the price indexes used for deflation come, mostly, from BLS in Laspeyres form; the resulting deflated output series is therefore Paasche, or worse, a chained series of changes in Paasche quantity indexes. BLS has announced that most CPI components (but not medical services) will be converted to geometric mean indexes in January, 1999, but no similar announcement has been made so far for the PPI. Currently, PPI medical care price indexes are used for deflation in the relevant components of the NIPA and of the NHA.

[6] Many medical procedures or expenditures are preventive in nature, they are not strictly speaking human repairs, nor are they disease-related. But car repair expenditures also include preventive maintainence.

Using equation (1), it is natural to measure the contribution of the health care sector to the production of health--its effectiveness--by the incremental contribution to health caused by medical interventions. That is:

(2) effectiveness of the health sector = $\partial$(health) / $\partial$(medical)

where $\partial$(health) is the change in health that is attributable to $\partial$(medical), the resources put into medical care interventions. Equation (2) says that the health care sector's contribution to health is the incremental impact on health produced by medical procedures, *all other influences on health constant*. To do this right, $\partial$(medical) should include all the resources required by a medical intervention, which may include direct and indirect costs (unpaid caregiving by the patient's family, for example), and $\partial$(health) should be a comprehensive measure that incorporates all of the effects on health of a medical intervention, including unwanted side effects, if any. Equation (2) implies that the health outcomes associated with medical interventions define the output of the health care sector. Let us call this the "medical interventions perspective" on health care output.

Equation (2) does not imply that a society's level of health is determined by its health expenditures or by the level of medical interventions it supports. Neither does it imply that a society with a higher level of health expenditures necessarily has a higher level of health than another society with lower health expenditures. One often reads or hears statements such as the following: U.S. spending on health care, which amounts to around 14 percent of GDP, must not be productive, says the speaker, because life expectancy in the U.S. is lower than it is in some other countries that spend a smaller amount on health care. This "total health" view implies that one can judge a health care system's effectiveness by comparing society's level of health with the health sector resources that presumably produce it. I believe this is not a useful way to look at the matter. The "other factors" in equation (1) are not necessarily constant in international comparisons of health and health expenditures, or in comparisons over time. The "total health" view, however, is widely expressed. An example is the following:

> Available estimates generally indicate that medical care has been accountable for only about 10% to 15% of the declines in premature deaths that have occurred in this century--the remainder attributable to factors that have helped prevent illness and injury from occurring. This suggests that the promise implicit in many technological inteventions may exceed their ability to deliver genuine health gains, at least on a population-wide basis. However, they certainly consume resources. McGinnis (1996)

Distinguishing between a society's level of health and the health implications of its medical interventions is particularly important where a medical intervention is undertaken to correct the health consequences of unhealthy lifestyles. A car repair analogy may be helpful. Suppose a car owner with a taste for stop light drag races. Severe acceleration has "unhealthy" consequences for the life expectancies of the clutch, transmission, and tires of his car. One would not assess the output of the car repair industry by the low life expectancy of clutches on cars used for stop light drag races, nor deduct from the output of the car repair industry an allowance for the low life expectancy of clutches on cars so used. The car mechanic repairs the consequences of the owner's lifestyle. The medical care sector also repairs, to an exent, the consequences of owners' lifestyles, and repairs as well the consequences of other sources of health problems.

Stop light drag races, in the car repairing example, and fatty diets, smoking, sedentary lifestyles, and so forth in the human repair example, are utility-generating activities--people like them, by and large, even though they may recognize quite well that they are harmful to health, or to cars. Although individuals get utility from better health, they also get utility from consumption activities that may have adverse health consequences. The way we want to model the output of health care is not therefore independent of the demand for health care, and the model is complicated by intertemporal considerations, both in the production process for health and in consumers' decision making.

The future level of health is a consequence, at least in part, of actions today--of expenditures for health care and of diet, environmental, and lifestyle influences. Thus, we might modify equation (1) into the intertemporal production process [7]:

(1a) $\text{health}_{(t+n)} = H(\text{medical}_{(t)}, \text{diet}_{(t)}, \text{lifestyle}_{(t)}, \text{environmental}_{(t)}, \text{genetic}_{(t)}, \text{etc.})$

Some consumption goods that yield current utility (smoking and fatty diets can serve as examples) have adverse consequences for health in subsequent periods. That is, there are some components of diet where $\partial(\text{health}_{(t+n)} / \partial(\text{diet}_{(t)})) < 0$, and similarly for some components of lifestyles and of environmental influences.

On the demand side, however, the current level of utility depends on current health (which depends, in part, on lagged values of the right hand side variables in equation 1a) and on the current level of consumption of normal consumption goods, including lifestyle components, such as restful liesure pursuits. Thus:

(3) $\text{utility}_{(t)} = U(\text{health}_{(t)}, \text{diet}_{(t)}, \text{other consumption goods and services}_{(t)}, \text{lifestyle}_{(t)}, \text{envionmental}_{(t)}, \text{etc.})$,

where $\text{health}_{(t)}$ is determined by the lagged values in equation (1b).

For some of the goods in equation (3), goods that I henceforth designate w, $\partial(h_{(t+n)})/\partial(w_{(t)})<0$, but $\partial(U_{(t)})/\partial(w_{(t)})>0$. These are goods whose consumtion has an adverse effect on future health. Grossman (1972) emphasized that abstaining from consumption of such goods is like an investment, in the sense that current consumption (utility) is reduced in order to have greater consumption in the future. The future periods may be a long way off, so the adverse

[7] This specification is not intended to deny that current levels of health care expenditure and current diet or lifestyle affect current utility, but rather to emphasize the time paths of the effects and the fact that individuals' decisions are intertemporal and have intertemporal effects.

consequences of current unhealthy behavior will be discounted by a rational consumer. The future health consequences are normally changes in probablilities, rather than deterministic. Discount rates, assessments of probabilitity changes, and--because of genetic factors, for example--the actual risks of adverse effects may differ greatly across individuals. Thus, their willingness to undertake "investments" in future health--to reduce current unhealthy, but utility-generating, consumption activities--may differ greatly.[8] Indeed, Garber and Phelps (1992) remark that a drastic reduction in fatty diets will only increase the (discounted value) of life expectancy by 4 days for men and 2 days for women.

As incomes rise and as consumers as a group become more wealthy, consumption of, say, rich diets and more sedentary lifestyles may increase because these are luxury goods.[9] Because expensive medical procedures are also more readily available in a more wealthy society, income affects health in two ways: It may encourage less healthy behavior, leading to lower health (Grossman, 1972, presents empirical evidence of this). But income also permits more resources to be devoted to medical care, which increases health.

Thus, the effects of fatty diets, sedentary behavior, and smoking on heart disease might merely be offset by the development of expensive treatments, such as heart bypass surgery. If so, the overall death rate from heart disease might be the same as the rate in a society with healthier living and a smaller amount of expensive surgery. But equality of the expected incidence of heart disease in the two cases tells us nothing about the value of the output of the medical sector.[10]

The question that needs exploring is not whether more medical expenditure gives "more" health, in the sense that the level of health is positively correlated with the level of a society's medical expenditures. In the specification of equation (1), the levels might not be closely correlated if other influences on health changed adversely. The task is, rather, to compute the marginal value of a medical intervention on health, holding constant or abstracting from nonmedical influences on health. To measure the output of the health sector we need to model the health consequences of medical interventions, and not to compare the aggregate level of health with the resources employed in the health care sector.

There is, however, a grain of truth in the assertion that the U.S. is not getting "enough"

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[8] There is a remark attributed to Mickey Mantle: "If I'd known I would live so long, I'd have taken better care of myself."

[9] Smoking apparently has a low income elasticity, but automobile transportation has a high income elasticity almost everywhere, leading to the remark that automobiles kill far more people through reduced exercise than they do in accidents.

[10] It might tell us a great deal about the allocation of public expenditures between, say, medical expenditures and education expenditures that are intended to make individuals more aware of the trade-offs between lifestyles and disease.

health for the 14 percent of GDP put into its health care sector. If all one cared about was health, then minimizing the cost of a given level of health would be the appropriate policy. One might reach the present level of health more cheaply by reducing unhealthy behaviors, rather than by treating their effects. Some of the current campaign against smoking seems to have this motivation (particularly the State Attorney Generals' assertion that tobacco companies are responsible for increased state medical costs). Public health officials, who are charged with improving the level of health, make similar statements. For society at large, however, health is not the only thing that matters, so "getting enough health" for a given health expenditure is an inappropriate specification of the social welfare optimization problem.

On the other hand, lifestyle and other unhealthy behaviors will complicate severely the empirical work necessary to estimate health sector output. It might not be clear whether the clutch failed because of the owner continued to endulge his taste for stop light drag racing or because the mechanic installed it improperly. If heart bypass recipients change their lifestyles in more healthful directions, it will lengthen the apparent effect of the medical intervention. Conversely, if they revert to unhealthy lifestyles, it will shorten the apparent effect on life expectancy of the medical intervention.

What are the conclusions of this discussion for measuring the output of the health care sector? I first considered the appropriate conceptual way to think about health care output. One should measure it by the health implications of medical interventions, not by the society's level of health.

The medical interventions approach also implies: To find the incremental impact of interventions on health, one cannot proceed by trying to estimate some aggregate of medical interventions. Interventions are, by their nature, specific, and they relate to specific diseases. Measuring the health implications of medical interventions inevitably implies a stategy of examining these interventions on an intervention-by-intervention basis, that it, on a human repair-by-human repair basis. Though the full implications of this will be developed later, at this point it is worth noting that health, in this respect, is modestly different from car repair, because we already measure price changes output by obtaining data for specific car repairs, though we deflate at an aggregate car repair level.

