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Estimating the Return-on-Investment From Changes in Employee Health Risks on The Dow Chemical Company's Health Care Costs

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Learning Objectives

- Recall the risk factors evaluated in the company's health assessment program, and the effects of advancing age over the 10-year study period on employees' risk factor profiles.
- Relate the degree of risk reduction to the company's health care expenditures under three scenarios: a large and a modest impact of risk reduction efforts on health risk, and a "break-even" condition in which the company saves the same amount it invests.
- Conclude whether health risk reduction efforts are worthwhile to companies in terms of the financial pay back.

Abstract

Objective: *We sought to estimate the impact of corporate health-management and risk-reduction programs for The Dow Chemical Company by using a prospective return-on-investment (ROI) model.* ***Methods:*** *The risk and expenditure estimates were derived from multiple regression analyses showing relationships between worker demographics, health risks, and medical expenditures.* ***Results:*** *A "break-even" scenario would require Dow to reduce each of 10 population health risks by 0.17% points per year over the course of 10 years. More successful efforts at reducing health risks in the population would produce a more significant ROI for the company.* ***Conclusions:*** *Findings from this study were incorporated into other components of a business case for health and productivity management, and these supported continued investments in health improvement programs designed to achieve risk reduction and cost savings.* (J Occup Environ Med. *2005;47: 759–768*)

Medical directors often need to build a business case for investing in health promotion as part of a comprehensive health management strategy. Their business case can be greatly strengthened if it includes a projected return-on-investment (ROI). How to best formulate a compelling ROI analysis has been a challenge, and several investigators have commented on the topic.[1–6] This article illustrates an approach used by staff at The Dow Chemical Company (Dow) to develop a credible ROI estimate as a component of their a business case for ongoing investment in the health and well-being of Dow's employees.

This analysis demonstrates how such investment can bring about medical cost savings for the company. With dramatic recent increases in company health care costs as a backdrop, many medical directors and corporate human resource executives are introducing innovative health and productivity-management (HPM) intervention programs. For these programs to be accepted and maintained, they must be supported by credible financial projections.

To formulate a financial argument for continued investment in health improvement and risk reduction programs for employees, the Dow's Health and Human Performance (H&HP) staff applied several strategies. These staff first quantified the large sums of money that the company was spending in several areas to address the broad impact that illness may have. Using methods developed as part

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of a benchmarking project coordinated by the American Productivity and Quality Center, and reported by Goetzel et al,[7] Dow staff calculated the company's total annual U.S. health care expenditures in 1998. These expenditures included medical expenditures for employees and dependents and productivity-related expenditures for employees (ie, dollars related to absence from work, disability, workers' compensation, and turnover). From this benchmark study, Dow staff estimated the gap between their actual expenditures and values derived from the experience of best-practice organizations. This "gap analysis" unearthed an opportunity for savings of approximately $30 million annually in 1998 dollars. (Note that this figure was estimated from a study of all Dow employees [actives and retirees] and their dependents; it was not limited to an analysis of only active Dow employees, as is the study we are reporting here.)[8] That savings opportunity, coupled with a delineation of the different programs and services provided by the company aimed at improving employee health and productivity, convinced senior management that more attention should be devoted to coordinating these activities so that multiple health-related programs and services could be delivered more effectively and efficiently. In addition, this analysis triggered a reframing of health and productivity-management programs offered by the company as investments to be carefully managed, rather than an inevitable cost of doing business.

With this activity as background, Dow's H&HP staff began developing a business case document that would project: 1) health care spending for the company over the next decade; and 2) alternative ROIs based upon assumptions related to the success of its preventive health management efforts. Dow's staff sought to translate health and medical care issues into language that would be familiar to corporate staff in charge of the financial health of the organization. Consequently, health and productivity initiatives recommended by H&HP staff could be seriously considered by company leaders in a manner similar to other operational priorities.

A 10-year financial impact cost projection model was developed that predicted the company's health care expenditures under alternative health risk-reduction scenarios. This article describes the mechanics of this cost-projection model and presents results from the analysis that predicted the economic consequences of shifts in the demographic and risk profile of Dow's employees over a 10-year period. The analysis was based on demographic and workforce information about Dow's employee population, and several behavioral and biometric health risk factors relevant to that population. This baseline information formed the foundation for a subsequent estimation of Dow's payments in future years and calculation of ROI and net present values (NPV).

