April 25, 2008

Materials submitted by J. Paul Leigh to the California Department of Toxic Substances Control In Fulfillment of Agreement Number 07-T3388

Costs of Toxic Chemical-induced Occupational Diseases Among Adults and Environmental Diseases Among Children within California

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Summary

Objective: To estimate the number of annual deaths and hospitalizations as well as the direct and indirect costs of chemically induced occupational disease among adults and environmental disease among children in California in 2004

Design: Aggregation and analysis of national data sets collected by the National Center for Health Statistics, the Health Care Financing Administration and other government bureaus and private firms. To assess mortality, we reviewed data from national surveys and applied population attributable risks (PAR). To calculate costs, we used the human capital method that decomposes costs into direct categories such as medical expenses as well as indirect categories such as lost earnings and lost home production. We calculated proportionately adjusted costs for other plausible PARs.

Results: The PARs result in costs of $1.4 billion for occupational diseases and $1.2 billion for childhood environmental diseases. For occupational diseases, 50.3% percent of costs were direct and 49.7% percent were indirect; for environmental diseases, 26.9% percent were direct and 73.1 percent indirect. Diseases generating the most costs are cancer ($1.2 billion), COPD ($0.08 billion), and asthma ($0.03 billion). These estimates are conservative since we ignore costs associated with pain and suffering as well as the value of care rendered by family members.

Conclusions: I estimated $2.6 billion cost of occupational and environmental disease in 2004.

List of Abbreviations

COPD	Chronic obstructive pulmonary disease
PAR	Population attributable risk
ICD9-CM	International Classification of Diseases, Ninth Edition, Clinical Modification
Med$COPD	Our estimate of the dollars spent on medical care for occupational COPD
COPDDays	The number of days in the hospital attributed to COPD diseases
TotalDays	The number of days in the hospital attributed to all diseases and injuries in the U.S
AIDS	Acquired immune deficiency syndrome
LFPR	Labor force participation rate
NCHS	National Center for Health Statistics

Introduction

The national costs of occupational illness were estimated to be between $19 and $30 billion in 1992 dollars[1, 2] . The national (medical only) costs were estimated to be between $9.6 and $19.7 billion in 1999 [3] ; California costs of occupational illnesses were estimated to be $2.9 billion in 1992 [4]. A report for the California Policy Research Center estimated 23,075 new cases of occupational disease and 6,566 deaths resulting from toxic chemical exposure in 2004[5]. The national costs of environmental pollutants and disease in children was estimated to be $54.9 billion in 1997[6.] .

In this study, we estimated the costs of toxic chemical-induced occupational diseases in adults and environmental disease in children for California in 2005. Costs estimates are useful because they can be used to assess the magnitude of disease burden and rank public health initiatives in order of economic importance. Our purpose in this study was to generate estimates of deaths and costs that incorporated the best methods from prior studies. We used standard methods with some simple improvements, such as adjusting for the mix of costs between inpatient and outpatient care. As a result, our estimates may be compared to published estimates for other diseases (whether or not job or environmentally-related). We also discuss how society at-large was likely to pay for a significant portion of these costs.

Methods

Epidemiology

We use the prevalence of occupational and environmental disease to measure overall burden. Prevalence may overstate or understate disease burden given that it does not account for time trends; it is merely a snapshot at a point in time (2005). An alternative method — using incidence — creates greater problems, however. The incidence method would necessitate forecasting the future course of disease, treatment and cost. Most cost-of-illness studies (whether or not occupational) have preferred the prevalence method precisely because it allows analysis of reliable data that are available and requires fewer forecasting assumptions than the incidence method.[7-12]

Occupational Epidemiology

Some proportion of fourteen broadly defined diseases have been identified as having causes or exposures that are job-related. [3, 13,14] . These 14 are the following: cancer , COPD , asthma , chronic renal failure, nervous system disorders , pneumoconiosis , circulatory to age 64 ,vascular and unspeicfied dementia, cryptogenic fibrosing alveolitis , pulmonary tuberculosis, pneumonia, depression , ulcers, and pneumococcal disease . However, not all of the causes or exposures are due to toxic chemicals relevant for this study. We defined toxic chemicals relevant for initiatives surrounding Green Chemistry to include the following: hydrocarbon solvents, asbestos, chlorinated hydrocarbon solvents, aliphatoc aromatic hyrdcarbons, acrylonitrile, nickel, hexavalent chromium, chromates ,arsenic, cadmium ,chromium(hexavalent), lead, nickel sulfate, hair dye, nonchlorinated hydrocarbon solvents, dry-clearning solvents, textile dyes, paint, 2-naphththylamine, aromatic amines, lubricating oils, trichoreethlene, phenoxyacetic acids, epoxy resins, isocyanates, epoxides, acrylic monomers, resins, phthalates, hair dyes and colorant, benzene, cadmium, a, nickel, ethylene oxide, sulfuric acid, , hexavalent chromium, ,lead, vinyl chloride, asbestos, benzidine, , sulfuric acid, beryllium, chromium, , 2-naphthylamine. We therefore did not include the following agents in our definition of toxic chemicals relevant for Green Chemistry initiatives: polycyclic aromatic hydrocarbons, welding fumes, (metal dust), diesel fuels, engine exhaust, ionizing radiation, wood dust, leather dust, radon progeny, gasoline, nonchlorinated hydrocarbon solvents, carbon monoxcide, oxides of nitrogen, microbial dust, and organic dust. With this definition in mind, the following diseases have causes that are not toxic-chemicals-relevant for this study: tuberculosis (infection in hospital), pneumococcal disease (environmental tobacco smoke), depression(job stress), ulcers (shift work and job stress), diseases of the nervous system other than Parkinson's(low frequency magnetic fields) , pneumonia(welding fumes, oxides of nitrogen, ozone) cryptogenic fibrosing alveolitis(wood dust, metal dust), and circulatory disease(shift work, job stress, noise, engine exhaust , environmental tobacco smoke). Nurminen and Karjalainen[13] estimate percents of the remaining occupational diseases that are attributable to various causes and exposures. These diseases include: cancer, COPD, asthma, pneumoconiosis, renal diseases, Parkinson's and vascular dementia. In many, but not all, cases, Nurminen and Karjalainen separate toxic chemicals from other causes. Steenland et al[14] also provide some information regarding the contribution of toxic chemicals. Our reading of Nurminen and Karjalainen[13] and Steenland et al[14] indicates the following percentages as contributions due to toxic chemicals: 90%(range 80-95%) for cancer; 20%(10-30%) for COPD; 20%(10-30%) for asthma; 100% for pneumoconiosis(assuming only asbestosis and silicosis in California, no coal-miners pneumoconiosis); 45%(40—50%) for renal; and 100% for Parkinson's. Whereas Nurminen and Karjalainen[13] estimate 100% for vascular and unspecified dementia, Steenland et al[14] do not find sufficient evidence that any dementia is job-related. We assumed Steenland et al[14] was correct.