B. The national accounts production boundary, health care output and car repair

In the previous section, I proposed that the health impact of medical interventions be the measure of health care sector output. The change in some measure of health that is caused by a medical procedure or intervention, or by the substitution of an improved procedure for another one, is called a "health outcome".

Valuing medical interventions, or valuing health outcomes, moves beyond the market transaction that has been the center of traditional price and output measurement. Crossing this traditional boundary has been, and remains, controversial. Gilbert (1961, page 290) asserted that

“...the production boundary must be fixed at the point at which transactions take place between buyer and seller because that is the only point at which value, output and price are settled for things that are bought and paid for. Recovering from an illness is not a unit of output nor its cost a price....” Although I do not know that someone has put forth this view in publication in recent years, it is still very much a part of the intellectual heritage of national accounts.

Thus, the health output proposal is not analogous to the way car repair output is measured in national accounts. One can think of car repair as a production process that combines a broken car and a repair to produce a functioning automobile. Yet, no national statistical agency computes in national accounts the increment that car repair makes to the stock of functioning cars, nor calculates explicitly the benefit of the repair to the car owner. In national accounts, the output of the car repair industry equals the quantity or number of, e.g., (constant quality) brake jobs and other repairs--output is measured by deflating car repair expenditures by a price index for brake jobs and so forth. Why not just measure the number of health care procedures, as we do for car repair? Doing so preserves the transaction as the unit of observation, which has practical advantages.

One part of the answer is: What we do for car repair is not all that satisfactory if there are significant improvements in the quality of car repair procedures, because the price indexes may not allow for those quality changes very well. Some may think that quality changes in car repair are not a major measurement problem (though they probably are). Nearly everyone agrees, however, that improvement in medical procedures is a major part of what we want to include in an output measure for health care. Thus, though both car repair and human repair pose similar price and output measurement problems, the "quality change problem" looms larger in measuring health care output, which justifies more radical solutions.

The other part of the answer involves two aspects in which health care differs from car repair or most other services: In car repair, we are willing to assume that the more expensive repair procedure must be the better one if the consumer chooses it. The consumer could, after all, sell the repaired car (or the unrepaired one); accordingly, the car repair meets a "willingness-to-pay" test. Economists, and the medical profession, are less convinced of the equivalent assumption in the case of human repair--there are serious doubts that the price of a more expensive medical procedure necessarily measures its greater contribution to health. The consumer has inadequate basis for making informed choices among medical care providers and among options for treatment.

That consumer ignorance makes health care special is frequently asserted, but one can make too much of it. Charging for unnecessary repairs, or for the wrong repair, is also notorious in car repair. A very large proportion of brake pad replacements are coupled with replacing brake disks as well, which should not be the case. Those Cambridge authorities, Click and Clack, recently reported the reason: It is easier to overcharge for the brake repair than to explain the harmless initial noise that normally accompanies replacement only of brake pads. In car repair, as in human repair, the choice of treatments is largely in the hands of professionals, rather than the consumer, and agent problems potentially interfere with the welfare maximising outcome in both cases.

Medical insurance drives a wedge between payment and valuation. A standard result in medical economics is that insurance causes more demand for medical care than would otherwise be the case. “For many people...[medical care is] paid for through health insurance, and the existence of moral hazard combined with reasonably generous health insurance policies can call into strong question the validity of the simple proposition that prices represent consumers’ marginal willingness to pay for the relevant products.” Keeler, BPEA Micro, 1996, p189

However, many car repairs are also paid by insurance, and it is a commonplace observation that car insurance also sometimes causes more car repair than would otherwise occur. It is not so clear that insurance makes a fundamental difference between human repair and car repair, though it may be a more important factor in human repair (or it gets more attention there because human repair is more important, both in the economy and in consumer welfare).

The most important difference is the fact that the owner can sell the car. A representive consumer's willingness to pay guides the determination of how quality improvements should be treated in the CPI.[11] For a car repair, a consumer routinely asks: Considering what the car is worth, should I repair it? Could I get auto transportation services more cheaply by selling the unrepaired car and buying another? Or even: Should I do without a car? If we were to collect the values of the unrepaired and repaired car, we presume that we would find that the change in value justified the cost of the repair. But we don't do that, largely because it is not necessary: Because the car could always have been sold, we know, or can assume, that the car repair normally meets the willingness-to-pay test.

Suppose for example that for a brake job the car owner had to choose between two different types of brake pads, one which claimed 20 thousand miles life, the other 30 thousand. In principle, one could evaluate the choice by obtaining “outcome” data (did the more expensive pads actually give longer life or more stopping effectiveness?). We could then ask, additionally, whether the improved outcome was worth it: We calculate (value, repaired car) - (value of unrepaired car), and compare this difference to the cost of the repair. The car repair was normally undertaken because it was economically appropriate, and for this reason, we do not consider carrying out these calculations in the case of car repair.[12]

Obviously, in the case of health care expenditure the consumer's decision is different. If

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[11] The literature on this is extensive. Fisher and Shell (1972) and Triplett (1983) provide theoretical rationales.

[12] We might also ask, but we don’t, whether the car owner really “needed” the better brake pads (possibly because the rest of the car would only last 15 thousand miles). These calculations would parallel “cost effectiveness analysis” for human repair (see section III).

the consumer were paying the full cost, the medical expenditure might meet the willingness-to-pay test in some sense.  But because the analogy to selling the unrepaired car is not normally among the consumer's options, ability to pay for medical care influences the result in a way that is not the case in car repair.

Thus, in the case of medical care output, it is necessary to estimate willingness to pay.  We cannot assume (as in the case of car repair) that payment for a procedure means that it meets the willingness-to-pay test.  Because the willingness-to-pay measure for health care must be estimated, we also need medical care outcome measures:  In health care, we need data that show that more resource-intensive procedures "work," in a sense that we do not need them in the case of car repair.  Section III addresses health care outcomes measures.

## III.  Existing Accounting Systems for Health Care Expenditures

Accounting for health care expenditures occurs in three major places in U.S. statistics. Past efforts to create real output or real expenditure measures for heath care have proceeded within one or the other of the first two accounting systems discussed below--national accounts and national health accounts.  In this paper, I propose to reorient that work toward the third system--cost of disease accounts.  Developing the proposals of this paper requires, accordingly, an extended overview of the three existing U.S. health care accounting systems.  All major countries share one or more of these health expenditure accounting systems, so the discussion and proposals apply to countries other than the U.S. (I consider explicitly in a separate section the task of constructing real output measures for countries that have public health care systems, for which prices are not available, and where price indexes therefore are not relevant).

### A.  National Accounts

Expenditures on health care are part of the U.S. National Income and Product Accounts (NIPA), whose best known statistic is Gross Domestic Product (GDP).  The statistical agencies of most countries follow, to a greater or lesser degree, the international standard for national accounting, the System of National Accounts, or SNA (IMF, et al, 1993).  There are no significant differences in the treatment of the health sector in the SNA and the NIPA, though the groupings may not be identical across countries, and procedures may differ substantially from those of the U.S. in countries that have government medical systems.

In the NIPA, personal health care expenditures are located primarily in Personal Consumption Expenditures (PCE), which means that they are mostly classified as final products. The PCE includes not just consumer out of pocket health spending, but also other payments for health care, such as by employer-provided health insurance.  In 1995, medical care expenditures in PCE amounted to $873 billion, about 18 per cent of Personal Consumption Expenditures and about 12 percent of GDP (table 1).

The product and service categories in PCE medical care include drugs, and so forth, but also institutional providers of services ("hospitals and nursing homes," for example). Medical *goods* that are inputs to medical care are classified by a product classification system, like other parts of the PCE, but medical services are classified by type of *provider,* or--another way to put it--medical services are grouped by an industry classification system. Thus, a particular pharmaceutical will be counted in the same place whether it is sold by a grocery store or a pharmacy, but if a medical procedure shifts from in-hospital to a doctor's office or clinic, it will show up in a different grouping in the PCE. The distinction between goods and services classifications in the NIPA is driven largely by data availability (or at least I have never seen a conceptual argument supporting the distinction). This characteristic of the NIPA classification system for health care expenditures is also present in other health accounting systems:

The NIPA classification system for health care expenditures is matched by the nature of the price indexes used as deflators. The price deflators for medical goods, primarily pharmaceuticals, come from the Consumer Price Index (CPI). Since 1992, the deflators for health care services expenditures in PCE have been computed from PPI price indexes for hospitals (Standard Industrial Classification 806) and for physicians' services (SIC 801); more recent PPI indexes have been introduced for nursing homes (SIC 8053), home health care (SIC 808) and medical labs (SIC 8071), and these have now been integrated into PCE. These are of course, industry price indexes.[13] Prior to 1992, CPI medical care indexes were employed (the behavior of the CPI medical indexes is discussed below).

The inconsistency between goods and services classifications is perhaps subsidiary to another point about the NIPA classification system: Nowhere in the categories used for medical expenditures in the NIPA is any distinction made about what medical spending is for, what is purchased when medical spending takes place. Expenditures for cosmetic surgery and heart surgery are both (if both are done in the hospital) grouped together in hospital expenditures, and pharmaceuticals for acne and for angina are combined in the medical goods components. If hospital expenditures are growing, there is little in the national accounts that will tell us very much about the hospital medical procedures that are fueling overall growth, or about the diseases that are being treated.

Moreover, the NIPA classification naturally orients national accounts producers and users to a particular specification of the deflation problem: With the NIPA classification system, it seems natural to look for deflators for "physicians" and "hospitals" (or even "nonprofit hospitals" and "propriety hospitals"), for those are the expenditure categories that are deflated. With the NIPA classification system it seems less natural to ask: "What is the price index for, e.g., coronary disease, or for heart attacks?" With the NIPA classification system for health care, it is not clear what one would do with price measures for treating diseases, even if they became available.

