COSTS OF OCCUPATIONAL CIRCULATORY DISEASE

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Circulatory diseases (CDs)— heart attack, stroke, and high blood pressure (BP), among others—are responsible for more deaths than any other disease or injury in the U.S. Rice, et al. estimated that these diseases generated more costs than any other disease or injury. The National Heart, Lung, and Blood Institute (NHLBI) estimated the cost to be $189 billion in 1992[7] and $274 billion in 1998.[20] This represents an increase in costs of more than 5% per year.

Few estimates of the numbers of deaths and costs of occupational CDs are available, however.[5,10,12,14] This is unfortunate, because we need some way to assess the magnitude of the burden. Moreover, costs have become a critical factor in the national debate on medical care. Our purpose in this study is to incorporate the best methods from prior studies to generate estimates of deaths, new disease incidence, and costs, and present a sensitivity analysis that demonstrates how our estimates vary with varying assumptions. In particular, we consider how costs vary as the allowable age ranges increase from 65 to 75, and the allowable range of diseases expands to include all circulatory diseases as opposed to just those that have been extensively studied. *Assumptions about percentage of the population exposed to job strain, vulnerable ages, and eligible ICD9 code are all new in this paper.*

METHOD

Epidemiology

There are a number of job hazards that could contribute to CD. A few chemical agents have been shown to cause or promote heart disease and hypertension. Carbon disulfide and nitroglycerin can cause or worsen ischemic heart disease (IHD). Carbon monoxide reduces oxygen supply to the heart and worsens symptoms of coronary heart disease (CHD). Lead raises BP. Second-hand (passive) smoking makes a substantial contribution. A number of nonchemical factors also have been implicated. These include noise, shiftwork, high risk of physical injury,[17] long working hours, social isolation, and physical inactivity inherent in many jobs. But the nonchemical factor that has received the most attention is job strain.

Ideally, we would like to measure how existing job hazards contribute to CD. To do so, however, requires making some assumptions that are truly heroic. We would have to: state how much of the workforce is currently exposed to job hazards that are risk factors for circulatory disease; allow for the fact that a given percent of

the workforce changes jobs and changes exposures; state what proportion of that exposed workforce would eventually develop job-related CD; assume (guess?) when the CD would occur, i.e., 10 years or 40 years into the future; hypothesize how many of those that develop circulatory disease would die from the CD, as opposed to some other disease or injury; and make assumptions pertaining to length of exposure, length of time until a stroke, expected changes in medical treatments for the next 40 years, and so on. Given these difficulties, and in the absence of longitudinal data to address these issues, we resort to the method used by all researchers attempting to estimate the costs of CDs: we estimate diseases and deaths occurring in a recent year (1992), rather than hazard precarious forecasts of future deaths.

There are no data available that unambiguously count the number of occupational CDs. All prior studies have estimated that number by attributing a given percentage of total CDs to occupational hazards. Those percentages have ranged from below 1% to over 40%.[5,10,12,14,22] Authors of prior studies are careful to point out the inherent difficulty associated with assigning only one cause—whether it be excessive alcohol use, obesity, cholesterol, smoking, or job-related conditions—to a person with a CD. All prior authors have simply assumed that if the risk were removed, for example, if all job-related CD hazards could be eliminated, the incidence or prevalence of CD would drop by a given percent. We concur with this view. The critical issue then becomes why "given" percentages are chosen.

We are familiar with only one study of CDs that attempts to assign percents to estimate specific job-related causes (as opposed to all job-related causes). Olson and Kristensen discuss most of the factors cited above (e.g., noise, shiftwork), and they assign various percentages: for example, 1% due to noise, 7% due to shiftwork, 2% due to passive smoking, 42% due to sedentary work, and 3–13% to job strain.[22] However, percentages are not assigned to men and women equally, nor to all ages. For example, a higher percentage of women are assumed to be in high job strain positions, and only persons under 70 years of age are considered (upper age bound is 70 years). Young ages are not restricted (no lower bound), perhaps due to reasoning that CD among children and youths is relatively rare and would not alter aggregate statistics.

The only other relevant studies to assign percentages have been those by Leigh, et al (U.S.),[12] Kraut (Canada),[10] and Markowitz, et al. (New York).[14] All three assigned 1–10% in a given age range and selected group of CD. Kraut simply applied Markowitz's percents and assumptions to Canada. In Leigh, et al., coauthor Markowitz applied some earlier assumptions to generate a national rather than a New York–only estimate. Thus, although there have been three separate studies, they are strikingly similar in their assumptions.