Environmental tobacco smoke at-the-job also makes a substantial contribution to COPD , asthma., cancer. But, again, for our purposes, environmental tobacco smoke is not a relevant toxic chemical from the Green Chemistry perspective.

.Apart from pneumoconiosis, there are no data available that unambiguously count the number of any occupational diseases or deaths. Fortunately, there are numerous highly regarded studies that have attempted to statistically estimate these numbers . The most current studies are those by Nurminen and Karjalain[13] and Steenland et al[14]. for all occupational diseases and Leigh et al[15] for COPD and asthma. These studies, as well as numerous prior ones, adopt the Attributable Fraction(AF)method. The method is straightforward. First, relative risk estimates are culled from the most highly regarded epidemiological studies that link job-related exposures (e.g. benzene) with an occupational disease (e.g. leukemia). Second, AFs are calculated using the following formula:

Equation 1: $AF = (P \times (RR-1)) / (1 + (P \times (RR-1)))$

Where P is the proportion in the population exposed to a given agent (e.g. benzene) and RR is the relative risk of death from a given disease (e.g. leukemia) for exposed persons compared to persons not exposed. Relative risks are frequently estimated with logistic regressions. Finally, judgment by Nurminen, Karjalain , Steenland and others is used to estimate an average AF and a reasonable range around a PAR for given occupational exposures. It is beyond the scope of this paper to present a discussion of the studies Numinen, Karjalain, Steenland et al used to develop their AFs . We merely combined the AFs they used to form our own: 8% for cancer (range 6-10%), 15% for COPD and asthma (range 10-20%), 100% for pneumoconiosis, and 2% for renal and Parkinson's (1%-3%).

Attributable Fractions are easily interpreted and the method has been applied to many diseases, not just occupational. For example, one study estimated a 32% AF for f smoking for pneumonia[16.] This means that if smoking were eliminated, the annual prevalence of pneumonia in the population would drop by 32%. An advantage of the AF method is that it is linear. Readers can easily generate their own estimates by multiplying by the ratio of their AF to our AF by the estimates presented below.

An age restriction was necessary because children do not hold jobs and teenagers typically work part-time, if at all. We assume that no job-related deaths or hospitalizations occurred in persons under 25 years of age.

Data on deaths were available for California, but they were not as rich as they are for data from the US[17,18]. We therefore used ratios from the US data for the categories needed to estimate deaths in California. For example, California 2004 data were available on deaths within the broad chronic lower respiratory disease category for all ages corresponding to ICD-10 codes J40-J47 (n =12,519). This broad category combined COPD and asthms. US data from 2004 were available for varying age brackets and differing codes, including those separate codes for COPD (ICD-10= J40-J44, J47 and ICD-9 =490-492, 494, 496) and asthma (ICD-10 = J45-46 and ICD-9 =493). We assumed the same age distribution for deaths in the US applied to California. USA asthma deaths from 25 and over were 92.1% of all asthma deaths for all ages in 2004. COPD deaths of those 25 and over were 99.3% of all COPD deaths in 2004. Asthma deaths were 3.1 % and COPD were 96.9% of all chronic respiratory disease deaths in the US. For California, all chronic disease deaths numbered 12,522[17]. We therefore estimated 12,522x.969x.993 or 12,049 COPD deaths among Californians aged 25 and above. We estimated 12,522x.031x.921 or 358 asthma deaths among those aged 25 and over. (Similar data were available for the other diseases: cancer or malignant neoplasms ICD-10 = C00-C97 and ICD-9

= 140-239; renal failure, ICD-10 = N17-19 and ICD-9 = 5836, 5837, 584-586; Parkinson's ICD-10=G20-G21 and ICD-9 = 332; pneumoconiosis ICD-10 = J60-J66, J68 and ICD-9 = 500-505 with 501 = asbestos and 502 = silicosis). For California, for ages 25 and over, we estimated 53,398 cancer deaths, 132 pneumoconiosis deaths[19] , 2314 renal failure deaths, and 1830 Parkinson's deaths. Occupational disease deaths due to toxic chemicals were estimated by multiplying our estimate of total deaths for these diseases within California for persons aged 25 and over with the AFs with our estimates for percent attributable to toxic chemicals . For example, we estimated 12,049x.15x.20 or 361deaths for COPD and 358x.15x.20 or 11 deaths for asthma. Table 1 provides our estimates on deaths.