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[13] The hospital PPI's are constructed by taking a sample of Diagnostic Related Groups (DRG); each DRG in the sample is priced repeatedly, with the characteristics of the patient and of the transaction held constant (Catron and Murphy, 1996). For an evaluation of these price PPI measures, see Berndt, et al. (1998).

B. National Health Accounts

A second U.S. accounting for health care expenditure is the National Health Expenditures (NHE), often referred to as the National Health Accounts (NHA). Where the NIPA treat health care as one among many products and services purchased or consumed by households, the emphasis in the NHE is on assembling comprehensive data on total national expenditures on health, and on the sources and recipients of those expenditures. As noted earlier, total U.S. health spending in the NHA equaled 14 percent of GDP in 1995; total *personal* health expenditures were $869 billion in the NHA in the same year, very close to the 12 percent of GDP total in PCE (table 1). The remainder of NHA health expenditures includes health education, investment, and certain other components, which appear in other parts of the NIPA, and are usually not identified separately.

The U.S. national health accounts have been produced since 1964 (Rice, Cooper, and Gibson, 1982; Lazenby, et al., 1992). Rice, Cooper, and Gibson (1982) refer to a compatible series for private health expenditure that extends back to 1948, and note even earlier estimates of total U.S. health care spending.[14] Health accounts are also constructed for demographic groups, the aged, for example (Waldo et al, 1989),

The national health accounts are organized in the form of a matrix. Table 2 presents a condensed form of the accounts as they are now published (see Lazenby, et al, 1992; Levit, et al., 1996).

The columns of the matrix arrange health care expenditures by major source of funding (for example, households, private health insurance, government). As table 2 shows, 54 per cent came from private funding, and 46 per cent from government funding; private insurance and the federal government are the biggest contributors to total national health expenditures and to expenditures on personal health care. More detail is routinely available in the NHA on Federal and on State and local funding sources, and more detailed estimates are periodically provided for business or households (Levit and Cowan, 1991).

The rows of the NHA matrix show the uses of the funds, the sectors or economic units that receive the expenditures on health care. The categories are similar to those in the NIPA (see table 1). However, the close agreement between NHA personal health care expenditures and PCE medical care expenditures at the aggregate level does not extend to the components of medical care. Hospital expenditures, for example, differ in the two accounts (see tables 1 and 2), as does "other professional services." Several categories appear in one system but not as a separate entry in the other (home health care is the largest such category). A NIPA-NHA reconciliation is contained in Rice, Cooper, and Gibson (1982); this appears to be the latest published reconciliation, though a new one is forthcoming.

[14] According to one of these early studies, health care accounted for 4 percent of GDP in 1929.

In the case of services, the national health accounts distinguish, again in parallel with the NIPA, the organizational unit that receives the funds, rather than, strictly speaking, the type of service. For example, the same type of service might be performed in a doctor's office or in a hospital; the national health accounts would distinguish whether the expenditure was received by a hospital or by a doctor's office, but would not distinguish the expenditure by the type of service performed, or by the disease category for which treatment was rendered. The classification of individual units receiving payments for medical services is the U.S. Standard Industrial Classification system (1987).

For drugs, eyeglasses, and other durable and non-durable "therapeutic goods," the national health accounts distinguish, as do the NIPA, the type of goods, using product code classifications from the U.S. Bureau of the Census. Expenditures on therapeutic goods count only those goods that are purchased from retail outlets. Any therapeutic goods that are received by patients in hospitals, for example, will be recorded in the expenditures on hospital care.

Thus, the NHA expenditure classification does not strictly speaking correspond to a "goods-services" distinction, nor does it group expenditures by commodities in the usual sense. It is instead a classification based on the institutional structure of the recipient of the funding. In fact, the category "drugs and other therapeutic goods" is really a classification that groups medical expenditures that are received by the retail trade sector. This has implications not only for the interpretation of the published components, but also for other aspects of the NHA: For example, the proper deflator for the pharmaceutical portions of NHA will exclude drugs sold to hospitals because they are not included in the drugs that are counted separately in the NHA "goods" classification scheme.

Because a national health accounts matrix is prepared for each year, it is useful to think of the national health accounts as a 3-dimensional matrix. There are the two dimensions shown in table 2. This is like one page in a book. Then, because there is an equivalent to table 2 for each year, there are a series of pages in the book. One can follow any of the columns, or any of the rows, or any combination of cells from the matrix, through time to construct a time series.

The U.S. NHA are well known and are widely used for analyzing the economics of the health care sector. Similar health accounts are produced in some other countries. For example, France has a system of health accounts, Comptes Nationaux de la Sante (Ministere du Travail et des Affaires Sociales, 1996) that is similar to the U.S. NHA, in that it provides information on the source of funds in France for health care and health spending and on the institutions receiving the funding. The French system dates from 1976, and is available, as is the U.S. system, in quarterly and annual time series.

The Comptes de la Sante are referred to as a "satellite account," a term that is not generally applied to the U.S. NHA.[15] Despite this, the groupings of data in the Comptes de la Sante are similar to those in the U.S. NHA, with some exceptions, such as the inclusion of expenditures for spas ("cures thermales") in France. OECD (1997, page 121) lists ten OECD countries where satellite accounts for health have been produced or are "under study;" the U.S. NHA is not included in the list of satellite health accounts.

Two properties of national health accounts deserve emphasis. First, total national health expenditures, and other aggregates, are built up from the bottom. For the most part, these are not estimates where one starts with a total and distributes the total among the different categories. Rather, one adds up the categories to get the total. Some alternative health accounting systems distribute totals to categories, and hence cannot be estimated independently of NHA-type accounts.

Second, the fact that the NHA accounts are arranged in a matrix means that there are cross checks. All the row and column totals must add up. But because estimates for different cells of the matrix come from different data sources, which may be compiled by different methodologies and may not be consistent across different sources, adjustments may have to be made to source data to insure that all row and column totals in the matrix balance. Though this assures consistency in the matrix and corresponds to good economic accounting principles, it can mean that the entry in a particular cell of the matrix does not agree with the best independent estimate of the value for that cell.

Unlike the case of national accounts, where the SNA provides a standard for producing internationally-comparable data, no international standard for health accounts exists at present. The World Bank has set out informal guidelines for NHA development for borrowing countries (McGreevey, 1996). However, the OECD, with funding from the US agency that produces the US NHA, has just recently released a proposal for an international standard (OECD, 1997).

[to discuss here: emphasize their "functional" approach here? Or later, after the discussion of cost of disease? And no price indexes or deflation in OECD]
[add: NHA also orients toward deflation for "hospitals." Recognized problems with past deflation (Freeland, 198x, and Fisher, 199x), has led to increased use of broader list of hospital inputs as a proxy for output measures]

C. Cost of disease accounting

In some respects, the concepts and structure of national health accounts resemble flow of funds accounts, in that they focus on financial flows of health expenditures, and on sources and uses of funds. The two dimensions of the national health accounts matrix--sources of funds and

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[15] On satellite accounts, see the description in the SNA (IMF, et al, 1993), though the reader is warned that this chapter is not particularly clear. For the development of the concept of the satellite account, see Vanoli (1975, 1986), and Teillet (1988).

recipients of expenditures--have been useful for many of the analytic tasks for which health expenditure data are required. However, these two dimensions are not the only useful way in which one might array health expenditure data.

Consider the subtotal "personal health expenditures." In the national health accounts this category has the following definition: "Personal health care comprises therapeutic goods or services rendered to treat or prevent a specific disease or condition in a specific person" (Lazenby, et al, 1992). As this definition suggests, one can envision disaggregating personal health care expenditures by types of diseases. Such disaggregation is most commonly performed as part of a "cost of disease" or "burden of disease" study.

For present purposes, I define a cost of disease study as one that estimates *expenditures* for treating disease. In addition to health care expenditures, a burden of disease study would consider unpaid care provided by family members, and loss or reduction of earnings, and it would put a value on the losses from premature mortality and from the disutility of disease itself. Thus, a burden of disease study would consider all the social and economic costs of disease, not just the direct, or monetary expenditure, costs. Put another way, a cost of disease study estimates the cost of treating diseases that are treated; a burden of disease study would include additionally the costs of diseases that are not treated, or for which treatment is ineffective. Examples of burden of disease studies are Rice (1966) and Murray and Lopez (1996).

Burden of disease studies could lead to a broader economic accounting that goes beyond the traditional market boundary adhered to in national accounts and in national health accounts. Mainly for reasons of space, I will not pursue any of the implications of this broader accounting in the present paper. The present inquiry, then, will concern only the direct costs of treating illness, not because those other costs are without relevance, but because understanding the implications of direct resources that are put into the healthcare sector is a step toward any broader accounting. At present, the goal is creating real measures of the costs of treating disease, and not, or at least not at present, of the real cost of diseases that are not treated.

The first systematic U.S. disaggregation of health expenditures by disease appears to be Rice (1966), although she cites predecessors. Subsequent updates include Cooper and Rice (1976), Hodgson and Kopstein (1984). An as yet unpublished study by Thomas Hodgson of the National Center for Health Statistics (Hodgson, 1997) provides a U.S. cost-of-disease account for 1995. These accounts are summarized in table 3.

There are of course thousands of diseases, conditions and diagnoses. Some grouping of conditions must be carried out. Classifications systems provide the building blocks for much of economic statistics--though their properties are often ignored by the economists who use them--and the classifications used for diseases, and displayed in table 3, must be discussed.

## D. Classification Matters

The most widely used disease classification system is the International Classification of Diseases (or ICD), which has gone through a number of revisions since its inception. The International Classification of Diseases, Injuries and Causes of Death, 9th Revision (ICD-9) [check title]was developed by the World Health Organization (WHO) and issued in 1977 (Manual of [ref--check what is right ref?]). The classification system is intended to produce comparable cross-country health statistics, parrticularly on causes of death, and has been developed over many years [the first version was published in 19xx--check]. A later revision (ICD-10) was released in 1990 [check date] but is not yet in general use. In most respects that are relevant for this paper, ICD-10 is similar to ICD-9 [check: what are the differences? in mental health codes? Other areas?].