Three different scenarios, compared to a "base case," were envisioned when making 10-year medical expenditure projections for Dow. The base case assumed that employee health risks would deteriorate in accordance with preexisting trends and with expected changes in demographics at Dow. The three comparison scenarios were: 1) Large program impact—each health risk was predicted to be reduced by 1.0% point per year, or 10% points over 10 years, as a result of significant risk factor reduction efforts by Dow H&HP staff; 2) modest program impact—each health risk was projected to be reduced by only 0.1% point per year, or 1 point over 10 years, through modest risk factor reduction efforts by Dow H&HP staff; and 3) break-even scenario—each health risk would need to be reduced by a particular percentage point each year (to be determined) so that the amount invested in risk reduction programs would exactly match the amount saved as a result of those efforts, thus producing a benefit-to-cost ratio of 1.0.

For each scenario described, an ROI analysis was conducted comparing program savings (compared with the base case) to program investments. To estimate ROI and a financial break-even point, program savings were compared with Dow's annual expenses for H&HP programs directed at employee health risk reduction.

Health and Human Performance Services at Dow

Dow developed a formal approach for HPM in 1997. Initially titled "Integrated Health Management," it later evolved into H&HP. At the start of its work, the core group at Dow presented a conceptual framework suggesting a relationship between employee health and human performance. Staff posited that money spent to improve the productivity capacity of employees should be viewed no differently than investments for facilities. Dow's comprehensive approach to employee health improvement rested on the shoulders of a cross-functional team that linked all the relevant health-related programs and services offered at Dow. Management of HPM at Dow was the responsibility of the Dow Global Health and Human Performance Leadership Team, which included representatives from the occupational medicine, health promotion, benefits, employee assistance and counseling, human resource development, work life and diversity, workers' compensation, and safety units of the company.

At Dow, H&HP staff developed a business strategy that aligned HPM programs with three critical business objectives. Successful HPM programs should: 1) demonstrate a positive impact on health of the workforce, 2) impact the financial health of the company by appropriately managing its health care cost burden, and 3) assure that HPM initiatives are viewed as a valued service by employees. To further advance these objectives, H&HP staff

conducted several financial impact analyses, including the one reported here.

Materials and Methods

Design

A case study design was used to estimate the financial impact of alternative risk reduction scenarios envisioned for Dow employees. To inform the analysis, data on employee demographics, job categories, and risk factors were collected from Dow's medical files, using methods that ensured individual employee confidentiality and anonymity. All personal information (ie, name, address, social security numbers) was removed from source files, and unique identifiers were "scrambled" to protect individual data. In performing cost-benefit analyses, employee information was aggregated and reported at a group level.

The methods used here were developed by Leutzinger et al[9] and explained in more detail in Ozminkowski et al.[10] These methods allowed us to project health risks on the basis of Dow company demographics and then to project medical expenditures on the basis of demographics and health risk information. Expenditures that were associated with different levels of risk reduction were estimated, and these expenditure estimates yielded the return on investment measures described in more detail below.

Analysis

Five major steps were completed to conduct analyses for this project. Key assumptions are noted for each step.

Step 1: Estimate Dow's Demographic Profile. The first step in the forecasting process required Dow to estimate the demographic profile of its employees over a 10-year period from 2002 through 2011. This information was based upon the demographic and organizational makeup of the 25,828 Dow employees in a base year (2001), as shown in Table 1.

TABLE 1
Dow U.S.-Based Employee Demographics—2001

Demographic Measure	Value	2001 Total
Population	Number	25,828
Age	Mean	43
Gender, %	Female	25%
	Male	75%
Race, %	American Indian/Alaskan Native	<1%
	Asian/Pacific Islander	3%
	Black	8%
	Hispanic	6%
	Non Applicable	<1%
	White	82%
Education, %	No College	17%
	Not Indicated	37%
	College Educated	46%
Job type, %	Laborer, Clerical, Technician	54%
	Professional or Managerial	44%
	Sales	2%

Includes all active Dow, Dow Agro Sciences, Union Carbide Company, and wholly owned subsidiaries.