We also estimated the number of hospital discharges due to these six occupational diseases. The initial data were drawn from the Agency for Healthcare Research and Quality, H-Cup-net data system which contains data on hospitalizations for the nation and for states, separately. H-Cup-net age brackets do not precisely coincide with ours, however. We wanted data on persons age 25 and above but H-Cup-net provided for under age 1, age 1-17, age 18-44, and older groups. For all diseases other than pneumoconiosis, we assumed that one-half of the hospitalizations in the 1-17 age group would apply to persons age 18-24, thus implicitly assuming that disease hospitalizations increased at an increasing rate from age 1 through 24 . For pneumoconiosis, we assumed 100% were job-related. Table 2 provides our estimates of numbers of hospital discharges or what are sometimes called "hospitalizations."

Table 1						
Occupational Disease Categories , ICD-9-CM code , USA Deaths age 25+, Attributable Fraction, Attributable Fraction, Deaths in California 2004[1]						
Disease	**ICD-9 Code**	**ICD-10 code**	**Percent US Deaths Age 25+**	**AF occup**	**AF chem**	**Deaths in Calif**
1.. Malignant Neoplasms	140-209	C00-C97	99.4%	8%	90%	3845
2. Chronic Obstructive Pulmonary Disease	490-492, 494-496	J40-J47	99.3%	15%	20%	361
3. . Asthma	493	J45-J46	92.1%	15%	20%	11
4. Pneumoconioses	501-506	J60-J66, J68	100%	100%	100%	132
5.. Chronic renal failure	582, 585, 586, 590, 593	N17-N19	99.3%	2%	45%	21
6. Parkinson's disease	332	G20-G21	100%	2%	100%	37

117. http://www.dhs.ca.gov/hisp/chs/OHIR/tables/death/causes.htm

18. Minino AM, et al, Deaths: Final Data for 2004. National Vital Statistics Reports. 2007, vol 55 , number 19: 1-120.

2. These columns multiplying a PAR with a factor.

3. These columns present the PARs for job-related conditions. These are drawn from Nurminen and Karjalainen. , Steenland et al and Leigh et al

California Department of Health Services. Healthy California 2010: Progress in Achieving the Healthy People 2010 Objectives, 2000-2005. http://www.dhs.ca.gov/chs/OHIR/hp2010/hc2010progressfiles/summary.pdf

Table 2: Hospital Discharges for Occupational Disease, California, 2004

Disease	Hospital discharges age 25+	AF occup	AF chem	Hospital discharges for occupational disease
1.. Malignant Neoplasms	120,840	8%	90%	8700
2. Chronic Obstructive Pulmonary Disease	38,162	15%	20%	1145
3. . Asthma	15,333	15%	20%	460
4. Pneumoconioses	171	100%	100%	171
5.. Chronic renal failure	14, 201	2%	45%	284
6. Parkinson's disease	1,359	2%	100%	27
Total				10,787

Table 2B reports on the prevalence of occupational disease, cancer, chronic obstructive pulmonary disease, asthma and chronic renal failure were estimated with data from the National Health Interview Survey (NHIS) (http://www.cdc.gov/nchs/data/series/sr_10/sr10_228.pdf) for 2004. We assumed that disease prevalence was uniformly distributed across ages for the 18-44 years age bracket. We assumed that our category of chronic obstructive pulmonary disease would be estimated by data on emphysema plus chronic bronchitis in the NHIS. We assumed that our category of chronic renal failure could be estimated by the NHIS of "liver disease." Data on pneumoconiosis and Parkinson's disease were not available in the NHIS. California population was 12.2% the size of the US population in 2004. (http://www.census.gov/compendia/statab/tables/07s0017.xls) . We estimated the prevalence of Parkinson's disease based upon the ratios of prevalence to hospitalizations for cancer, COPD, asthma and kidney disease combined. That ratio was 4,849,134/188,536 or 25.72. We therefore estimated prevalence Parkinson's disease to be 34,953 in California in 2004. We assumed the ratio was 10/1 for pneumoconises given that pneumoconioses results in hospitalizations death more quickly than other occupational disease.

Table 2B: Prevalence for Occupational Disease, California, 2004

Disease	Estimate of prevalence, age 25+, US	Estimate of prevalence, California, age 25+	AF occup	AF chem	Prevalence due to occupational exposures
1.. Malignant Neoplasms	12,978,000	1,583,316	8%	90%	113,999
2. Chronic Obstructive Pulmonary Disease	11,641,000	1,420,202	15%	20%	42,606
3. . Asthma	12,529,000	1,528,538	15%	20%	45,856
4. Pneumoconioses	See text	1,710	100%	100%	1,710
5.. Chronic renal failure	2,599,000	317,078	2%	45%	2,854
6. Parkinson's disease	See text	34,953	2%	100%	699
Total					207,724

Economics

Costs were estimated using the human capital method whereby two broad categories were constructed: direct and indirect costs. Within the direct category, there were medical expenses and administrative expenses. Medical costs included payments to hospitals, physicians, pharmaceutical companies, nursing homes, and vendors of medical supplies including oxygen and administration.