Experiments with using the ICD system for producing U.S. hospital statistics began in the 1950's. Experience led to a U.S. modification of ICD-9, known as ICD-9-CM (for Clinical Modification), that is now in extensive use for coding hospital records. The main differences from the international system are: more detail (that is, more specific and precise codes for medical conditions), elimination of some ambiguities in pregnancy and childbirth conditions and in some other areas, and changes in the presentation to make the system easier to use by data coders (Introduction, ICD-9-CM [ref]). Despite claims on the latter point, private publishers have introduced their own, more user-friendly editions of the classification manual. The growth of such a publication market underscores the increasing practical utilization of ICD-9. It is now used, not just for classifying incidences of diseases and causes of death, but also for classifying a wide range of economic data, compiled mainly for administrative purposes.

The ICD-9 classification contains XX chapters. Most chapters are organized by the part of the body affected. For example, tonsillitis, pneumonia, asthma, and pulmonary collapse are all classified in ICD-9 chapter 8, Diseases of the Respiratory system. Exceptions to the “part of the body” rule are infectious diseases and cancer (ICD-9 chapters 1 and 2). As examples, lung cancer is classified in ICD-9 chapter 2 (Neoplasms), rather than with the respiratory diseases in chapter 8, and fungal infections are in ICD-9 chapter 1 (Infectious and Parasitic Diseases), where they are grouped by the type of infecting organism, regardless of the part of the body infected.

Below the chapter level the classification may switch organizationing principle. For example, within chapter 2 neoplasms are organized at the three-digit level by the part of the body affected, so codes 150-159 in chapter 2 encompass malignant neoplasms of the digestive system (among which is code 151: malignant neoplasm of the stomach). And pneumonia is distinguished by type of infectious agent (480, viral pneumonia; 480.0, pneumonia due to adenovirus; 482, other bacterial pneumonia; and so forth).

Thus, the ICD-9 classification system conforms consistently neither to an anatomomical nor to an etiological or causal principle. It does, however, conform generally to the way diseases are treated and to the way medical specialties are demarcated. This makes the ICD an advantageous and natural system to use to generate economic data on the treatment of disease.

A second classification system is relevant to this paper--the "Diagnosis Related Groups" system (DRG) of the Health Care Financing Administration (HCFA). This system is used to classify hospital and medical procedures for the purpose of making government reimbursements under Medicare and other government health programs. The third revision of the DRG system was introduced for Medicare hospital services in 1986 and is still in effect. The Australian DRG system is a modification of the U.S. DRG system.

The first level of the DRG system depends on the "principal diagnosis," which is the diagnosis that initially caused the patient's admission to the hospital (Averill et. al., 1997). Principal diagnoses are grouped into twenty-three Major Diagnostic Categories (MDC). "The diagnoses in each MDC correspond to a single organ system or etiology and in general are associated with a particular medical specialty" (Averill et. al., 1997, p. 5). Correspondance with the divisions of medical specialties is referred to as assuring that DRG's would be" clinically coherent."

The coding of principal diagnoses under the DRG system conforms, with certain exceptions, to the ICD-9, or more precisely, to the ICD-9-CM. At the chapter level, the major deviation of the DRG system from the ICD-9 classification involves the latter's chapter 2 (Neoplasms). Codes in this ICD-9 chapter were reassigned to the parts of the body affected because "clinical care is generally organized in accordance with the organ system affected, and not the etiology" (Averill et. al., 1997, p.5). Thus DRG neoplasms MCD's correspond to the second level groupings of the ICD-9 neoplasms chapter [check: correct? Or approximate?] Additionally, ICD-9 chapter 6 is split into Diseases and Disorders of the (a) Nervous System, (b) Eye, and (c) Ear, Nose and Throat, the latter incorporating portions of ICD-9 chapter VV [check]. With the modifications noted, MCD groups conform to ICD-9 chapters or to regroupings of them.

Below the first level, ICD-9 and DRG classifications diverge. The second level of the DRG hierarchy depends on whether the admission involved a surgical procedure. Starting from within an MDC, if surgery was not performed in conjunction with an admission, then the second level again consists of groupings of principal diagnoses, which can be thought of as groupings of detailed ICD-9 codes, with exceptions. If surgery was performed, then the second level of the DRG hierarchy depends on the surgical procedure--type of operating room or other procedural description, with the most resource intensive treatment dominating in cases where multiple surgical procedures are performed.

The final levels of the DRG classification depend on comorbitities, age, and discharge status, for classes where these variables were associated with higher costs of care. The third revision of the U.S. DRG system has 469 DRG's. The Australian version of the DRG system has YYY DRG's.

The entire structure of the DRG system is intended to organize hospital admissions by the resources that would be expected to be spent in the treatment of a particular admission. It is thus a classification system that yields, by its design, economic data on the costs of illness.

The DRG system has, nevertheless, two deficiencies for the purposes of this paper. First, it is not an international system, even though the U.S. and Australia share similar DRG systems. Second, it is not well suited to recording the incidences and prevalences of diseases because, below the first level or chapter groupings, each DRG is a grouping of diseases which might be rather different, but which have similar expected treatment costs. Averill et. al. (1997), for example, cites zzzz and yyyy as two unrelated diseases that have similar treatment costs, even though they have very different etiologies and different treatments.

Available classifications of the cost of disease therefore use ICD-9 chapters as the basis for calculating the cost of disease. At the chapter level, ICD-9 and DRG systems are similar.

Two of the U.S. studies in table 3 use the ICD-8 system and the other two use the ICD-9. Notes to table 3 [notes? Or additional table, table 3A, or something] list the major changes in classifications between these two systems. However, not all changes are listed, and sometimes what seems minor in a classification system may have a major impact on the data. Another problem is inconsistency in coding practices: special problems here are the coding of diseases of infancy, of old age, of certain respiratory diseases, and of diseases, like diabetes, that typically have extensive co-morbidities.[16] Coding inconsistency is a long-standing problem with medical data. For example, McKeown (197x) notes the long-term decline in "old age" as a cause of death--it has gradually been replaced with more precise coding of the medical condition, which reflects not only increased medical knowledge, but also changes in attitudes and social mores.[17]

E. Methods for Estimating Cost-of-Disease Accounts

As noted above, similar cost-of-disease disaggregations have been produced recently for several countries, including the U.S. (Hodgson, 1997), Canada (Moore, Mao, Zhang, and Clarke, 1997), England (actually, England and Wales--NHS, 199x, 1996?), and Australia (ref. hosp.1995?96?; Mathers, Penm, Carter, and Stevenson, 1998). This section describes their methodologies.

Cost of disease studies typically distribute totals for healthcare expenditures, as from NHA, among disease categories. That is, they are not "bottom-up" estimates, as are the NHA.

The methodology can best be understood by an example, for which I use the allocation of hospital expenditures. The other components of medical expenditures are calculated in similar ways, but of course the data vary according to the component. Details are contained in Hodgson

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[16] Hodgson (1997) contains a special chapter on the problems of estimating costs for diabetes.

[17] Aaron and Schwartz (1983) quote a British physician, who remarked that the body gets "a bit crumbly" after age 55. For a very different view of aging, see Vaupel (199x) and Manton (199y).

(1998), Chapter 5.

Total expenditures for inpatient hospital care are computed and published in the NHA (see table 2). This expenditure is allocated to ICD-9 chapters by the following steps.

The National Hospital Discharge Survey (NHDS) gives the total number of inpatient hospital days and subtotals by ICD-9 Chapter. The average charge per inpatient hospital day, grouped by ICD-9 chapter, is found in the National Medical Expenditure Survey (NMES) for the year 1987; this charge is updated to 1995 by the CPI Hospital Room Price Index. [18] For each ICD-9 chapter, the number of hospital days (NHDS) is multiplied by the average charge per day corresponding to diseases in that chapter (NMES); when each of these products is divided by the total for all ICD-9 chapters, the result is the share of expenditures allocated to each chapter. This share is multiplied by total NHA hospital expenditures (which are, of course, determined independently of the two data sources used to calculate the share) to determine the hospital inpatient expenditures for each ICD-9 chapter.[19]

Hodgson (1998) was able to allocate 88 percent of NHA personal healthcare expenditures to a medical diagnosis, and 98 percent of major categories such as hospitals, physicians and dentists services, and nursing homes (see table 4). Although all expenditures for prescription drugs were allocated to an ICD-9 chapter, only 35 percent of nonprescription drugs and related goods could be allocated. It is not entirely clear, for example, for what medical condition aspirin will be used. Information on amounts allocated is contained in table 4.

The basic methodology for cost-of-disease studies was developed by Rice (1966). The methodology used in Canada (Moore, et al., 1998) is very similar to that used in the United States. Estimates in the UK (Department of Health, 1996) apply a single average cost of hospitalization across all medical conditions, and thus lack the refinement of the Canadian and U.S. studies, which differentiate cost per day across different classes of illnesses. The Australian study [complete sentence].

Though the basic estimating methodologies are similar, that does not mean cost of illness studies are exactly comparable over time, or across countries at one point in time. Estimating methods, classifications, data sources, and to some extent medical practice, the diseases

[18] [Note: These NMES charges are specific to each ICD-9 category, judging from the S,D,E subscripts in Equation 1 on page 68. Check this.]