In the most recent study, the assumed percentages were 5–10, but the age restriction (25 to 64, inclusive) was narrow.[12] Moreover, not all CDs were included. Markowitz included only hypertension, IHD, cerebrovascular disease, and atherosclerosis: ICD9 codes 401–404, 410–414, 430–438, 440. These codes cover only about 68% of all CD deaths. Since so many CDs do not manifest themselves until retirement, and since not all were considered to have job-related causes, the effective range was not 5–10%, nor was the point estimate 7.5%. The effective range became .56–1.11%, with a point estimate of .84% for job-related factors.

We believe .56%, .84%, and 1.11% represent unrealistic estimates. A lifetime spent in high job strain work may not generate clinically noticeable CD until after the person retires. Hypertension, for example, is progressive and, for most patients, irreversible. In addition, the Markowitz list excludes several "unspecified" ICD9

categories with great numbers of deaths. ICD9 code 429.2—CVD, unspecified—contained 69,379 deaths in 1992. It is likely that coroners did not have time to record these deaths in other, more precise categories, such as the ICD9 codes that Markowitz did include. Finally, although little research has been conducted on CDs and job strain associations outside of the ICD9-coded diseases included in the Leigh, et al. study, it is possible (though less likely) that job strain and other psychosocial factors play a role in other CDs as well.

Here, we alter these two assumptions about age and ICD9 codes, setting the upper age restriction at 70 in one calculation, 75 in another, and no upper limit in a third. In addition, in some calculations we restrict ICD9 codes to the narrow group in the Leigh, et al. study; in others, we consider the broad group and allow all CDs—ICD0 codes 390 to 448. Thus, for example, we include pulmonary embolism (ICD9 code 415.1), cardiomyopathy (425), cardiac dysrhythmia (427), heart failure (428), CVD-unspecified (429.2; 69,379 deaths), aortic aneurysm (441), and so on. We refer to these groups as the "short" ICD9 code list (the 68% from Markowitz[14]) and the "long" ICD9 list (100% of all ICD9 circulatory disease codes). The long list represents an outside upper limit of the psychosocial-related occupational disease burden. Some of the diagnoses in the long list currently are not believed to be related to occupation, while some (e.g., heart failure) could be a manifestation of stress-induced illness resulting from silent myocardial infarction (MI).

In 1992 the long list included 913,908 deaths, job-related and not. The short list included 623,297 deaths. The short list of diseases thus comprised 68.2% of the long list. The short list combined with the 25–65 age limit yielded 101,846 deaths, thus comprising 16.3% (101,846/623,297) of the short list. But 101,846 represents 11% of deaths on the long list. Importantly, deaths are heavily skewed towards older persons (Table 1). Roughly one-third of deaths occur at ages 0 to 74, whereas two-thirds occur after age 75.

The assumptions about which diseases to include and exclude and about age are critical. The long list combined with the least restrictive age assumption yields roughly nine times as many deaths as the short list combined with the most restrictive age assumptions (911,245 compared to 101,846).

The next assumption involves the percentage of occupationally-related deaths. Leigh, et al. assumed a 5–10% range,[12] which we believe is too conservative, especially given that odds ratios are 1.5 for CVD and hypertension when comparing workers exposed to job strain with those not exposed to job strain. Here, we consider a 5–20% range.

The same techniques could be applied to estimating the incidence of disease. However, incidence numbers are not readily available. Therefore, we rely on the estimate for the short list and least restrictive ages by Leigh, et al., who estimate that the 5% assumption results in 41,550 *job-related* new cases of CD. We use this

TABLE I. Numbers of Deaths Regardless of Cause, Age, and ICD9 Assumptions in the U.S.

	Ages 25+†	Ages 25–74	Ages 25–69	Ages 25–64
All CDs (Long List)*	911,045	346,608	233,799	149,332
Only Short List**	621,344	236,390	159,453	101,846

* Includes all circulatory diseases (ICD9 codes 390 to 448); ** Only includes ICD9 codes 401–404; 410–414; 430–438; and 440

† Roughly .313% of all deaths were among those less than 25 years of age.

41,550 as an anchor and assume that all other combinations of assumptions and ICD9 codes are proportional to 41,550.

Economics

Costs are estimated using the human capital method, whereby two broad categories are constructed: direct and indirect costs. **Direct costs** include medical and administrative expenses. Medical costs include payments to hospitals, physicians, drug companies, and nursing homes. Insurance administration includes the cost of processing claims and managing financial accounts. Administrative expenses are split into administration for medical and administration for indemnity insurance.