Indirect costs included lost wages, lost fringe benefits, and lost home production. Lost wages were meant to capture not just the hardship for the person and family without the wages, but also the cost to the economy in terms of lost output. Lost fringe benefits were included for the same reason. In the language of economics, the wage plus the fringe benefit equal the marginal product, the additional output the worker added to the economy. Home production included the time costs of childcare, making home repairs, preparing meals and so on. General discussions of the advantages and disadvantages of the human capital method are available.[20]

Direct Costs

Our "top-down" approach to estimating direct costs was similar to that of Rice et al.[21,22] Our estimates relied on ratios involving hospital charges multiplied by California estimates of medical spending (see equation 1 below). These hospital charge ratios acted as anchors in the estimation of all direct costs. Hospitalizations were the most expensive broad category of medical care, responsible for 34.8% percent of medical costs in 2004[23]. Doctors' services are second at 29.8 percent.[2]

Our “top-down” approach began with an estimate of California expenditures on medical care in 2004: $167.228 billion or roughly 11 percent of Gross State Product .[23] Medicare and Medi-Cal contributed 19 and 17 percent, respectively; all other payers, including other third-party government spending , direct out-of-pocket expenditures , and private health insurance and health maintenance organizations[24]. These $167.228 billion in health care expenditures included payments for hospitalizations, physician visits, nursing home care, medications, medical supplies, and dental services, among other services. We accepted the roughly 6.3 percent of medical spending deriving from administration as reflective of medical insurance administration. We excluded dental services (4.357%, nationwide, which we assumed also applied to California) .

Our estimates relied on a formula. This formula is best illustrated with a specific example. We choose, as our example, cancer (ICD9-CM codes 140-209).

Equation 1: CANCER$ = ((CALTOTALSPEND – CALDENTALSPEND) x AGE25 x(CANCERCHRG/TOTALCHRG) x (AFOCCDIS x AFTOXICCHEM)

Where CANCER$ is our estimate of the medical dollars spent for occupational cancer due to toxic chemical exposures;

CALTOTSPEND is California total spending on medical care;

CALDENTAL is California spending on dental services;

AGE25 is percent of all spending among persons age 25 and over;

CANCERCHRG are the dollar hospital charges attributed to cancer;

TOTALCHRG are the dollar hospital charges attributed to all diseases and injuries in California.;

AFOCCDIS is the attributable fraction of cancer among persons age 25 and over due to occupation.

AFTOXICCHEM is the attributable fraction of occupational disease among person age 25 due to chemical exposure on-the-job.

Table 2

Occupational Disease Categories Attributable Fractions, , Costs age 25+, in California 2004[1]

Disease	All medical cost minus dental for persons over 25 (millions)	Ratio of disease hospital costs to all hospital costs	Attributable Fraction for Occup. Disease	Attributable Fraction for Toxic Chemicals	Medical costs of Occup Disease due to toxic Chemicals(Product of Columns 2-5)(millions)	
1.. Malignant Neoplasms	$138,715	0.061802	8%	90%	$617.246	
2. Chronic Obstructive Pulmonary Disease	$138,715	0.010237	15%	20%	$42.601	
3. . Asthma	$138,715	0.006106	15%	20%	$25.410	
4. Pneumoconioses	$138,715	0.00011	100%	100%	$15.259	
5.. Chronic renal failure	$138,715	0.003913	2%	45%	$4.885	
6. Parkinson's disease	$138,715	0.00038	2%	100%	$1.054	
Total					$706.455	

Indirect Costs

Indirect mortality costs captured wages, fringe benefits and home production for years of life lost due to premature death. Indirect morbidity costs captured the same three categories for persons who had not died, but who at least partially experienced some disability due to one of the six occupational diseases. Mortality costs typically are estimated using present value equations.[15,20,22] The present value equation method assumes the person did not die. The equation sums the discounted values of forecasted wage, fringe benefits and home production that would have accrued had the person lived to the average life expectancy for his or her age and gender. Life expectancy exceeded 65 years for all of our cases and diseases. The equations typically use age-specific, sex-specific, life table estimates and disease-specific mortality data from the National Center for Health Statistics, Vital Statistics Division,[25-27] as well as earnings and labor force participation data from the Bureau of Labor Statistics.[28]

In this study, we relied on our prior estimates to calculate indirect costs[15,20]. We assumed that the ratios of inflation-adjusted and California-adjusted wages-to-medical costs calculated in 1992 and 1996 for the US applied to 2004 for California. National medical prices in 2004 were 35.9% higher than they were in 1996 and 63.1% higher than they were in 1992[29]. Similarly, national total wage compensation (including fringes and employer-provided medical insurance premiums) in 2004 were 33.0% higher in 2004 than 1996 and were 50.6% higher than in 1992. [30] . Whereas California medical prices were 3.22% less than the nation, California wages were 19.4% more than the nation in 2004. [29,30] ……

Table 4						
Indirect Costs in California 2004[1]						
Disease	**California Medical Costs (millions $)**	**Adjusted 1992 or 1996 mortality cost to medical cost ratio[1]**	**Mortality Costs (millions $) (col. 2 x col. 3)**	**Adjusted 1992 or 1996 morbidity cost to medical cost ratio**	**Morbidity Costs (millions$) (col 2 x col 5)**	**Indirect Costs: mortality + morbidity costs**
1.. Malignant Neoplasms	$617.246	0.796354	$491.546	0.20887	$128.927	$620.473
2. Chronic Obstructive Pulmonary Disease	$42.601	0.41231	$17.565	0.59116	$25.1839	$42.7489
3. . Asthma	$25.410	0.034324	$0.87217	0.26017	$6.6110	$7.48315
4. Pneumoconioses	$15.259	0.55171	$8.418555	0.82398	$12.57311	$20.99166
5.. Chronic renal failure	$4.885	0.52857	$2.58207	0.64603	$3.15585	$5.737923
6. Parkinson's disease	$1.054	0.67246	$0.70877	0.511067	$0.53867	$1.24744
Total for dollars	$706.455		$521.692		$176.989	$698.681

Adjustment was to both the old mortality cost and old medical cost. For example, for cancer, the USA 1992 mortality costs were $3.984 billion. We multiplied by a wage-compensation inflation factor of 1.506 and a California wage factor of 1.194 to reflect the higher wages in California compared to the US.The product was $7.16389. For cancer, the US medical cost less indemnity insurance administration and less one-half of estimated medical insurance administration for 1992 was $5.69906 billion. This $5.6906 was then multiplied by a medical cost inflation factor of 1.631 and a California medical cost factor of 0.9678 to reflect the lower medical prices in California compared to the US.. The product was $8.99586. The ratio was $7.16389/$8.99586 = 0.796354.