[19] "In effect, HCFA's estimates of inpatient hospital expenditures are distributed by sex, age, and diagnosis, according to the distribution of days of hospital care weighted by the average charge per day." Hodgson, 1998, page 6. In the above, I have ignored the demographic parts of the calculation. Catron and Murphy (1996) present a similar disaggregation of U.S. hospital revenue for 1987. Circulatory diseases rank first in hospital revenues, and digestive system diseases second.

themselves and how they are diagnosed, classified and treated, as well as other considerations have changed over the nearly 35 years that are covered by cost of disease estimates in the United States. For all of these reasons, intertemporal comparability may be compromised.

Similarly, data sources, national practices, and estimating methods create noncomparabilities in international comparisons. For example, in the U.S. estimates drugs administered in hospitals are included in hospital expenditures; in Canada, drugs administered in hospitals are removed from hospital expenditures and placed in pharmaceutical expenditures.

## E. Comparisons and Trends

Exactly comparable or not, it is very useful to examine the trends of expenditures by disease category, and to make international comparisons of them. I do so partly because demand for statistics tends to create its own supply: To date, cost of disease studies have not been produced with an eye toward time series comparability or toward international comparability. Though a more comprehensive study would first make adjustments for time series and international comparability, this exceeds the scope of the present study, and I according content myself with a contribution to the demand for future comparability in cost-of-disease studies.

### 1. International comparisons of expenditures by disease

Table 5 compares partitions by chapters of the ICD-9 for total health expenditures in the U.S., Canada, England, and Australia.[20] Table 6 shows a similar partition for hospital expenditures.

The proportions of health spending by disease differ from country to country, yet there are also broad similarities. For example, circulatory system diseases are the largest expenditure category in U.S. overall health care spending (nearly 15 per cent of the total) and in U.S. hospital spending (19 per cent); they are also the largest expenditure category in Canada, and the second largest expenditure category in the U.K. (12 per cent) and in Australia (12 percent). Circulatory diseases are only the fourth largest category of spending in Australian hospitals (however, our preliminary concordance for the classification system for Australian hospitals may have noncomparabilities in it). In the U.K., mental disorders are the largest spending category; in the U.S., they are the second largest category of hospital spending, and third in overall expenditure. Endocrine, metabolic and immunity disorders account for a larger proportion of U.S. spending than in the U.K., Canada and Australia, presumably because of AIDS. Digestive system diseases are relatively more important in the U.S. and in Australia than in the U.K., with Canada in an intermediate position--closer to the U.K., overall, but close to the U.S. in hospital spending. Other differences exist.

What accounts for international differences in the composition of healthcare spending?

Several potential causes are topics for future research.

First, there are international differences in the incidence of diseases. For example, Australia reportedly has one of the highest rates of skin cancer in the world; that would push up Australia's relative spending on ICD-9 chapter 2 (cancers), which at six percent is somewhat higher than the proportion in the U.S. and England (though less than in Canada). I have examined international data on incidence rates, but those data are problematic in some cases. The results will be reported elsewhere.

Second, there are also case-mix effects. For example, skin cancer is a relatively low cost form of cancer, and it is frequently treated outside of hospitals; the proportion of Australian hospital spending on cancer is substantially lower than in the other three countries.

Third, there may be international differences in cost per case, even aside from case-mix considerations. Costs per case may differ because some countries employ less effective treatments (see Aaron and Schwartz, 1983, for some examples), or because some countries adopt more cost-effective procedures, or because of international differences in medical industry efficiency. These matters are not pursued here.

Note that international comparison of costs requires information on prices. Cross-country prices for medical care appear in the "purchasing power parity" statistics published by the Organization for Economic Cooperation and Development (OECD). However, the adequacy of PPP indexes has been questioned (Castles, 1997). Additionally, international comparisons of the costs of diseases requires price or cost differences by ICD-9 Chapter, and not just for an overall "medical care" aggregate.

Finally, as already noted, noncomparablilities exist in these data. The totals do not correspond to exactly the same definitions. For example, Australian hospital data exclude certain hospitals. Though the ICD-9 provides an international standard for classifications, it is sometimes not applied consistently. For example, it appears from tables 6 and 7 that complications of pregnancy and childbirth account for a considerably smaller proportion of U.S. health care spending than in the other three countries (and birth rates are similar in the U.S. and Australia, for example). However, an examination of incidence rates made it clear that data for the other three countries include normal pregnancies, which are not treated as a disease in U.S. data. An adjustment for pregnancy and childbirth costs can be made to U.S. data, but there are doubtless other noncomparabilities that have not yet been explored.

## 2. Trends in US health expenditure by disease, 1963-95

Table 3 shows cost of disease accounts for the United States for the four years for which these accounts have been compiled (1963, 1972, 1980, and 1995). Table 6 shows average annual rates of increase between each of the accounting years.

The first caveat to be expressed about these tables is that researchers who have assembled cost of disease accounts warn that they are not comparable over time. For one thing, the classification systems have changed. The first two studies use ICD-8, the second two, ICD-9. Unlike conventional national accounts, where "bridge" tables would have been constructed to permit moving more or less consistently across changes in classification structures, such adjustments have not in the past been carried out for cost of disease accounts, precisely because they have not been used for time series comparisons. Judging from the demands for other economic statistics, when cost of disease accounts are shown to have a time series use, producing time series comparability will be added to the tasks of their producers.

Another noncomparability arises because the proportion of expenditures that can be allocated to disease changes over time. The effect of this at the aggregate level can be seen from Table 6: When the proportion of unallocated expenditures falls (true between 1972 and 1980), the rate of growth of allocated expenditures will exceed that of total expenditures. Conversely, when the proportion of unallocated expenditures grows, the rate of growth of allocated expenditures will fall short of the growth rate of total expenditures (as is true for the 1980-1995 comparison).

Changes in unallocated expenditure may affect rates of growth for ICD-9 chapters as well. For example, if data become available to allocate ambulance expenses by disease category, the new allocation would probably affect, disproportionately, ICD-9 chapters "Injury and Poisoning" and "Diseases of the Circulatory System," compared with, say, "Skin Diseases" and "Congenital Anomalies." Again, it is common practice in national accounting to link out, so far as possible, the effects of changes in data availability, so as to construct a more nearly comparable time series. Increased demand for adding time series properties to cost of disease accounts would, no doubt, bring about the same result.

Leaving aside the noncomparabilities and time series inadequacies of the basic data, and taking the data only for what they present, the results are interesting.

Though diseases of the circulatory system are the largest expenditure category in the U.S., growth rates are only marginally above average for recent years (9.9 compared with the average of 9.3 percent between 1980 and 1995). Diseases of the digestive system, once the largest category of U.S. expenditure, show a growth rate that is well below average in recent years (7.3, compared with 9.3). [add more]

Considering the number of diseases identified in ICD-9 categories, disaggregating by ICD-9 chapter, though it is a beginning, does not go far as one might like for empirical work on the human repair model. For example, ICD-9 chapter 7 (Circulatory Diseases) covers ICD-9 codes 390-459; of these, codes 393-429 are heart disease codes, of which codes 410-414 are ischemic heart disease, among which code 410 is acute myocardial infarction, or heart attack. For this chapter, some additional disaggregation has been carried out: Hodgson, for example, estimates that coronary (ischemic) heart disease (ICD-9 codes 410-414) accounts for roughly half of total expenditure for all heart disease, and additional detailed estimates may be available in the future.

Though additional disaggregation beyond the ICD-9 chapter is essential, at some point more expenditure detail will be both impossible to obtain and perhaps inappropriate: The greater the detail at which expenditures are disaggregated, the more likely that expenditures on a particular illness episode encompass multiple individual ICD-9 codes.

## IV. Implementing the Human Repair Model

National accounts measures of the health sector, national health accounts, and health satellite accounts all share an unresolved problem: How does one construct adequate real output measures for medical care? The present section asks how we can construct, from existing and prospective data, a health account that will yield a real output measure and at the same time, what are the directions in which we can push data development to facilitate improved measurement of the output of the healthcare sector. It presents an accounting structure that is derived from the human repair model, and which is implementable, in principle, in all the cases discussed above, and for which data that can fill in the accounting structure are being generated from a variety of sources.

### A. Data for Estimating the Output Model

Section II developed the idea that the output model for health care must build in data on the outcomes of health care procedures. Two recent bodies of research make use of or generate health outcomes.

1. An increasing number of cost effectiveness studies are being carried out within the health care industry itself. Gold, Siegel, Russell, and Weinstein (1996) provide a common protocol for carrying out such studies, and United Kingdom Department of Health (1994), provides a tabulated review of cost effectiveness studies. Garber and Phelps (1992) provide a theoretical framework for cost-effectiveness studies and show that medical cost-effectiveness studies can be interpreted as willingness to pay for medical interventions.

A typical cost-effectiveness study compares alternative health care procedures for a particular disease or condition. The numerator of the cost-effectiveness ratio is the total cost difference between two alternatives, including all direct costs and indirect costs such as family provided care during convalescence. The denominator is the difference in health outcomes for the same two alternatives. Gold, Siegel, Russell, and Weinstein (1996) recommend a relatively new health outcome measure called the QALY--the quality-adjusted life year--in the denominator of the cost-effectiveness ratio.

2. A number of recent studies have been undertaken by a group of NBER researchers that have the explicit objective of measuring a price index for some part of the health care sector. Examples are Cutler, McClellan, Newhouse, and Remler (1996) on heart attacks, and Frank, Berndt, and Busch (1997) and Berndt, Cockburn and Griliches (1996) on the treatment of depression, Ellison and Hellerstein (1997) on infantile fever, and Shapiro and Wilcox (1996) on cataract surgery. In the first study, the outcome measure was the increase in life expectancy

associated with more resource intensive heart attack treatments. In the depression studies, the outcome measure was the elimination of the symptoms associated with a diagnosis of severe depression, without holding constant methods of treatment (or, to put it another way, without necessarily holding constant the characteristics of the transaction, as with traditional price and output measurements). Other, similar studies are underway.