Dow's historical experience was relied upon to generate predictions of demographic changes in the coming years. Dow officials expected Dow's U.S. population to remain fairly stable over the 10-year period examined, with the following exceptions. During the period of 2002 to 2011, employees in the oldest demographic group (ie, active employees aged 55 to 64) were expected to retire or leave voluntarily at a rate of 1.25% per year. Those leaving or retiring were expected to be replaced, person for person, by workers who fell into the youngest demographic stratum (ie, ages 18 to 34). Other factors built into demographic projections included an assumption that professional or managerial employees would increase at the rate of 1% per year, and that the distribution of older staff among the various Dow divisions would remain constant.

Step 2: Estimate the Risk Profile of Dow Employees. The next step in the analysis involved estimating Dow employees' risk profile over the 10-year study period from 2002 to 2011. This estimate of the risk profile over time was required for subsequent analyses designed to forecast medical expenditures on the basis of demographics and health risks in the Dow population.

The following 10 risk factors were considered in these analyses: 1) poor exercise habits (ie, exercising less than once per week, being sedentary); 2) poor eating habits (ie, not limiting the consumption of high-fat foods, not eating the recommended number of food servings from each of the major food groups daily); 3) being significantly overweight (ie, having a body mass index [BMI] of 30 and greater); 4) being a current tobacco user (ie, smoking cigarettes, cigars, or pipes or using smokeless tobacco) or being a former tobacco user (ie, having smoked cigarettes, cigars, or pipes or used smokeless tobacco); 5) having a high total cholesterol level (ie, 240 mg/dL or higher); 6) having a high blood glucose level (ie, greater than 115 mg/L); 7) having high blood pressure (ie, having systolic blood pressure equal to/or greater than of 160 mm Hg and/or diastolic blood pressure equal to or greater than 100 mm Hg); 8) having a high level of stress (reporting having problems with excessive stress or nervousness) and not being able to effectively manage the stress; 9) being depressed or sad (for a period of 2 weeks or more); and 10) heavy alcohol use (ie, reporting consumption of three or more alcoholic beverages a day for 2 or more days per week).

To estimate the risk profile of Dow employees, we relied primarily upon Dow's internal screenings and health assessment studies. Dow administers a Health Questionnaire and conducts a health screening to collect basic biometrics (equivalent to a Health Risk Appraisal or HRA) as a part of a Health Assessment Program (HAP). Biometric data collected as part of the HAP include information on height, weight, pulse, blood pressure, fasting lipid profile, and fasting blood glucose levels. Employee behavioral risks are self-reported.

Participation in the HRA portion of the HAP is voluntary. Invitations are sent to all active employees once every 2 years. In the United States, Dow has consistently achieved high participation in this voluntary component, with participation ranging from 75% to 90% of all U.S. employees.

To inform the analysis, Dow's actual risk data were used whenever possible. In situations in which Dow data were unavailable, employee risk values were estimated using the original HERO study[11] as a foundation. To estimate the risk profile for future Dow populations, outputs from logistic regression models developed earlier using the HERO research database were used for each risk category. These regressions were described in Leutzinger et al[9] and Ozminkowski et al[10] The dependent variable for each logistic regression was coded as "1" if the respondent was at high risk for the category of interest; otherwise, it was coded as "0." The independent variables for these models included the demographic characteristics of the respondents, reflecting their age, gender, race, and job type.

This demographic information was input into the logistic regression models to obtain predictions of risk prevalence for Dow employees at different points in time, which was accomplished by multiplying Dow's demographic and job type values by the associated parameter estimates from the logistic regression model and summing these values, along with the intercept, to obtain an estimate of the log odds of being at high risk. The log odds were then algebraically converted into an estimate of the population risk prevalence.

The methods used to create estimates of risk prevalence for each year were the same. However, as changes over time in demographics were forecasted, these changes were inserted into the regression equations to update the risk prevalence estimates for each year in the ten-year study period.

The resulting risk projections for Dow employees over the 10-year study period are presented as Table 2.

Step 3: Estimate Health Care Expenditures. The next step of the analysis involved estimating the annual per-employee health care expenditures over the 10-year study period (Fig. 1). These projections were derived from the two-stage regression models constructed earlier as part of the original HERO study.[11] The first stage included a logistic regression model to predict the probability of Dow employees having any medical expenditure during the study period. The second stage consisted of a linear regression model to predict the amount of expenditures for Dow employees who incurred any medical expenditure and who were at high risk for any of the factors examined. Both demographic and risk characteristics were used as predictors in each of the regression models.

