THE HEALTH CONSEQUENCES OF SHIFT WORK

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In the summer of 1975, the National Institute for Occupational Safety and Health (NIOSH) awarded a contract for a project on the health consequences of shift work to SRI International, Menlo Park, California. At the time, shift work was primarily found in industries where it was necessary to offer round-the-clock services, such as in hospitals, or to maintain 24-hour operations as in pulp and paper plants. Recently, however, another phenomenon is increasing the prevalence of shift work in this country, and will undoubtedly increase it to an even greater extent in the near future.

As energy utilization has emerged as a critical problem, it has become clearer that one of the main difficulties in designing energy plants is that they have to be large enough to handle loads at peak times; but this inevitably means that at other times they have more capacity than they need. To help level out demand, and thus make their plants run more efficiently, energy companies are reducing prices for energy utilization at other than peak hours. This is inducing many energy-intensive firms to take advantage of reduced costs at off hours by putting on afternoon and evening work shifts.

The *Wall Street Journal* recently published two separate articles on this topic, showing, among other things, that the differential in costs for states in which an off-hour rate now applies is considerable. The savings in energy costs well exceeds potential increases in wages for off-hour shift work. I believe more and more companies that have never heretofore seen the advantage in shift systems will begin to start using afternoon and night shifts because of this inducement.

However, we need more information on the effects of working these shifts on the health and well-being of the workers who will be employed for afternoon and night work. What happens when their conventional daytime routine is broken up this way? Because few studies have been conducted on this issue in this country, there is still inadequate information on the American worker's adaptability to shift systems.

We do know what happens in general when you invert your sleep cycle, whether you do so by traveling halfway around the world or by staying here and working at night. Either way, inverting the sleep cycle interrupts those body rhythms called circadian rhythms, or diurnal cycles, which are manifested in body temperature, blood pressure, pulse rate, urine volume, urine components, and in certain endocrine functions. And we know that as you adjust to an inverted sleep-wake cycle, these 24-hour rhythms begin to come back into phase at different rates, so they are no longer in synchronization: one of the main effects of disrupting sleep cycles is to desynchronize circadian rhythms in the body. Ad-

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justment to inverted sleep cycles and resynchronization of circadian rhythms can take as little as three or four days, or it can take as long as a few months. Some people never adjust completely to night work.

We also need to know whether disrupting circadian rhythms in this way is related to the increased prevalence and severity of health problems, accidents, psychological disorders, and social maladjustments. The results of the NIOSH-SRI study are, I believe, a significant contribution to our understanding of these areas.

Our preliminary review of the literature in the field indicated that not only sleep patterns, but also eating and digestion patterns were clearly susceptible to disruption by afternoon, night, and rotating shift work schedules. As one might expect, elimination problems, such as constipation and diarrhea, are also common.

However, few illnesses, with the possible exception of gastrointestinal ulcers, have been clearly linked to shift work. Certain studies show an increased frequency in the rate of ulcers among rotating workers as compared to day shift workers (8.1).

The NIOSH-SRI study included 2,400 subjects: 1,200 nurses and 1,200 food processors. We originally intended to sample six different occupational populations, but various design and procedural constraints required us to reduce the sample to three groups: nurses, food processors, and coal miners, all of which have large numbers of shift workers. We then discovered that coal miners' health records are kept with their private physicians, not at onsite work clinics, so we also dropped that occupation from the study sample.

Each sample group was composed of equal numbers of day,afternoon, night, and rotating shift workers. Rotators tended to come from different organizations altogether than did the permanent day, afternoon, and night shift workers because individual companies do not, by and large, combine permanent (or fixed) shift systems with rotating systems. The entire 24-hour span can be covered by either assigning workers permanently to each of the three basic shifts, or by having them rotate among them. Although few companies now use a blend of both systems, we feel, as we discuss below, that such a mixed system would improve worker adaptation to shift work.

There were two phases to the study. In the first, we reviewed worker health and safety files and compiled information on three major outcome variables--sick days, clinic visits, and accidents--for the previous six months. In the second phase, we distributed a questionnaire to about 3,500 workers, again dividing our distribution equally among day, afternoon, night, and rotating shift categories. The response rate was slightly under 60%; about 2,000 questionnaires were returned to us.