A price index study such as Cutler, McClellan, Newhouse, and Remler (1996) is similar to a cost-effectiveness study, differing mainly in the following ways (a more extended discussion is contained in Triplett, forthcoming). First, the health outcome measure in Cutler, McClellan, Newhouse, and Remler (1996) was life expectancy, not QALY (cost effectiveness studies have also employed life expectancy in the past: see U.K. Department of Health, 1994, and Gold, Siegel, Russell, and Weinstein, 1996). If heart disease treatments had no implications for quality of life (for example, the ability to exercise or conduct daily living without chest pain), then an increase in life expectancy is an increase in QALY. Use of QALY would extend and enhance the measures in Cutler, McClellan, Newhouse, and Remler (1996). Second, Cutler, McClellan, Newhouse, and Remler (1996) value the change in life expectancy, that is, they put a dollar value on the medical outcome; medical cost-effectiveness studies do not do this. Valuing medical outcomes is, however, necessary for price indexes. This question is also discussed in Triplett (forthcoming).

B. Some examples: The human repair model and implementation examples with available data

**[Section to come: Circulatory disease chapter and heart attacks; Mental disorders chapter and depression; Nervous system and sense organs chapter and cataracts]**

Medical outcome measures are disease specific. There are obviously many human repairs to be considered, even in one ICD-9 chapter, let alone across all of them. Moving through the ICD-9 chapters on a disease-by-disease basis is clearly a very big job. Yet, there is no reasonable alternative but to take samples of human repairs and compute the value of medical interventions on the health of the recipients.

To put this task in context, however, personal health care accounts for about 12 per cent of GDP in 1995; the Producers' Durable Equipment (PDE) portion of investment in the NIPA was roughly 7 ½ percent of GDP in the same year. The unpublished detail from which PDE is calculated runs to something on the order of 800 lines; not all of them have their own deflators, but the deflation detail incorporates some 400 lines, for which in many cases both domestic and imported products are distinguished and deflated separately. Additionally, the Bureau of Economic Analysis computes a capital flow matrix that distributes these investment components to the more than one thousand industries identified in the SIC system, though not to every one of them at the finest level of SIC detail.

Measuring health is not a bigger job than measuring PDE, nor a less important one. The difference is, rather, that the investment accounts have many years' head start.

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**Table 1: Comparison of NHA and NIPA Medical Care Expenditure Categories, 1995**

| NHA | | NIPA | |
|---|---|---|---|
| Category | $ billion | $ billion | Category |
| Personal Health Care | 869.0 | 871.6 | Medical Care |
| Hospital Care | 346.7 | 310.6 | Hospitals |
| Physician Services | 196.4 | 191.4 | Physicians |
| Dental Services | 44.7 | 47.6 | Dentists |
| Other Professional Services | 54.3 | 104.4 | Other Professional Services |
| Home Health Care | 28.4 | -- | |
| Drugs and Other Medical Nondurables | 84.9 | 85.7 | Drug preparations and sundries |
| Vision products and Other Medical Durables | 13.1 | 13.1 | Opthalmic products and orthopedic appliances |
| Nursing Home Care | 75.2 | 65.2 | Nursing Homes |
| Other Personal Health Care | 25.3 | -- | (Other Categories) |
| Program Administration and Net Cost of Private Health Insurance | 60.1 | 40.7 | Medical Care and Hospitalization |
| (Other Categories) | -- | 12.9 | Income Loss and Workers' Compensation |

source: HCFA website, http://www.hcfa.gov/stats/NHE-OAct/tables/t11.htm; and *Survey of Current Business*, August 1997, Table 2.4.

**Table 2: National Health Expenditures, by Source of Funds and Type of Expenditure: 1995**
(Amount in Billions)

| | | Private | | | | | Government | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Consumer | | | | | | |
| | Total | All Private Funds | Total | Out of Pocket | Private Insurance | Other | Total | Federal | State and Local |
| National Health Expenditures | 991.4 | 536.2 | 493.6 | 166.7 | 326.9 | 42.6 | 455.2 | 328.7 | 126.5 |
| Health Services and Supplies | 960.7 | 525.3 | 493.6 | 166.7 | 326.9 | 31.7 | 435.4 | 314.7 | 120.6 |
| Personal Health Care | 869.0 | 480.4 | 449.4 | 166.7 | 282.6 | 31.1 | 388.5 | 301.7 | 86.8 |
| Hospital Care | 346.7 | 136.2 | 121.2 | 9.6 | 111.6 | 15.0 | 210.5 | 172.3 | 38.2 |
| Physician Services | 196.4 | 133.1 | 128.9 | 29.0 | 99.9 | 4.1 | 63.3 | 50.7 | 12.6 |
| Dental Services | 44.7 | 42.7 | 42.5 | 21.0 | 21.5 | 0.2 | 2.0 | 1.1 | 0.9 |
| Other Professional Services | 54.3 | 41.9 | 38.1 | 20.4 | 17.7 | 3.8 | 12.4 | 9.5 | 2.9 |
| Home Health Care | 28.4 | 12.4 | 9.1 | 5.9 | 3.2 | 3.3 | 16.0 | 14.1 | 1.9 |
| Drugs and Other Medical Nondurables | 84.9 | 73.1 | 73.1 | 48.6 | 24.5 | -- | 11.7 | 6.3 | 5.5 |
| Vision products and Other Medical Durables | 13.1 | 7.7 | 7.7 | 7.1 | 0.6 | -- | 5.4 | 5.3 | 0.1 |
| Nursing Home Care | 75.2 | 30.2 | 28.8 | 25.1 | 3.7 | 1.4 | 45.1 | 29.5 | 15.6 |
| Other Personal Health Care | 25.3 | 3.3 | -- | -- | -- | 3.3 | 22.0 | 12.9 | 9.1 |
| Program Administration and Net Cost of Private Health Insurance | 60.1 | 44.8 | 44.2 | -- | 44.2 | 0.6 | 15.3 | 9.2 | 6.1 |
| Government Public Health Activities | 31.5 | -- | -- | -- | -- | -- | 31.5 | 3.8 | 27.7 |
| Research and Construction | 30.7 | 10.9 | -- | -- | -- | 10.9 | 19.8 | 14.0 | 5.8 |
| Research | 16.7 | 1.3 | -- | -- | -- | 1.3 | 15.3 | 12.9 | 2.4 |
| Construction | 14.0 | 9.6 | -- | -- | -- | 9.6 | 4.5 | 1.1 | 3.4 |

note: 0.0 denotes less than $50 million. Research and development expenditures of drug companies and other manufacturers and providers of medical equipment and suplies are excluded from "research expenditures," but are included in the expenditure class in which the product falls. Numbers may not add to totals because of rounding.

source: "Table 11: National Health Expenditures, by Source of Funds and Type of Expenditure: Selected Calendar Years 1991-96," *Health Care Financing Review* 19(1) (Fall): 189-191.

**Table 3: US health expenditures by ICD chapter (amount in millions)**

| ICD Chapter Headings | Estimated direct expenditures[1] 1963 | Estimated direct costs[2] 1972 | Estimated amounts of direct costs[3] 1980 | Estimated amount of personal health care expenditures[4] 1995 |
|---|---|---|---|---|
| Total expenditures | 29,394[a] | 78,537[d] | 219,443[g] | 897,510[j] |
| All conditions (total allocated expenditures) | 22,530 | 75,231 | 206,878 | 787,510 |
| Infectious and parasitic diseases 001-139 | 502 | 1,412 | 4,300 | 17,656 |
| Neoplasms 140-239 | 1,279 | 3,872 | 13,049 | 42,917 |
| Endocrine, nutritional and metabolic diseases, and immunity disorders 240-279 | 903 | 3,436 | 7,329 | 33,825 |
| Diseases of the blood and blood-forming organs 280-289 | 156 | 491 | 1,155 | 4,890 |
| Mental disorders 290-319 | 2,402 | 6,985 | 19,824 | 74,707 |
| Diseases of the nervous system and sense organs 320-389 | 1,416 | 5,947 | 17,132 | 65,847 |
| Diseases of the circulatory system 390-459 | 2,267 | 10,919 | 32,488 | 133,196 |
| Diseases of the respiratory system 460-519 | 1,581 | 5,931 | 16,661 | 61,481 |
| Diseases of the digestive system 520-579 | 4,159 | 11,100 | 30,974 | 89,656 |
| Diseases of the genitourinary system 580-629 | 1,210 | 4,471 | 12,313 | 37,462 |
| Complications of pregnancy, childbirth, and the puerperium 630-676 | 1,391 | 2,607 | --[h] | 3,555 |
| Diseases of the skin and subcutaneous tissue 680-709 | 248 | 1,525 | 5,940 | 18,824 |
| Diseases of the musculoskeletal system and connective tissue 710-739 | 1,430 | 3,636 | 13,124 | 50,309 |
| Congenital anomalies 740-759 | 113 | 381 | 1,345 | 5,046 |
| Certain conditions originating in the perinatal period 760-779 | 30 | --[e] | --[h] | 3,349 |
| Symptoms, signs, and ill-defined conditions 780-799 | 624 | --[e] | 3,815 | 23,487 |
| Injury and poisoning 800-999 | 1,703 | 5,121 | 18,684 | 71,806 |
| Supplementary classifications V01-V82 | 966 | -- | | 49,494 |
| other | 150[b] | 7,398[e] | 8,746[h] | |
| unallocated | 6,864[c] | 3,306[f] | 12,656[i] | 110,000 |

1 Source: Dorothy P. Rice, "Estimating the Cost of Illness," Health Economics Series Number 6, US Department of Health, Education, and Welfare, Public Health Service Publication No. 947-6. Washington: US Government Printing Office, 1966. Tables 1 and 31, pp. 3 and 109. Note that the disease classification used at this time period was the ICD-8 or ICDA.