Step 4: Simulate the Impact of Alternative Population Risk Profiles. We then estimated medical expenditures for Dow assuming three different population risk profiles (described as the aforementioned three scenarios) emerging in the decade following the baseline year. For each scenario, we reported expenditure estimates in constant baseline (ie, 2001) dollars, to adjust for the impact of inflation.

Finally, we estimated an ROI by comparing the costs of Dow's H&HP programs (Table 3) over a 10-year period with the savings projected to emerge from effective risk reduction programs. A "break-even" scenario was calculated that determined the minimum level of risk change required to achieve savings in medical expenditures equal to the cost of the H&HP program.

The expenses associated with risk factor management within Dow's H&HP programs were estimated to be approximately $1.8 million in 2001 (Table 3). These total $18.1 million over 10 years, before discounting, and $15.4 million after discounting. All of the estimates included in the analysis are presented in 2001 dollars. Program expenses and savings are discounted at the rate of 3%, to account for the changing value of a dollar over time.

Results

Our results show that even small reductions in health risks for Dow employees would yield large savings in health care costs for the company. The "break-even" point, in which savings exactly equal investment dollars, occurs when each health risk is reduced by 0.17% points annually. Table 4 presents a summary of our analysis. The table shows four columns of cost data for different scenarios that were modeled.

Base-Case Scenario

The first column (referred to as the *base case* or *reference scenario*) presents Dow's medical expenditure projections for the period 2001 to 2011, assuming that the demographics of the population drive changes in population risk and consequent changes in medical costs. In this base case, where Dow's demographic profile is projected to remain fairly constant, the population was assumed to age approximately ten years over the 10-year study period. This scenario resulted in an overall deterioration of health risks as employees got older, (ie, employees would be expected to gain weight, their average blood pressure would increase, their average cholesterol levels would rise, they would become more prone to

TABLE 2
Summary of Adjusted Probabilities of Being at High Risk Over Time, and Lower and Upper Bounds of the 95% Confidence Intervals for 2001

Variable	2001 Risk	2003 Risk	2005 Risk	2007 Risk	2009 Risk	2011 Risk
Poor exercise habits	23.0%	23.9%	24.8%	25.8%	26.8%	27.9%
	22.5%					
	23.5%					
Poor eating habits	20.2%	19.4%	18.7%	17.9%	17.1%	16.3%
	19.7%					
	20.7%					
Deviate from ideal body weight	40.0%	40.9%	41.8%	42.8%	43.9%	45.0%
	39.3%					
	40.7%					
Current tobacco user	19.1%	19.1%	19.1%	19.1%	19.1%	19.1%
	18.6%					
	19.6%					
Former tobacco user	31.1%	31.1%	31.l%	31.1%	31.1%	31.1%
	30.5%					
	31.7%					
High cholesterol	14.0%	15.2%	16.4%	17.8%	19.4%	21.1%
	13.6%					
	14.4%					
High blood glucose	7.0%	8.0%	9.1%	10.5%	12.1%	14.1%
	6.8%					
	7.2%					
High blood pressure	2.0%	2.2%	2.5%	2.8%	3.2%	3.6%
	1.9%					
	2.1%					
High stress	7.0%	7.0%	6.9%	6.9%	6.9%	6.8%
	6.8%					
	7.2%					
Depression	5.0%	5.0%	5.0%	4.9%	4.9%	4.9%
	4.9%					
	5.1%					
Heavy alcohol use	3.7%	3.4%	3.2%	2.9%	2.7%	2.5%
	3.6%					
	3.8%					

The second and third values listed for 2001 are, respectively, the lower and upper borders of the 95% confidence intervals for the risk percentages.

Risk refers to estimated percent at high risk in each year, based upon demographic trends.

Adjustments were made to compensate for over- or underestimation of risks based on HERO model.

Risks for former tobacco users were set to increase at same percent that the risks for current tobacco users decrease.