Indirect costs include lost wages, fringe benefits, and home production. Lost wages are meant to capture not just the hardship on the person and family without the wages, but the cost to the economy in terms of lost output. Lost fringe benefits are included for the same reason as lost wages. The total economic loss is assumed to be what is required for the business to attract a qualified person to the job, including wages and fringe benefits. Home production includes time costs of nonpaid labor such as making home repairs and preparing meals.

General discussion of advantages and disadvantages of the human capital method is available.[12] Despite its weakness, it is the most popular method for estimating the costs of any illness or injury.

Direct Costs

Our "top-down" approach to estimating direct costs is similar to that of Fahs, et al.,[5] Rice, et al.,[23,24] and Leigh, et al.[12] Estimates rely on ratios involving hospital days multiplied by national estimates of medical spending. These hospital day ratios act an anchors in the estimation of all direct costs. Hospitalization data are highly regarded, are collected annually, and are summarized within the same definitions, thus permitting comparisons across diseases. Similar data are not available for doctor's visits or drug use. Moreover, hospitalizations are the most expensive (broad) category of medical care, contributing 44.6% of medical costs in 1992. Doctors' services are second at 20.9%.[26] We assume that spending on all other direct costs is proportional to hospital spending.

We begin with an estimate of national expenditures on medical care—$820.3 billion or 13.6% of the gross domestic product in 1992. This is equivalent to spending $3086 per person. Medicare and Medicaid contributed 16.9% and 13.2%; other third-party government spending contributed 13.6%; direct out-of-pocket expenditures by patients and families contributed 18.9%. The remainder, 37.9%, was contributed by private health insurance and HMOs. Our estimate of $820.3 billion in healthcare expenditures includes payments for hospitalizations, doctor and dentist visits, nursing home care, drugs, and medical supplies; it also includes public healthcare expenditure, such as construction of hospitals and offices, government public health activities, and research. We include public healthcare expenditures on the grounds that without occupational circulatory disease, some portion of these public expenditures would not be necessary. We do not include cost of program administration and net cost of public health insurance in our calculations, however. We believe these figures are underestimates. The National Center for Health Statistics estimates this amount to be $39.5 billion. This would be the equivalent of roughly 5.06% of expenditures (39.5/780.8 = .506). Studies have shown that administrative costs can add up to an additional 45% to the total cost of medical care.[3,4,25,28] Cutler's estimate of 15%[3] appears to be the most reliable, and the one used in previous analyses.[12,13] We exclude the $39.5 billion, but

include a 15% administrative expense to our calculations. Therefore, we use \$820.3–39.5 = \$780.8 to begin our calculations.

Using the National Hospital Discharge Survey[8] we then calculate the total number of days spent in the hospital by patients with a primary diagnosis for the attributable occupational CDs. Total days of hospitalization by circulatory diseases are then divided by total hospital days for all diseases and injuries in the U.S. in 1992 (190,386,000). This percent is subsequently multiplied by \$780.8, which in turn is multiplied by the ratio of occupational deaths to total deaths. The procedure is displayed in Equation 1:

$$\text{Med\$Cir} = \$780.8 \times (\text{CirDays/TotalDays}) \times (\text{OccCirDeaths/TotCirDeaths})$$

Med\$Cir is our estimate of the medical dollars spent for occupational CDs; CirDays are number of days in the hospital attributed to CDs; TotalDays are the number of days in the hospital attributed to all diseases and injuries in the U.S.; OccCirDeaths are numbers of circulatory deaths attributed to occupations; and TotCirDeaths are total number of circulatory deaths due to all causes.

However, Equation 1 estimates do not account for the administrative costs. To obtain administrative costs we assume: (1) \$630.2 billion was spent by insurance companies, HMOs, and governments (\$150.6 billion in out-of-pocket expenditures by individuals is subtracted from \$780.8 to obtain \$630.2), and (2) the average of private and public insurance and HMO administrative costs is 15%.[3] Our effective multiplier is .1211 ([.15 × 630.2]/780.8) which is multiplied by the estimate above (Med\$Cir) to derive the overall administrative costs. The variable OccCirDeaths itself will vary depending on our assumptions regarding age ranges and whether we use the short or long list for CDs.