Lead Landrigan et al estimated the effects of lead levels in 5-year-olds on IQ and the effects of IQ on lifetime earnings. We attempted a similar calculation for California for 2004.For California in 2004, we combined US Census data and estimated 269,271 numbers of 5-year-old boys and 257,529 number of 5-year-old girls. (http://www.census.gov/prod/2005pubs/06statab/pop.pdf http://www.census.gov/population/projections/state/stpjage.txt) . For lifetime earnings , we began with Wendy Max's national estimates that include the value of household production. We assumed the value for ages 5-9 applied to our cohort of 5-year olds. Max's estimates were $877,833 for females and $1,187,240 for males. (Max W, Rice Dp, Sung H-Y, Michel M. Valuing human life: Estimating the present value of lifetime earnings, 2000. Center for Tobacco Control Research and Education, Economic Studies and Related methods, University of California, San Francisco, , Paper # PVL E2000, 2004.) We adjusted Max's estimates to reflect wage inflation from 2000 to 2004 and to reflect the relatively higher wages in California[29,30].

Table 5. Estimated Costs of Pediatric Lead Poisoning, California, 2004

Definitions, Conditions	Assumptions and Estimates
1..Environmental Attributable Risk	100%
2. Main Consequence	Loss of IQ over lifetime
3. . Mean blood level in 2004 among 5-year old children	1.9 ug/dL
4. A blood lead level of 1 ug/dL	Mean loss of 0.25 IQ points per child
5.. Therefore, a level of 1.9 ug/dL	Mean loss of 0.??? IQ points per child
6. Loss of 1 IQ point	Loss of lifetime earnings of 2.39%
7. Therefore , loss of ??? IQ points	Loss of 1.61% of lifetime earnings
Economic Consequences	
For boys: loss of ___x 1,656,424(lifetime earnings) x269,271 5 yr old boys in Calif	___ billion
For girls: loss of___x $1,224,743.(lifetime earnings) x 257,529 5-year-old girls	___ billion
Total costs of pediatric lead poisoning	___ billion

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For asthma for children ages 0-17 we combined hospital data from H-Cup-net (http://hcupnet.ahrq.gov/HCUPnet.jsp) with aggregate California medical costs from the Office of the Actuary, Centers for Medicare and Medicaid (http://www.cms.hhs.gov/NationalHealthExpendData/downloads/nhestatesummary2004.pdf) with estimates on asthma costs from Weiss et al (Weiss KB, Sullivan SD, Lyttle CS. Trends in the cost of illness for asthma in the United States, 1985-1994. Journal of Allergy and Clinical

Immunology 2000. 106 (3) : 493-499) . We obtained national data on asthma prevalence from the National Health Interview Survey. ((http://www.cdc.gov/nchs/data/series/sr_10/sr10_227.pdf) . Estimates for indirect costs were derived from national estimates in Wang, Zhong, and Wheeler (2005) (Wang LY, Zhong Y, Wheeler L, Direct and indirect costs of asthma in school-age children. Preventing Chronic Disease ; Public Health Research, Practice and Policy. 2005. 2 (1): 1-10) Wage inflation was estimated from Bureau of Labor Statistics data. (http://www.bls.gov/web/echistry.pdf) . From 2003 to 2004 we estimated 3.724% wage inflation. Deaths for the US were drawn from national data (http://www.cdc.gov/nchs/data/dvs/mortfinal2004_worktableipt2.pdf) combined with state hospital data (http://www.cdc.gov/nchs/data/dvs/mortfinal2004_worktableipt2.pdf) . The national data provided age categories in 5-yer increments. We assumed that 3/5ths of the deaths in the 15-19 age bracket applied to persons aged 15-17, inclusive. We therefore estimated 290 asthma deaths for ages 0-17 in the US for 2004.

Table 6. Estimated Costs of Pediatric Asthma (ages 0-17), California, 2004

Definitions, Conditions	Assumptions and Estimates
1..Ratio of asthma hospital charges to all hospital discharges for persons age 0 -17 in California, 2004	.001367
2. Aggregate hospital costs in California for 2004	$58,199 million
3. .Estimate of hospital costs due to asthma (multiply row 1 with row 2)	$80.578 million
4. Ratio of all non-hospital medical spending—including physician visits and medications—to hospital spending in Weiss et al , 2000	0.98409
5.. Estimate of non-hospital medical spending (multiply row 3 with row 4)	$79.296
6**. Total Direct costs** (add rows 3 and 5) and multiply by attributable fraction of 30%(and number of hospitalizations multiplied by 30% = 13,173 x 30%	**$47,962,200** **(3952)**
7. Number of children age 0-17 ever told had asthma, US, 2004	8,890,000
8. Ratio California hospitalizations with asthma to US hospitalizations with asthma, 2004	0.089
9. Estimate of number of California children with asthma (multiply row 7 with row 8) (and multiply by attributable fraction 30%)	791,210 (237,363)
10. US costs of lost productivity due to asthma-related school absences , 2003	$719,142,352
11. Estimate of California costs of lost productivity due to absences (multiply row 8 with row 10 with 1.194 (California wage factor) and 1.03724 (national wage inflation))	$79,266,274
12. Estimate of US asthma deaths for children ages 0-17	290
13. Estimate of California asthma deaths for children ages 0-17(multiply row 8 with row 12) (and multiply by attributable fraction, 30%)	8
14. Estimate of lost lifetime earnings per death for US, 1996, adjusted to 2004(1.330) and to California's higher wages(1.194). We assumed Wang's estimate from ages 5-17 was same as ages 0-17.	$1,992,175
15. Estimate of lost productivity due to death in 2004 in California among children ages 0-17 (multiply row 13 with row 14)	$51,796,550
16. **Total indirect costs** (add row 11 with row 15) and multiply by attributable fraction 30%	**$39,318,846**
17. **Total direct plus indirect costs** (add row 6 with row 16)	**$87,281,046**