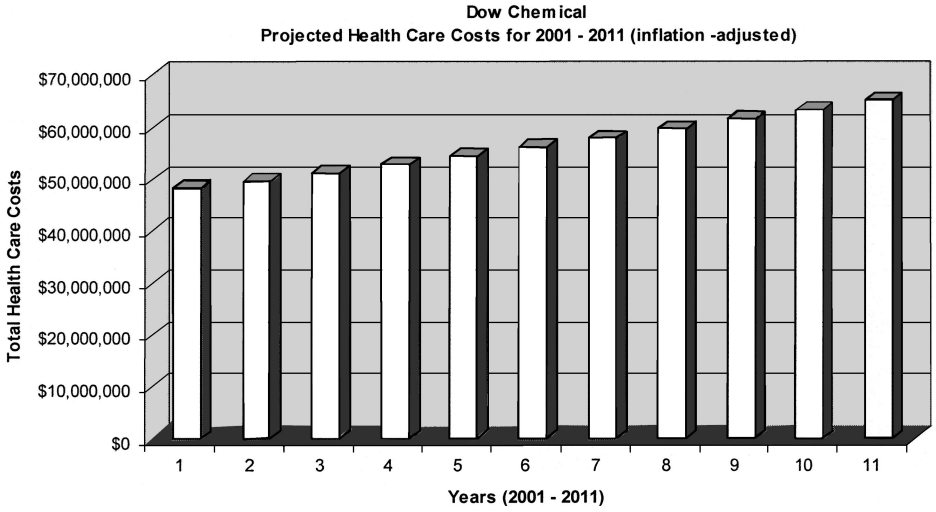

Fig. 1. 10-year projections of health care costs assuming population aging and no reductions in health risks (employees only).

TABLE 3
Dow Health and Human Performance Program Expenses in 2001

Program	2001 Expense
Fitness center management	$633,808
Smoking-cessation efforts	$13,100
Stress/mental health (PMI)	$14,400
Health-promotion education/awareness	$440,900
Health-promotion resource center	$315,800
Occupational health risk-assessment program	$255,200
CHF disease-management program	$11,700
Diabetes disease-management program	$16,100
Employee assistance program	$107,413
Total	$1,808,421

diabetes, and so forth). Interestingly, for some risk factors, aging would actually improve the employees' risk profile, as in the case of eating habits, stress management, depression management and heavy alcohol use (Table 2).

As shown, holding dollars constant at 2001 levels to adjust for inflation, Dow's health care expenditures were expected to increase by approximately $17.1 million from $48.2 million in 2001 to $65.3 million in 2011, a 35.5% increase, or approximately 3.1% per year, compounded annually. This base case was used as a reference point for three other potential scenarios that are described below.

Scenario 1: Large Program Impact—Health Risks Reduced 1% per Year—10% Over Ten Years

Scenario 1 is the most aggressive scenario of those considered. It assumes that the H&HP program is successful in reducing each health risk by 1% point per year, or by 10 points over 10 years. Under this scenario, Dow's health care expenditures continue to increase, but at a much more modest rate. Medical costs increase $6.6 million compared to the base year, an increase of 13.7% over 10 years or approximately 1.3% per year. The benefits under scenario 2 amount to about $49.5 million, compared to the base case. When benefits of $49.5 million are contrasted program expenses of $15.4 million, the program achieves an ROI of $3.21 to $1.00, (ie, $3.21 would be saved for every dollar invested).

Scenario 2: Modest Program Impact—Health Risks Reduced 0.1% per Year—1% Over Ten Years

Scenario 2 assumes the H&HP program is effective in reducing employee health risks, but only modestly. The scenario assumes that each risk would be reduced by 0.1% point each year (ie, by 1% point over 10 years). Under this scenario, Dow's health care expenditures continue to increase. Medical costs increase $14.3 million compared with the base year, an increase of 29.7% over 10 years, or approximately 2.6% per year. The benefits under scenario 2 total approximately $11.7 million, which, when compared with company program expenses of $15.4 million, results in a slight loss (ie, an ROI of $0.76 to $1.00, meaning that only approximately 76 cents would be saved for every dollar invested in the program).

Scenario 3: Break-Even Scenario—Health Risks Reduced 0.17% per Year—1.7% Over Ten Years

Because a reduction in risk of 1% per year is likely to yield large savings and a reduction in risk of 0.1% per year is likely to yield some losses, the break-even level of risk reduction must lie somewhere within this range. Scenario 3 shows the break-even point for the H&HP program. To achieve an ROI such that one dollar is saved for every dollar invested in the program, Dow would have to reduce each health risk by 0.17% points per year, or by 1.79% points over ten years (see Table 4). Under this scenario, the company saves the same amount of dollars it invests in the H&HP program, (ie, about $15.4 million).