INDIRECT COSTS

Indirect mortality costs were established using a standard present value equation.[13] Information for use in the present value equation was age-specific, sex-specific, and disease-specific mortality data from the National Center for Health Statistics, Vital Statistics Division, as well as life table estimates[19,27] and earnings and labor force participation data from the Bureau of Labor Statistics.

Finally, we calculated national disease-specific ratios for morbidity costs to direct costs from Rice[23,24] to obtain an estimate of the morbidity costs.

RESULTS

Results for Epidemiology

Table 2 presents results for occupationally related CD based on assumptions involving which ICD9 codes to include, which ages apply, and which percentages are appropriate. The percentages in Table 2—5%, 10%, 15%, 20%—refer to the percent of all CD deaths we assume are caused by job-related factors.

The significance of the assumptions regarding the percent attributable can now be seen. By definition, the 20% assumption provides numbers four times the size of those of the 5% assumption. If we combine the percents assumptions (5%, 10%, 15%, 20%) with the other two about including/excluding ICD9 diseases and age restrictions, we find that the numbers of deaths range from a low of 5092 to a high of 136,657—for a 36-fold difference.

Our preferred estimate is a proportion of 15%, the short list, and ages 25 through 74:35,459 deaths due to job-related factors.

TABLE 2. Occupational Circulatory Disease Deaths in the U.S.

	Ages 25+	25–74	25–69	25–64
All CDs (Long List)*				
5%	45,552	17,330	11,690	7,467
10%	91,105	34,661	23,380	14,933
15%	136,657	51,991	35,070	22,400
20%	182,208	69,320	46,760	29,868
Only Short List**				
5%	31,067	11,820	7,973	5,092
10%	62,134	23,640	15,945	10,185
15%	93,202	35,459†	23,918	15,277
20%	124,268	47,280	31,892	20,368

* ICD9 codes 390 to 448; ** ICD9 codes 401–404; 410–414; 430–438; 440
† This is our preferred estimate.

Table 3 presents similar results for the incidence of disease. Again, a 36-fold difference is apparent in comparing the least restrictive assumptions to the most restrictive (1,486,712 to 41,550). Our preferred estimate is the 15% proportion, ages 25 through 74, short list: 289,320 new diseases in 1992.

In Table 3, the factors of proportionality are ratios from Table 1. The first cell corresponding to the long list, ages 25+, is determined as follows: multiply the ratio of 911,045/101,846 by 41,550. The product is 371,678. The Leigh, et al. estimate of 41,550 new job-related cases[12] has as its counterpart in Table 1 the number 101,846. We essentially assume that the same percentage increase that "lifts" 101,846 to, for example, 911,045, also lifts 41,550 to 371,678. All other estimates are derived in a similar fashion. For example, by multiplying the ratio 346,608/101,846 by 41,550, we obtain 141,405. We assume that the same percentage increase that lifts 101,846 to 346,608 also lifts 41,550 to 141,405. In other words, we assume that the incidence of disease is proportional for all ages and all ICD9 codes.

Results for Costs

Table 4 presents our estimates of direct costs, for the two age groups (25–74 and 25–64) and the three percents (10%, 15%, and 20%). From this point on we will present a more restricted set of estimates based on these parameters. Our cost estimates are roughly proportional to those for deaths and incidence; hence, in the interest of brevity, we restrict our attention to a narrower set of assumptions.

TABLE 3. Occupational Circulatory Disease Incidence in the U.S.

	Ages 25+	25–74	25–69	25–64
All CDs (Long List)*				
5%	371,678	141,405	95,383	60,923
10%	743,356	282,810	190,766	121,846
15%	1,115,034	424,215	266,149	182,769
20%	1,486,712	565,620	381,532	243,692
Only Short List**				
5%	253,489	96,440	65,052	41,550
10%	506,978	192,880	130,104	83,100
15%	760,467	289,320†	195,156	124,650
20%	1,013,956	385,760	260,208	166,200

* ICD9 codes 390 to 448; ** ICD9 codes 401–404; 410–414; 430–438; 440
† This is our preferred estimate.

TABLE 4. Direct Costs in the U.S. (Billions)

	Ages 25–74	Ages 25–64
All CDs (Long List)*		
10%	$7.3760	$3.1778
15%	$11.0640	$4.7667
20%	$14.752	$6.3556
Only Short List**		
10%	$5.0307	$2.1674
15%	$7.5460†	$3.2511
20%	$10.0614	$4.3348

* ICD9 Codes 390 to 448; ** ICD9 Codes 401–404; 410–414; 430–438; 440
† The preferred point estimate

Again the importance of the assumption is clear. The costs in Table 4 range from $2.1674 billion to $14.752 billion. Had we included all possibilities, as in Tables 1, 2, and 3, the range between the lowest and highest would again be about 36-fold. Our preferred estimate is $7.5460 billion.