2 Source: Barbara S. Cooper and Dorothy P. Rice, 1976, "The Economic Cost of Illness Revisited," *Social Security Bulletin*, 39 (2): 21-36. Table 1, p. 23.

3 Source: Hodgson, Thomas A., and Kopstein, Andrea N. : Health care expenditures for major diseases in 1980. *Health Care Financing Review*. HCFA Pub. No. 03173. Office of Resesarch and Demonstrations. Health Care Financing Administration. Washington. US Government Printing Ofice, June 1984. (Source information was taken from table 5, p. 69 of 1985 Rice paper.)

4 $110 billion could not be allocated by diagnosis, and this constitutes 12% of personal health care expenditures. Source: Thomas A. Hodgson 1997 database of the National Center for Health Statistics, unpublished data.

a From Rice (1966) Table 1: Differs from NHA personal health care expenditures by $0.1 billion.

b The "Other" category for this year was actually labeled "Miscellaneous" from the publication, and includes special conditions and examinations.

c Not given explicitly; calculated as "Total expenditures" less "All conditions (total allocated expenditures)."

d From Cooper and Rice (1976) table on page 22: the entry for "other health services" is understood to be the equivalent of the "unallocated" category in this table. This number is added to the "All conditions" number to give the total expenditure.

e The "Other" category for this year includes certain causes of perinatal morbidity and mortality, symptoms of ill-defined conditions, and special conditions without sickness and symptoms.

f From Cooper and Rice (1976) table on page 22: "other health services" is the equivalent of "unallocated."

g Differs from NHA by 2x.

h The "Other" category includes complications of pregnancy, childbirth, and puerperium and certain conditions originating during the perinatal period.

i Includes $8.3 billion of personal health care expenditures that could not be allocated by age and sex, and $4.265 billion that could not be allocated for other reasons.

j Differs from NHA. Original total was taken from a projection to 1995; the initial NHA actual estimate was about 2% below the projection and the revised estimate is lower than the projection by 3.2%. See Hodgson (1992) page x.

**Table 4: Personal health care expenditures, by allocation status and type of health service: US, 1995 estimates[1]**

| Type of health service | HCFA NHE Total | Hodgson's estimated national health expenditures Total | Allocated | Unallocated | Unallocated |
|---|---|---|---|---|---|
| | Amount in milions | | | | Percent |
| All personal health care | $869,000 | $787,510 | $694,584 | $92,926 | 11.8 |
| Total hospital care | 346,700 | 360,341 | 356,377 | 3,694 | 1.1 |
| Inpatient care | | 242,231 | 242,231 | 0 | 0.0 |
| Total outpatient care | | 88,281 | 88,281 | 0 | 0.0 |
| Outpatient departments and emergency room | | 83,729 | 83,729 | 0 | 0.0 |
| Facility home health agencies | | 4,552 | 4,552 | 0 | 0.0 |
| Non-Federal non-community hospitals | | 16,770 | 14,255 | 2,516 | 15.0 |
| Veterans Administration hospitals | | 13,059 | 13,059 | 0 | 0.0 |
| Other Federal hospitals | | 0 | | | 100.0 |
| Total physician services | 196,400 | 185,329 | 173,4704 | 11,861 | 6.4 |
| Physician offices | | 91,477 | 91,477 | 0 | 0.0 |
| Hospital inpatients | | 37,224 | 37,224 | 0 | 0.0 |
| Hospital outpatients | | 19,206 | 19,206 | 0 | 0.0 |
| Nursing homes | | 1,188 | 1,188 | 0 | 0.0 |
| Lab and x-ray services | | 36,234 | 36,234 | 0 | 0.0 |
| Merchandise sales | | 0 | | | 100.0 |
| Dental services | 44,700 | 42,900 | 42,900 | 0 | 0.0 |
| Total other professional services | 54,300 | 21,717 | 7,492 | 14,225 | 65.5 |
| Chiropractors | | 8,029 | 8,029 | 0 | 0.0 |
| Foot specalists | | 2,579 | 2,579 | 0 | 0.0 |
| Optometrists | | 6,205 | 6,205 | 0 | 0.0 |
| Dialysis centers | | 3,299 | 3,299 | 0 | 0.0 |
| Medicare ambulance services | | 1,605 | 1,605 | 0 | 0.0 |
| Other licensed professional services | | 0 | | | 100.0 |
| Blood banks, etc. | | 0 | | | 100.0 |
| Specialty outpatient clinics | | 0 | | | 100.0 |
| Home health care | 28,400 | 27,900 | 27,900 | 0 | 0.0 |
| Drugs and other medical non-durables | 84,900 | 55,224 | 36,006 | 19,218 | 34.8 |
| Total vision products and other medical durables | 13,100 | 13,900 | 13,900 | 0 | 0.0 |
| Vision products | | 7,814 | 7,814 | 0 | 0.0 |
| Hearing aids | | 1,354 | 1,354 | 0 | 0.0 |
| Other medical durables | | 4,732 | 4,732 | 0 | 0.0 |
| Nursing home case | 75,200 | 80,200 | 80,200 | 0 | 0.0 |
| Other personal health care | 25,300 | 0 | | | 100.0 |

[1] Estimates are based on data provided by Thomas Hodgson of the National Center of Health Statistics, and calculated by using "Unallocated" percentage for 1993 data and applying it to 1995 estimated expenditures; actual 1995 numbers are updated in the *Health Care Financing Review* 19(1): 191. (Hodgson's personal health care expenditure total does not include $110 billion that could not be allocated according to disease category.)

**Table 5: Total Health Expenditures, United States, England, Canada, and Australia, Disaggregated by ICD-9 Chapters**

| | United States[1] | | England, net public expenditure[2] | | Canada | | Australia | |
|---|---|---|---|---|---|---|---|---|
| | 1995 | | 1992/93 | | 1993 | | 1993-94 | |
| Diagnosis and ICD-9-CM chapters and codes | All personal health care | | NHS and PSS expenditure | | Total Direct Costs | | Total Health System Costs | |
| | millions of US dollars | % of total | millions of UK pounds | % of total | millions of Can. dollars | % of total | millions of Aus. dollar | % of total |
| All conditions | $787,510 | 100.0% | £31,060 | 99.9% | $44,130 | 100.0% | $31,397 | 100.0% |
| 1) Infectious and parasitic diseases 001-139 | 17,656 | 2.0% | 311 | 1.0% | 787 | 1.8% | 849 | 2.7% |
| 2) Neoplasms 140-239 | 42,917 | 4.8% | 1,273 | 4.1% | 3,222 | 7.3% | 1,905 | 6.1% |
| 3) Endocrine, nutritional and metabolic diseases, and immunity disorders 240-279 | 33,825 | 3.8% | 497 | 1.6% | 1,334 | 3.0% | 966 | 3.1% |
| 4) Diseases of the blood and blood-forming organs 280-289 | 4,890 | 0.5% | 155 | 0.5% | 274 | 0.6% | 192 | 0.6% |
| 5) Mental disorders 290-319 | 74,707 | 8.3% | 5,156 | 16.6% | 5,051 | 11.4% | 2,634 | 8.4% |
| 6) Diseases of the nervous system and sense organs 320-389 | 65,847 | 7.3% | 2,609 | 8.4% | 2,252 | 5.1% | 2,333 | 7.4% |
| 7) Diseases of the circulatory system 390-459 | 133,196 | 14.8% | 3,758 | 12.1% | 7,354 | 16.7% | 3,672 | 11.7% |
| 8) Diseases of the respiratory system 460-519 | 61,481 | 6.9% | 1,926 | 6.2% | 3,787 | 8.6% | 2,510 | 8.0% |
| 9) Diseases of the digestive system 520-579 | 89,656 | 10.0% | 2,578 | 8.3% | 3,326 | 7.5% | 3,712 | 11.8% |
| 10) Diseases of the genitourinary system 580-629 | 37,462 | 4.2% | 1,118 | 3.6% | 2,248 | 5.1% | 1,658 | 5.3% |
| 11) Complications of pregnancy, childbirth, and the puerperium 630-676 | 3,555 | 0.4% | 1,025 | 3.3% | 2,025 | 4.6% | 1,051 | 3.3% |
| 12) Diseases of the skin and subcutaneous tissue 680-709 | 18,824 | 2.1% | 528 | 1.7% | 892 | 2.0% | 955 | 3.0% |
| 13) Diseases of the musculoskeletal system and connective tissue 710-739 | 50,309 | 5.6% | 2,423 | 7.8% | 2,460 | 5.6% | 2,971 | 9.5% |
| 14) Congenital anomalies 740-759 | 5,046 | 0.6% | 124 | 0.4% | 305 | 0.7% | 191 | 0.6% |
| 15) Certain conditions originating in the perinatal period 760-779 | 3,349 | 0.4% | 217 | 0.7% | 551 | 1.2% | 247 | 0.8% |
| 16) Symptoms, signs, and ill-defined conditions 780-799 | 23,487 | 2.6% | 1,273 | 4.1% | 1,851 | 4.2% | 1,336 | 4.3% |
| 17) Injury and poisoning 800-999 | 71,806 | 8.0% | 1,180 | 3.8% | 3,122 | 7.1% | 2,607 | 8.3% |
| Supplementary classifications V01-V82 | 49,494 | 5.5% | 1,553 | 5.0% | | | | |
| Supplementary (health status) | | | 93 | 0.3% | | | | |
| Well-patient | | | | | 2,741 | 6.2% | | |
| other | | | | | 549 | 1.2% | 1,607 | 5.1% |
| unallocated | 110,000 | 12.3% | 3,230 | 10.4% | | | | |

[1] Expenditures include:  services provided in short-term community hospitals, $9 billion of expenditures by the Department of Defense, patients seen in hospital outpatient departments and emergency rooms, and may include those for hospice services.  From the data by Thomas Hodgson, listed below in Sources.