For cancer for children ages 0-17 we combined hospital data from H-Cup-net (http://hcupnet.ahrq.gov/HCUPnet.jsp) with aggregate California medical costs from the Office of the Actuary, Centers for Medicare and Medicaid (http://www.cms.hhs.gov/NationalHealthExpendData/downloads/nhestatesummary2004.pdf. We drew numbers of cancer deaths from Lau (Lau C. Cancer deaths in California, 2004. Center for Health Statistics. California Dept of Health Services . Data Summary No DS06-11000, November 2006, Sacramento, CA. http://www.dhs.ca.gov/hisp/chs/OHIR/reports/leadingcause/Cancer2004.pdf . We again used Max's estimates of lost lifetime a productivity. Morbidity costs were drawn from Chang et al (Chang S, Long SR, et al. Estimating the cost of cancer: Results on the basis of claims data anaylsis for cancer patients diagnosed with seven types of cancer during 1999 to 2000. Journal of Clinical Oncology. 2004. 22(17) : 3524-3530)

Cancer prevalence for the US was derived from the SEER http://www.seer.cancer.gov/faststats/sites.php?site=All%20Cancer%20Sites&stat=Prevalence . There were 61,017 persons aged 0-14 who had been diagnosed with cancer sometime in their lives for the US in 2004. Assuming a uniform distribution from ages 15-19, we estimated an additional 24,165 persons age 15-17 who had been diagnosed with cancer sometime in their lives. The total for the US was therefore 85,183. Multiplying by ratio of hospitalizations of California children with cancer to US children with cancer yields 0.1619 x 85,183 = 13, 791 . This 13,791 must then be multiplied by the 5% that is assumed to be the result of toxic chemicals. (Alternative estimate: In the 2000 US Census, 12.8% of persons age 18 and under lived in California. http://statecancerprofiles.cancer.gov/census/index.php?stateFIPS=06&demo=00002&type=m

anyareacensus&sortVariableName=value&sortOrder=default. Multiplying the two, 85,183 x .128 = 10,903. But because the cancer incidence rate for California was a little less(6.4%) than the rest of the US , we reduced our estimate by 5% , to 10,358. (The cancer incidence for the US was 474.6 per 100,000 in the population versus 444.0 in California for 2000-2004. http://statecancerprofiles.cancer.gov/census/index.php?stateFIPS=06&demo=00002&type=manyareacensus&sortVariableName=value&sortOrder=default).).

Table 7. Estimated Costs of Pediatric Cancer (ages 0-17), California, 2004

Definitions, Conditions	Assumptions and Estimates
1..Ratio of cancer persons age 0 -17 hospital charges to all hospital discharges for in California, 2004	.00285
2. Aggregate hospital costs in California for 2004	$58,199.000 million
3. .Estimate of hospital costs due to cancer ages 0-17 (multiply row 1 with row 2)	$165.867 million
4. Ratio of all non-hospital medical spending—including physician visits and medications—to hospital spending for all diseases and injuries, California, 2004.	1.87338
5.. Estimate of non-hospital medical spending (multiply row 3 with row 4)	$310.7324
6**. Total Direct costs** (add rows 3 and 4) and multiply by environmental attributable fraction of 5%. (Number of hospitalizations multiplied by 5%)(Number deaths multiplied by 5%)	**$23,829,968** **(156)** **(15)**
7. Number of children age 0-17 ever diagnosed with cancer, US, 2004	85,183
8. Ratio California hospitalizations in age 0-17 with cancer to US hospitalizations in age 0-17 with cancer, 2004	0.1619
9. Estimate of number of California children with cancer (multiply row 7 with row 8) times 5% due to toxins	690
10. Ratio of morbidity cost to direct costs, assuming child's economic value is one-half adult's and assuming value of care-giver is same for adult and child. (Chang et al 2004)	0.113
11. Estimate of morbidity costs (row 10 times row 6)	$2,692,786
12. Estimate of California cancer deaths for children ages 0-17, (assuming equal number of deaths per year from 15-24)	305
13. Estimate of California cancer deaths for children ages 0-17 due to environmental exposures(multiply row 12 by 5%)	15
14. Estimate of lost lifetime earnings per death for US, 2000 adjusted to 2004(1.166) and to California's higher wages(1.194). We assumed Max's estimate for ages 10-14 applied to all of our cases. ($,1824,746 per child)	$1,824,746
15. Estimate of lost productivity due to death in 2004 in California among children ages 0-17 (multiply row 13 with row 14)	$27,371,190
16. **Total indirect costs** (add row 11 with row 15) and multiply by attributable fraction 30%	**$30,063,976**
17. **Total direct plus indirect costs** (add row 6 with row 16)	**$53,893,944**