Discussion

A cost-benefit analysis performed for Dow projected company health care expenditures over a 10-year period under three scenarios. A base case was first created in order to project future health care costs, assuming no intervention took place and the population simply aged. In the base case scenario, health care costs were estimated to increase at a rate of about 3.1% per year, not including health care inflation, simply as a result of an aging workforce.

Three possible scenarios were then developed and subsequently compared to the base case. An intervention program that reduced each risk by 1% point per year over 10 years was estimated to result in approximately $49.5 million in savings and annual cost increases of only 1.3%. A more modest program that reduced each health risk by 0.1% points per year would yield a small loss to the company. The break-even for Dow's HPM program was expected to be achieved if each health risk was reduced by 0.17% point per year. At this level of risk reduction, Dow was projected to save $1.00 for every $1.00 invested in the program over a ten year span.

Applications and Actions by Dow

The results of this analysis were incorporated into a business case document presented to senior leaders at Dow, to guide their planning and implementation of new HPM pro-

TABLE 4
Summary of Results in Year 2001 Dollars for Dow

Year	No. Employees	Reference Case: Total Expenditures With Demographics and Risk Shifting as Forecasted (ie, Pre-Existing Trends Remain)	Scenario 2: Total Expenditures When Each Risk Declines by 1 Percentage Point per Year and Demographics Change as Forecasted	Scenario 3: Total Expenditures When Each Risk Declines by 0.1 Percentage Point per Year and Demographics Change as Forecasted	Scenario 4: Break-Even (Reduce Each Risk Factor by 0.17 Percentage Points per Year)
2001	25,828	$48,184,200.24	$48,184,200.24	$48,184,200.24	$48,184,200.24
2002	25,828	$49,567,321.73	$48,455,508.20	$49,350,274.17	$49,274,562.38
2003	25,828	$50,950,443.22	$48,726,816.15	$50,516,348.10	$50,364,924.52
2004	25,828	$52,475,607.39	$49,047,321.38	$51,786,609.40	$51,556,180.38
2005	25,828	$54,000,771.56	$49,367,826.61	$53,056,870.71	$52,747,436.24
2006	25,828	$55,687,290.61	$49,940,738.20	$54,448,051.94	$54,050,876.97
2007	25,828	$57,373,809.66	$50,513,649.78	$55,839,233.18	$55,354,317.70
2008	25,828	$59,244,428.05	$51,453,585.63	$57,363,594.22	$56,782,765.99
2009	25,828	$61,115,046.44	$52,393,521.47	$58,887,955.26	$58,211,214.28
2010	25,828	$63,196,710.47	$53,593,299.44	$60,698,517.50	$59,914,721.33
2011	25,828	$65,278,374.50	$54,793,077.40	$62,509,079.75	$61,618,228.38
Increase in expenditures from 2001 to 2011		$17,094,174.26	$6,608,877.16	$14,324,879.51	$13,434,028.14
Percent change between first and last year		35.48	13.72	29.73	27.88
Sum of total expend		$617,074,003.89	$556,469,544.50	$602,640,734.47	$598,059,428.40
Potential benefits of risk management (with a 3% discount rate)		Not applicable; base case	$49,512,590.66	$11,705,745.61	$15,426,671.88
Dow investment (also with a 3% discount rate)			$15,426,671.88	$15,426,671.88	$15,426,671.88
Return on investment			$3.21	$0.76	$1.00

Return on investment is calculated relative to scenario in which demographics and risk shift as according to pre-existing trends.

grams. Results were used to quantify the amount of risk reduction needed in the employee population to achieve an expected ROI. The relatively small amount of improvement needed to achieve a positive ROI was not clearly understood by management before the analysis. Findings from this study supported Dow's H&HP staff in their efforts to introduce and maintain risk reduction interventions designed to achieve health improvements for employees and cost savings for the company.

The analysis was used to communicate to corporate and functional managers the importance and value of the H&HP program, and the importance of risk management, in particular. Result were combined with other business articles to help create a paradigm shift from thinking about health care as an expense to one that views it as an important investment in human capital.