Table 5 presents our estimates of indirect costs. The range in the estimates for Table 5 is from $2.4413 billion to $15.4232 billion. Table 6 presents the total of direct plus indirect. Our preferred estimate assumes 15% of circulatory disease is due to occupation, the age range is 25–74, and the short list of circulatory diseases applies: $15.4353 billion.

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DISCUSSION

Limitations

There are a number of limitations to our study. First, we did not assume any deaths or illnesses resulted from workers who worry about layoffs. As corporate restructuring continues, so do feelings of job insecurity that can lead to circulatory disease.[9,11] We do not have reliable national estimates for this association, however.

Second, disease deaths were counted as occurring in 1992. However, the exposures leading to the deaths could have occurred 20 or 30 years prior to the death. CD death rates have been slowly dropping for 20 years. On the other hand, the labor

TABLE 5. Indirect Costs in the U.S. (Billions)

	Ages 25–74	Ages 25–64
All CDs (Long List)*		
10%	$7.7116	$3.5793
15%	$11.5674	$5.3691
20%	$15.4232	$7.1586
Only Short List**		
10%	$5.2596	$2.4413
15%	$7.8893†	$3.6619
20%	$10.5192	$4.8826

* ICD9 Codes 390 to 448; ** ICD9 Codes 401–404; 410–414; 430–438; 440
† Our preferred estimate

TABLE 6. Total Costs in the U.S. (Billions)

	Ages 25–74	Ages 25–64
All CDs (Long List)*		
10%	$15.0876	$6.7571
15%	$22.6314	$10.1358
20%	$30.1752	$13.5142
Only Short List**		
10%	$10.2903	$4.6087
15%	$15.4353†	$6.9130
20%	$20.5806	$9.2174

* ICD9 Codes 390 to 448; ** ICD9 Codes 401–404; 410–414; 430–438; 440
† Our preferred point estimate

force grows virtually every year. The point is, the true numbers are moving targets. Our estimates apply only to 1992. These numbers are likely to change in the future, but not by a great amount.

Third, several limitations suggest we underestimated costs. We did not adjust for current employment status in the present value of earnings tables; we merely adjusted for the labor force participation rate. Those currently employed are not a random sample of all persons in the labor market, and they probably have better lifetime employment prospects than all persons in the labor force. All persons in the labor force included the unemployed.

We assumed that fringe benefits were equal to 23.3% of the wage. Most studies show fringe benefits above 25%.

We ignored pain and suffering costs and quality of life issues. For example, patients can take hypertensive medications for 20 years or more with accompanying side-effects. Many patients experience shortness of breath with CHD. It is difficult to estimate these costs. Lawsuits involving nonfatal injuries almost always involve some payment for pain and suffering. A rule of thumb frequently cited in the courts is that pain and suffering equal three times the nonadministrative medical expenses. This would mean adding another roughly $22 billion to our costs. We may have *significantly* underestimated costs, since $22 billion is more than our total of $15.4 billion.

We did not include the costs of family caregiver's time nor the costs of health problems that occur among caregivers. These costs are undoubtedly large, but are difficult to estimate.[1] McFloyd and Flanagan document the deleterious psychological effects on spouses of caregiving.[16]

Critics might argue that current deaths and numbers of new disease cases do not reflect current job conditions. Rather, they reflect conditions in the workforce perhaps 40 years ago, given that sometimes CD takes 40 years to manifest. But our alternative is to develop estimates based on assumptions that many reasonable researchers would simply dismiss as fantasy, as indicated in our methods section. We generated prevalence and incidence numbers for a given year (1992) so that a general picture of the overall burden of occupational CD can be envisioned. As our ability to generate credible assumptions about the further course of CDs and their treatments improves, a study of current job hazards and exposures will become more viable. In any event, the methods and estimates we develop in our limited attempt here will likely prove useful to future researchers.

We have more confidence in our mortality and cost estimates than in the incidence estimates. Incidence numbers are notoriously hard to come by for most diseases, and this is especially true of CDs.