or children ages 0-17 we combined hospital data from H-Cup-net (http://hcupnet.ahrq.gov/HCUPnet.jsp) with aggregate California medical costs from the Office of the Actuary, Centers for Medicare and Medicaid (http://www.cms.hhs.gov/NationalHealthExpendData/downloads/nhestatesummary2004.pdf. We drew numbers of cancer deaths from Lau (Lau C. Cancer deaths in California, 2004. Center for Health Statistics. California Dept of Health Services . Data Summary No DS06-11000, November 2006, Sacramento, CA. http://www.dhs.ca.gov/hisp/chs/OHIR/reports/leadingcause/Cancer2004.pdf . We again used Max's estimates of lost lifetime a productivity. Morbidity costs were drawn from Chang et al (Chang S, Long SR, et al. Estimating the cost of cancer: Results on the basis of claims data anaylsis for cancer patients diagnosed with seven types of cancer during 1999 to 2000. Journal of Clinical Oncology. 2004. 22(17) : 3524-3530)

For mental retardation and cerebral palsy we used CDC data (http://www.cdc.gov/ncbddd/dd/cp3.htm#cost) that applied to a cohort of newborns in 2000. We made adjustments to estimate cases and costs for a cohort born in 2004 in California. In 2004 , there were 4,077,000 resident persons under one year of age in the US http://www.census.gov/prod/2005pubs/06statab/pop.pdf . .There were no data available for persons under 1year old in Calfornia. We assumed that the ratio of California residents under 5 to US residents under 5 could be multiplied by the US resident population under 1 to estimate the California resient population under 1. So, (2,634/20,071) x 4,077,000 = 0.1312 x 4,077,000 = 535,041. . Multiplying by the 12.0 per 1000 rate in Honeycutt et al. we estimated 48,408 cases of mental retardation for the US in 2000. Assuming same 0.12

applied to 2004 but tht an adjusted figure applied to California, we estimated 10.56 rate per 1,000 children under age would have mental retardation. The 10.56 = 12.0 x 0.88 wher 0.88 is the ratio of rates per 1,000 children with learning disabilities in California compare to the US as a whole. (National Health Interview Survey for Children, 2004) Honeycutt et al estimate total direct cost to be $12,310 million and total indirect costs to be $38,927. They estimate average costs per person to be $1,014,000. We assume 12,310/38,927 or 31.62 percent to be direct and 68.38 percent to be indirect costs. We therefore estimate $320,627 and $693,373 for direct and indirect costs. Direct cost must be adjusted upwards by 2000-2004 medical inflation factor (310.1/260.8) or 1.189 and downwards by the California medical price adjustment, 0.9678. http://data.bls.gov/cgi-bin/surveymost . Therefore, $320,627 x 1.189 x 0.9678 = $368,950. Similarly, indirect costs can be adjusted upwards by wage inflation from 2000 to 2004 (94.7/81.2) or 1.1663, and the California wage advantage of 1.194 http://data.bls.gov/cgi-bin/surveymost . Multiplying, $693,373 x 1.1663 x 1.194 = $965,565.

Births in 2004 were 540,000 in California

http://www.dof.ca.gov/HTML/FS_DATA/STAT-ABS/2006_statisticalabstract.pdf

in 2000, there were approximately 5,042,426 births in the US

http://www.census.gov/prod/2003pubs/02statab/abstract-02.htm

San Diego wildfires costs in excess of $ 1 billion

http://www.reuters.com/article/americasCrisis/idUSN25466505

Table 8 . Estimated Current and Future Costs of Mental Retardation for a cohort of children born in 2004 in California

Categories, definitions, assumptions	Amount
1.Rate per 1,000 children in US	12.0
2. Rate per 1,000 children in California (row 1 times 0.88, where 0.88 is ratio of West region to all US in prevalence of learning disabilities in NHIS.)	10.56
3. . Number of children under age 1 in California, 2004	535,041
4. Estimated number with mental retardation (row 2 times row 3)	5650
5.. Estimated per-person direct costs in California (adjust Honeycutt numbers for inflation from 2000 to 2004 and higher prices in California)	$368,950
6. .. Estimated per-person direct costs in California (adjust Honeycutt numbers for inflation from 2000 to 2004 and higher prices in California	$965,565
7. Total direct costs (multiply row 4 by row 5)	$2,084,567,500
8. Total indirect costs (multiply row 4 by row 6)	$5,455,442,200
9. Total costs (add rows 7 and 8)	$7,540,009,700
10 Total costs due to toxic chemicals(.Multiply row 9 by 10% which is Environmentally Attributable Fraction from Landrigan et al)	$754,000,970
11. Number of Mental retardation cases under age 1 due to toxic chemicals(.Multiply row 4 by 10% which is Environmentally Attributable Fraction from Landrigan et al)	565
12. Estimate of direct costs due to toxic chemicals (multiply row 7 by 10%)	$208,456,750
13. Estimate of indirect costs due to toxic chemicals (multiply row 8 by 10%)	$545,544,220