Additionally, the analysis was used in education efforts directed at health-related program and service managers, and implementation staff. It served to underscore the potential cost savings from prevention. Further, it highlighted the need to measure risk reduction outcomes from prevention efforts. Some adjustments in resource allocations and program design were made to better reinforce and support these efforts. Finally, health staffs created new tools to enable decision-making at the site level, in support of HPM activities.

In summary, H&HP staffs have successfully leveraged the ROI analysis described here to support their contention that investments in employee health have the potential to deliver a financial payback for the corporation.

Limitations

The analyses described in this articleare subject to several limitations. First, the aforementioned analysis considered only savings in direct medical expenditures. Previous research by Medstat and Cornell University has shown that medical costs constitute a fraction of total company HPM expenses that include the cost of employee absence for illness, short-term disability, workers' compensation program use, and employee turnover.[7,12] Further, on-the-job productivity losses, referred to as presenteeism, have been estimated to account for between 18% and 61% of total health and productivity related expenditures for certain high cost and prevalent health conditions.[13] Thus, this study is likely to underestimate the effect of risk reduction because productivity-related gains or losses were not counted.

Second, the underlying regression analyses used to forecast risk and expenditures were based upon an external data set. Forecasts might be more accurate if Dow's actual claims and risk data had been used. This limitation may be more problematic for risk estimation than cost estimation, however. Using 2001 as a reference, we found that HERO-based expenditure forecasts using Dow demographic data were very similar to actual Dow costs. The HERO-based forecasts overestimated Dow expenditures by 6.9%. Thus, we applied an adjustment factor to each subsequent year's dollar forecasts to lower them that proportion.

Using 2001 as the base year, we also forecasted Dow's risks on the basis of the company's demographic make-up. We then compared the forecasted risks to the actual risk information provided to us by Dow. For some risks (eg, those related to poor eating habits, current smoking, and former smoking habits) the forecasts were quite accurate, missing the mark by 4.0% or less. For others, the forecasts either over- or underestimated Dow's risks more substantially. Adjustment factors were therefore calculated for each year, to assure that the risks forecasted for Dow were more in line with prior expectation. The value of those adjustment factors (which varied by risk type) was equal to the HERO-based forecast in 2001 divided by the Dow risk value for 2001. A value of 1.0 would indicate a perfect forecasting process. This was not always achieved since there is always a random component to human behavior that makes any forecasting process imperfect. Thus, depending upon the risk factor, the adjustment factors used in this analysis ranged from 0.39 (for depression) to 2.08 (for stress).

Third, given the nature of the forecasting process, it was not possible to specify confidence intervals around many of the risk and expenditures forecasts. The demographic projections that were made for the 2002 to 2011 period are point estimates based upon internal discussion, and statistical confidence intervals could not be provided for these projections. This precluded the estimation of confidence intervals for risks and expenditure projections for that period as well, and this is why those confidence intervals are not provided in the tables. Although we believe the estimates contained in this paper are the best ones that could be generated with the data at hand, we do not know how much statistical certainty to ascribe to them.

Finally, this analysis focused on the employee population, whereas Dow is at risk for the health care costs of employee dependents, retirees, and retiree dependents. The benefits of reducing health risks for these populations could not be included in the model because of data limitations.

Conclusion

To develop a sound business case for continued investment in employee health and prevention efforts as part of a comprehensive approach to HPM, Dow's H&HP staff developed a cost-benefit model that considered the demographics of company employees, health risk factors, and consequent company health care expenditures over a 10 year period, setting aside the effects of inflation. By effectively managing employee health risks, the model projected medical costs savings for the company that exceeded program expenses. Assuming that even a minor decrease in health risks is achieved over the next decade, Dow should realize significant direct medical cost savings from its HPM programs. These savings estimates have helped senior management to guide the resources of the company, so resources can be more appropriately spent on risk reduction and health promotion efforts over the coming decade.

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Appendix

Results of Regressions of Health Risks and Other Variables on Medical Expenditures, as Reported in the HERO Analyses Published by Goetzel et al[11]

This appendix reprints Table 2 from the HERO analyses published by Goetzel et al.[11] The table shows the impact of risks and other variables on the odds of having any medical expenditures and on the magnitude of those expenditures when they were incurred. This information can be used to estimate the overall impact of each health risk on medical expenditures, controlling for other health risks and the covariates included in the regression model. The article by Ozminkowski et al[10] describes in detail how this information can be used by employers to forecast medical expenditures as their demographics and health risks change over time.