[2]The definition of "net public expenditure" is assumed to undertake the explanation provided in Annex A, part A.4.1.2 that describes expenditure data:  "The analysis includes the majority of health andsocial services expenditure, around 85%.  The major exclusions comprise NHS headquarters administration, ambulance and accident and emergency services, day hospital care, services classified in the programme budget as "other hospital", and social services for children.  Department of Health administration costs and centrally financed services (such as, for example, Departmental grants to voluntary organisations) are also excluded.  Income support expenditure for residents in independent residential care is included...in view of the community care reforms."
NHS is the National Health Service, and PSS is the Personal Social Service; total percent for all conditions do not add up to 100.0% due to rounding.

Sources: Electronic database, provided by Thomas Hodgson at the National Center for Health Statistics, US Department of Health and Human Services; the NHS Executive publication, "Burdens of Disease, A Discussion Document," Table 6.1, October 1996; and Health Canada, Environmental Risk Assessment and Case Surveillance Division, "Economic Burden of Illness in Canada, 1993"; Colin Mathers, Ruth Penm, Rob Carter, and Chris Stevenson, *Health System Costs of Diseases and Injury in Australia 1993-94:  An Analysis of Costs, Service Use and Mortality for Major Disease and Injury Groups*, Australian Institue of Health and Welfare, Canberra, February 1998, p. 34, "Table C.2:  Total health system costs for diseases and injuries by health sector and ICD-9 chatper, 1993-94 ($ million)."

**Table 6: Hospital Expenditures, United States, England, Canada and Australia, Disaggregated by ICD-9 Chapters**

| Diagnosis and ICD-9-CM codes | United States, 1995 Hospital care[1] | | England, 1992/93 NHS hospital expenditure[2] | | Canada, 1993 Direct costs, hospitals | | Australia, 1994-95 Private acute hospitals[3] | |
|---|---|---|---|---|---|---|---|---|
| | millions of US dollars | % of total | millions of UK pounds | % of total | millions of Can. dollars | % of total | millions of Aus. dollars | % of total |
| All conditions | $360,341 | 100% | £16,200 | 99.9% | $26,096 | 100.0% | $2,399 | 100.0% |
| 1) Infectious and parasitic diseases 001-139 | 9,426 | 2.6% | 162 | 1.0% | 345 | 1.3% | 14 | 0.6% |
| 2) Neoplasms 140-239 | 28,104 | 7.8% | 1,021 | 6.3% | 2,467 | 9.5% | 79 | 3.3% |
| 3) Endocrine, nutritional and metabolic diseases, and immunity disorders 240-279 | 14,643 | 4.1% | 194 | 1.2% | 527 | 2.0% | 20 | 0.8% |
| 4) Diseases of the blood and blood-forming organs 280-289 | 2,641 | 0.7% | 113 | 0.7% | 157 | 0.6% | 3 | 0.1% |
| 5) Mental disorders 290-319 | 43,172 | 12.0% | 2,770 | 17.1% | 3,632 | 13.9% | 113 | 4.7% |
| 6) Diseases of the nervous system and sense organs 320-389 | 13,247 | 3.7% | 810 | 5.0% | 793 | 3.0% | 210 | 8.7% |
| 7) Diseases of the circulatory system 390-459 | 67,604 | 18.8% | 1,847 | 11.4% | 4,862 | 18.6% | 225 | 9.4% |
| 8) Diseases of the respiratory system 460-519 | 31,039 | 8.6% | 940 | 5.8% | 1,788 | 6.9% | 97 | 4.0% |
| 9) Diseases of the digestive system 520-579 | 28,688 | 8.0% | 826 | 5.1% | 2,093 | 8.0% | 326 | 13.6% |
| 10) Diseases of the genitourinary system 580-629 | 18 | 4.9% | 778 | 4.8% | 1,076 | 4.1% | 260 | 10.8% |
| 11) Complications of pregnancy, childbirth, and the puerperium 630-676 | 2,121 | 0.6% | 875 | 5.4% | 1,650 | 6.3% | 217 | 9.1% |
| 12) Diseases of the skin and subcutaneous tissue 680-709 | 6,411 | 1.8% | 324 | 2.0% | 223 | 0.9% | 96 | 4.0% |
| 13) Diseases of the musculoskeletal system and connective tissue 710-739 | 20,512 | 5.7% | 923 | 5.7% | 1,286 | 4.9% | 486 | 20.2% |
| 14) Congenital anomalies 740-759 | 2,728 | 0.8% | 113 | 0.7% | 232 | 0.9% | -- | -- |
| 15) Certain conditions originating in the perinatal period 760-779 | 2,535 | 0.7% | 211 | 1.3% | 518 | 2.0% | 35 | 1.5% |
| 16) Symptoms, signs, and ill-defined conditions 780-799 | 7,682 | 2.1% | 761 | 4.7% | 845 | 3.2% | 10 | 0.4% |
| 17) Injury and poisoning 800-999 | 40,433 | 11.2% | 940 | 5.8% | 2,253 | 8.6% | 22 | 0.9% |
| Supplementary classifications V01-V82 | 21,572 | 6.0% | 810 | 5.0% | | | 63 | 2.6% |
| Well-patient care | | | | | 1,349 | 5.2% | | |
| unallocated | -- | -- | 1,761 | 10.9% | | | 125 | 5.2% |

[1]Unallocated expenditures are not given here for hospital care, but are part of the $110 billion or 12% of personal health care expenditures for all persons, that could not be allocated by diagnosis (Table 1).

[2]NHS is the National Health Service; total percent for all conditions do not add up to 100.0% due to rounding.

[3]Australian figures were converted from an alternative classification system by diagnoses; as such, congenital anomalies were not assigned figures, and additional information on the classification will be built into a subsequent revision.

Sources: Electronic database, provided by Tom Hodgson at the National Center for Health Statistics, US Department of Health and Human Services; the NHS Executive publication, “Burdens of Disease, A Discussion Document,” Table 6.1, October 1996; conversions from data diskette included in Commonwealth Department of Health and Family Services, “Australian Casemix Report on Hospital Activity 1994-95”; and Health Canada, Environmental Risk Assessment and Case Surveillance Division, “Economic Burden of Illness in Canada, 1993.”

**Table 7: Direct Cost or Public Health Expenditure Average Annual Rate of Increase by Disease Category, Various Years[1]**

| ICD-9-CM / ICDA chapter heading | 1963-1972[2] | 1972-1980[3] | 1980-1995[4] |
|---|---|---|---|
| Total expenditures | 11.54 | 13.71 | 9.85 |
| All conditions (total allocated expenditures) | 14.35 | 13.48 | 9.32 |
| Infectious and parasitic diseases | 12.18 | 14.94 | 9.87 |
| Neoplasms | 13.10 | 16.40 | 8.26 |
| Endocrine, nutritional and metabolic diseases, and immunity disorders[5] | 16.01 | 9.93 | 10.73 |
| Diseases of the blood and blood-forming organs | 13.60 | 11.29 | 10.10 |
| Mental disorders[6] | 12.59 | 13.93 | 9.25 |
| Diseases of the nervous system and sense organs | 17.29 | 14.14 | 9.39 |
| Diseases of the circulatory system | 19.08 | 14.60 | 9.86 |
| Diseases of the respiratory system | 15.82 | 13.78 | 9.09 |
| Diseases of the digestive system | 11.53 | 13.69 | 7.34 |
| Diseases of the genitourinary system | 15.63 | 13.50 | 7.70 |
| Complications of pregnancy, childbirth, and the puerperium[7] | 7.23 | -- | -- |
| Diseases of the skin and subcutaneous tissue[8] | 22.36 | 18.53 | 7.99 |
| Diseases of the musculoskeletal system and connective tissue[9] | 10.93 | 17.40 | 9.37 |
| Congenital anomalies[10] | 14.46 | 17.08 | 9.21 |
| Certain conditions originating in the perinatal period[11] | -- | -- | -- |
| Symptoms, signs, and ill-defined conditions[12] | -- | -- | 12.88 |
| Injury and poisoning[13] | 13.01 | 17.56 | 9.39 |
| Supplementary classification (V or E codes)[14] | -- | -- | -- |
| Other | -- | -- | -- |

[1] All calculations originate from sources giving direct cost figures, except for the 1995 data set, where only public health

expenditures were available.

[2] Source: 1963 data: Rice, Dorothy P. 1966. *Estimating the Cost of Illness*. Washington: US Government Printing Office. Table 31, p. 109.
1972 data: Barbara S. Cooper and Dorothy P. Rice, 1976, "The Economic Cost of Illness Revisited," *Social Security Bulletin*, 39 (February): 21-36. Table 1, p. 23.

[3] Source: 1972 data: Cooper and Rice (1976).
1980 data: Rice, Dorothy P., Thomas A. Hodgson, and Andrea N. Kopstein. 1985. "The Economic Costs of Illness: A Replication and Update." *Health Care Financing Review* 7 (Fall): 61-80. Table 1, p. 62.

[4] Source: 1980 data: Rice, Hodgson, and Kopstein (1985).
1995 data: Thomas A. Hodgson 1997 database of the National Center for Health Statistics, unpublished data.
Note: for the "All Conditions" category, the original amount used from the 1995 data source is the amount originally cited ($787.5 billion) added to the amount not originally included due to the uncertainty of allocation by diagnosis ($110 billion).

[5 - 14] These chapter headings, listed as found in the ICD-9-CM, is listed differently in the ICDA (ICD-8), which affects the 1963 and 1972 data sources, and which may or may not affect comparisons.

Note: Calculations of rates were made using $x_1(1+r)^{1/n-1}=x_n$.