For cerebral palsy we used CDC data (http://www.cdc.gov/ncbddd/dd/cp3.htm#cost) that applied to a cohort of newborns in 2000. We made adjustments to estimate cases and costs for a cohort born in 2004 in California. In 2004 , there were 4,077,000 resident persons under one year of age in the US http://www.census.gov/prod/2005pubs/06statab/pop.pdf . .There were no data available for persons under 1 year old in California We assumed that the ratio of California residents under 5 to US residents under 5 could be multiplied by the US resident population under 1 to estimate the California resident population under 1. So, (2,634/20,071) x 4,077,000 = 0.1312 x 4,077,000 = 535,041. . Multiplying by the 3.0 per 1000 rate in Honeycutt et al. we estimated 1650 cases of cerebral palsy for California in 2004. Honeycutt et al estimate total direct cost to be $2,229 million and total indirect costs to be $9,241. They estimate average costs per person to be $921,000 We assume $2229/$11470 or 19.43 percent to be direct and 80.57 percent to be indirect costs. We therefore estimate $$921,000 x .1943 = $178,950 and $742,050 for direct and indirect costs per person . Direct cost must be adjusted upwards by 2000-2004 medical inflation factor (310.1/260.8) or 1.189 and downwards by the California medical price adjustment, 0.9678. http://data.bls.gov/cgi-bin/surveymost . Therefore, $178,950 x 1.189 x 0.9678 = $205,920. Similarly, indirect costs can be adjusted upwards by wage inflation from 2000 to 2004 (94.7/81.2) or 1.1663, and the California wage advantage of 1.194 http://data.bls.gov/cgi-bin/surveymost . Multiplying, $742,050 x 1.1663 x 1.194 = $1,033,351

Table 9 . Estimated Current and Future Costs of Cerebral Palsy for a cohort of children born in 2004 in California

Categories, definitions, assumptions	Numerical estimates
1.Rate per 1,000 children in US	3.0
2. Rate per 1,000 children in California (assume same as for US.)	3.0
3. . Number of children under age 1 in California, 2004	535,041
4. Estimated number children under age 1 with cerebral palsy in California, 2004	1605
5.. Estimated per-person direct costs in California (adjust Honeycutt numbers for inflation from 2000 to 2004 and higher prices in California)	$205,920
6. .. Estimated per-person direct costs in California (adjust Honeycutt numbers for inflation from 2000 to 2004 and higher prices in California	$1,033,351
7. Total direct costs (multiply row 4 by row 5)	$330,501,600
8. Total indirect costs (multiply row 4 by row 6)	$1,658,528,300
9. Total costs (add rows 7 and 8)	$1,989,029,900
10 Estimate of total costs due to toxic chemicals. (Multiply row 9 by 10% which is Environmentally Attributable Fraction from Landrigan et al) less 15% overlap with mental retardation	$198,902,990 ($169,067,460)
11. Estimate of number of cases due to toxic chemicals (.Multiply row 4 by 10% which is Environmentally Attributable Fraction from Landrigan et al) less 15% overlap with mental retardation	137
12. Estimate of direct costs due to toxic chemicals (multiply row 7 by 10%) less 15% overlap with mental retardation	$28,092,636
13. Estimate of indirect costs due to toxic chemicals (multiply row 8 by 10%) less 15% ovelap with mental retardation	$140,974,900

Table 10

Summary of Prevalence, Incidence, and Costs for Occupational and Environmental Disease Due to Toxic Chemicals Prevalence , California 2004[1]

Disease or Disability	Deaths	Prevalence of Occupational Disease and Asthma and Incidence of cancer and disabilities	Direct costs	Indirect costs	Total costs	
Occupational Disease among Adults	number	hospitalizations	millions of dollars	millions of dollars	millions of dollars	
1.. Malignant Neoplasms(cancer)	3845	8700	$617.246	$620.473	$1237.719	
2. Chronic Obstructive Pulmonary Disease	361	1145	$42.601	$42.7489	$85.350	
3. . Asthma	11	460	$25.410	$7.48315	$32.893	
4. Pneumoconioses	132	171	$15.259	$20.99166	$36.251	
5.. Chronic renal failure	21	284	$4.885	$5.737923	$10.623	
6. Parkinson's disease	37	27	$1.054	$1.24744	$2.301	
7. Sub-total for occupational disease	*4407*	*10,787*	*$706.455*	*$698.682*	*$1405.136*	
8. Environmental Disease among Children		Hospitalizations or prevalence				
9. Asthma(ages 0-17)	8	3952 hospitalizations	$47.962	$39.319	$87.281	
10. Cancer(ages 0-17)	15	156 hospitalizations	$23.830	$30.064	$53.894	
11. Mental retardation(age <1)	0	565 prevalence	$208.457	$545.544	$754.001	
12. Cerebral palsy(age < 1)	0	137 prevalence	$28.093	$140.975	$169.068	
13. Sub-total for	*23*	*4108*	*$308.342*	*$755.902*	*$1,064.243*	

environmental disease		*hospitalizations* *702 prevalence*				
14. Sum of sub- totals	**4430**	**14,895 hospitalizations** **702 new cases of disability**	**$1,014.797**	**$1,454.584**	**$2,469.379 or $2.469 billion**	

Cancer. 2002 Jun 1;94(11):2906-13.

The economic burden of prostate cancer, California, 1998.

Max W, Rice DP, Sung HY, Michel M, Breuer W, Zhang X.

RESULTS*: Prostate cancer direct health care costs in California were estimated at 180 million dollars, and lost productivity from premature death was estimated at 180 million dollars, for a total cost of 360 million dollars in 1998.*

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Max W, Sinnot P, Kao C, Sung HY, Rice DP.

Institute for Health & Aging, School of Nursing, University of California, San Francisco, 94143-0646, USA.

Osteoporosis accounted for over $2.4 billion in direct health care costs in 1998, and over $4 million in lost productivity resulting from premature death. Most of the cost results from hip fractures and other fractures

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Estimating the economic burden from illnesses associated with recreational coastal

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Environmental Health Science and Policy Program, University of California, Irvine, CA, USA.

The combination of excess illnesses associated with coastal water pollution resulted in a cumulative public health burden of 3.3 million dollars per year for these two beaches.

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o to *12.1 billion dollars in California*.