In estimating days of work loss for diseases, we used the Bureau of Labor Statistics' (BLS) Annual Survey data that were restricted to a 12-month calendar year. But many serious illnesses can generate work loss for much longer than 12 months. Oleinick, et al. showed that BLS data misses as much as 70% of workdays lost.[21]

Comparison to Other Studies

Studies by Markowitz, Fahs, and Leigh, et al. have received the greatest attention.[5,13,14] Their assumptions were especially conservative, however, They restricted attention to ICD9 coded diseases on our short list; they did not include any deaths or diseases in people over age 64; and they imposed a 5–10% range. The effect was to attribute less than 1% of all CDs to working conditions. We used the short list of circulatory diseases; ages 25–74, inclusive; and 15% attribution to job-related factors. Our preferred number of deaths is 35,459. We estimate nearly five times as many deaths as Markowitz[14] and Fahs.[5] If these numbers prove to be correct, job-related CD is responsible for more deaths than any other job-related disease (e.g., cancer, pulmonary disease).

Fahs preferred costs estimates were $3.5 billion to $6.0 billion. Our preferred cost estimate is $15.4 billion. Thus, we estimate costs roughly 2 to 4 times as large as Fahs. The disparity in costs is not as great as the disparity in deaths, because most deaths occur after people retire, when indirect costs are small.

NHLBI estimated 1992 costs for all CDs at $189 billion. Our estimate of $15.4 billion indicates that roughly 8.2% of these costs can be attributed to job-related factors.

Implications

We estimate 35,459 deaths and 289,320 new cases of disease. These are large numbers. In 1992, 50,067 people died from diabetes; 33,566 died of AIDS; 30,484 died by suicide; and 25,488 died from murder. Most categories of disease in government reports, in fact, record fewer than 35,000 deaths.[18] Incidence of diseases are difficult to estimate; thus, few comparisons are possible. But 289,320 per year is obviously a significant number of people newly becoming afflicted with a disease that may eventually kill them.

Assuming 8.2% also applies to the current costs of all CD, we estimate job-related CD cost to be $22.5 billion in 1998. This represents an important burden on medical care and a drain on the economy in general. Costs have become a critical factor in the national debate on the allocation of medical spending. Rarely, however, has that debate addressed job-related circulatory disease. This is a serious omission since much of this disease could be prevented.

It is likely that the lion's share of the $15.4 billion is not paid by business, but rather by workers and their families, as well as taxpayers. Most of businesses' contributions to the cost of job-related disease derive from workers' compensation (WC) premiums. Only infrequently, however, do WC systems pay for CDs. For example, firefighters and police officers in California are compensated for heart attacks whether they occur on or off the job (but not during retirement). But these are exceptions to the rule. In part, this lack of WC coverage is because the diseases do not manifest themselves until retirement, and they are assumed to have many causes other than job hazards, so that it is difficult to prove job causation. Nevertheless, some costs are absorbed by businesses in the form of high absenteeism, low morale,[2] and higher health insurance premiums. However, the specific dollar amounts have never been reliably estimated.

Most of the costs for medical care are borne by Medicare and Medicaid, i.e., by taxpayers. A significant portion of lost wages are paid for by the Social Security Administration, either through survivors' benefits or disability benefits, i.e., taxpayers. Most economic studies of the Social Security payroll tax and the Medicare tax indicate that workers pay for the tax in the form of lower wages.[12] The "workers" here refers to all workers, whether or not they develop job-related CD.

In summary, workers and taxpayers, not businesses, bear the brunt of the costs. In the language of economics, a "negative externality" exists. Businesses are not paying for the true costs of production, but are shifting the costs to others. Simple economic analysis shows that under these conditions an inefficient amount (too much) of the negative externality (job-related CD) is produced by businesses.[15] But economists have a solution: tax the negative externality. To correct this inefficiency, a tax could be imposed on those industries with jobs that are especially prone to producing CD. The proceeds from this tax could be used to defray the costs currently being absorbed by Medicare and the Social Security Administration. This **Circulatory Disease Tax Fund** could be modeled after the Black Lung Trust Fund that taxes coal companies on a per-ton-of-coal basis and uses the money to pay medical and indemnity benefits for persons with pneumoconiosis.

The Circulatory Disease Tax Fund would have two beneficial effects. First, it would resolve the equity problem. Taxpayers should not have to pay for a problem for which they are not responsible. Second, and equally as important, the tax would provide an economic incentive to businesses to decrease the causes of job-related CDs. It would encourage businesses to reassess their workplace arrangements, to decrease job strain and other job-related causes of CDs.

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