APPENDIX: TABLE 2

From Goetzel et al: Estimated Impact of Health Risks and Covariates on the Odds of Having any Medical Expenditures (Based on Logistic Regression Using the Whole Sample) and on the Natural Log of Inpatient Expenditures (Based on Least Squares Regression on Those Having Non-Zero Expenditures)

Variable	Relative Odds of Having any Medical Expenditures, 95% Confidence Interval, and *P* Value, From Logistic Regression (*n* = 46,026)	Coefficient, Standard Error, and *P* Value From Least Squares Regression of Log Dollar Expenditures (*n* = 33,237)
Risk and Biometric Measures (in order of prevalence)		
Poor exercise habits	1.077 (1.015–1.144) (0.0150)	0.086 (0.019) (0.0001)
Former tobacco user	1.055 (0.992–1.121) (0.0873)	0.171 (0.020) (0.0001)
Poor nutritional habits	0.994 (0.931–1.062) (0.8592)	−0.096 (0.021) (0.0001)
Extremely high or low weight	1.109 (1.035–1.188) (0.0032)	0.177 (0.021) (0.0001)
Current tobacco user	0.977 (0.908–1.051) (0.5327)	0.139 (0.023) (0.0001)
High cholesterol	1.097 (1.024–1.176) (0.0081)	−0.023 (0.021) (0.2812)
High stress	1.288 (1.198–1.385) (0.0001)	0.342 (0.021) (0.0001)
High blood glucose	1.237 (1.091–1.402) (0.0009)	0.265 (0.040) (0.0001)
High blood pressure	1.152 (1.016–1.306) (0.0272)	0.088 (0.043) (0.0391)
High alcohol use	1.065 (0.919–1.235) (0.4041)	−0.041 (0.043) (0.3469)
Depression	1.414 (1.151–1.737) (0.0010)	0.483 (0.055) (0.0001)
Control variables		
Female gender	1.623 (1.524–1.728) (0.0001)	0.539 (0.019) (0.0001)
Age	1.016 (1.013–1.019) (0.0001)	0.020 (0.001) (0.0001)
College graduate	0.970 (0.911–1.031) (0.3281)	−0.048 (0.019) (0.0142)
Black race	0.805 (0.736–0.880) (0.0001)	0.126 (0.029) (0.0001)
Hispanic race	0.659 (0.586–0.741) (0.0001)	0.118 (0.051) (0.0205)
Other nonwhite race	0.439 (0.391–0.492) (0.0001)	0.024 (0.052) (0.6490)

(*Continued*)

APPENDIX: TABLE 2
(*Continued*)

Variable	Relative Odds of Having any Medical Expenditures, 95% Confidence Interval, and *P* Value, From Logistic Regression (*n* = 46,026)	Coefficient, Standard Error, and *P* Value From Least Squares Regression of Log Dollar Expenditures (*n* = 33,237)
Sales job	1.641 (1.295–2.079) (0.0001)	−0.054 (0.090) (0.5439)
Professional or managerial job	1.010 (0.950–1.075) (0.7437)	−0.051 (0.020) (0.0096)
Employer 1*	0.443 (0.393–0.499) (0.0001)	−0.226 (0.045) (0.0001)
Employer 2*	0.597 (0.406–0.877) (0.0087)	−0.342 (0.121) (0.0046)
Employer 3*	0.034 (0.031–0.037) (0.0001)	−0.277 (0.023) (0.0001)
Employer 4*	0.433 (0.379–0.495) (0.0001)	0.103 (0.040) (0.0111)
Employer 5*	0.477 (0.415–0.549) (0.0001)	−0.263 (0.048) (0.0001)
Number of months post-HRA	3.102 (2.981–3.227) (0.0001)	0.648 (0.014) (0.0001)
−2 Log Likelihood χ^2 or Regression F-statistic	17,825.91	222.265
P value for −2 Log Likelihood or Regression *P* value	0.0001	0.0001
Score statistic and *P* value or Adjusted r-squared	15,309.95 (*P* = 0.0001)	0.1890

Rows associated with the intercept and missing data indicators are not shown, for brevity.
*Employer names not used to preserve confidentiality.