We first looked at the sick day variable for the nurse sample. Our analyses showed that rotating nurses tended to take slightly more sick days than all other workers assigned permanently to a shift, regardless of which shift that happened to be. But the difference between rotators and permanent shift workers was not significant, indicating that rotators were not taking many more sick days than were permanent workers.

We then looked at the reasons that nurses gave for taking time off sick, and we noticed that again there was a clear difference between rotators and all fixed-

shift workers: rotators tended to give more serious reasons for taking sick days than did fixed-shift workers. Among the fixed-shift group (comprising all permanently assigned day, afternoon, and night workers) the reasons for sick leave tended to be the same: headache, colds, earache, and so forth. But rotators tended to give more serious reasons, such as acute respiratory infection and upper-GI tract distress.

The same pattern prevailed in the food processor sample: the total number of sick days taken was about the same for rotating and fixed-shift workers, but the rotators gave what appear to be much more serious reasons for taking time off.

It was only when we then looked at information on clinic visits that our data began to seem quite revealing. Not only did rotators tend to go to worksite clinics much more often than did workers permanently assigned to their shifts, but they tended to go for the same reasons that fixed-shift workers gave as excuses for taking sick time.

In short, rotators used their sick leave for graver complaints while they visited the clinics at the worksite for the same reasons that caused fixed-shift workers to stay home. Rotators didn't take more sick time off because sick time is limited for all workers.

We concluded that the number of sick days taken was not a reliable indicator of health problems. One must also carefully analyze the reasons given for sick leave, the total amount of sick leave allowed, and the attendance patterns at onsite health clinics, where these are available to workers.

Unfortunately, we were unable to analyze corresponding clinic-visit data for food processors because most sites that used a rotating shift system did not maintain clinics.

The same patterns were confirmed by our data on accidents. Rotating workers had more total accidents than did fixed-shift workers. About 20% more rotators than fixed-shift workers had reported having at least one accident during the six months prior to our records review.

Our examination of the kind of accidents reported was not particularly fruitful. Rotators tended to have significantly more finger and superficial leg, hip, and foot injuries, but we concluded that, by and large, it was not the type so much as the small increase in incidence of all accidents that differentiated rotators from fixed-shift workers.

The questionnaire phase of the study led to more general findings. There do not appear to be radical differences in general health variables that are attributable to shift differences. Other areas of analysis for the questionnaire phase included sleep patterns, eating and digestion patterns, psychological mood, and life style, including personal, domestic, and recreational pursuits.

Disruption of sleep patterns seems to be the most widespread problem imposed by shift work. It tends to affect both recent and long-term shift workers alike.

Shift work also interferes with the domestic life of almost all workers who have off-hour schedules, particularly with respect to their sexual activities and their childrearing responsibilities. However, worker satisfaction on these variables

seems not to be so much a function of the absolute amount of time available as the compatibility of this time with others' schedules.

We found no evidence that shift workers were suffering from severe health problems, though some do report increases in stomach and digestion disorders, including constipation.

There was some indication that shift work may be related to decreased psychological well-being. Workers understandably do not like having to orient themselves to one schedule at work and to a dissonant schedule in their social and personal lives.

One very promising area of study in this field is that which focuses on the relationship between accidents and performance efficiency. One might reasonably posit that accidents tend to be an indicator of worker errors, and thus a high number of accidents would imply less efficient performance. As we saw earlier, rotators generally incur more accidents than fixed-shift workers, possibly because of the disruption of their diurnal cycles that their work schedules cause.

Past research has demonstrated that body temperature is also predictive of performance. Specifically, Prof. W. B. Colquhoun found in 1976 that British sailors, who stand rotating four-hour watches at sea and thus undergo constant disruption of sleep-wake cycles and, presumably, circadian rhythms, performed better on a simple task as their body temperature rose. But when the task was made somewhat more complex, the direct relationship between temperature and performance efficiency disappeared. And when the job became quite complex, the relationship turned out to be inverse: high body temperature meant worse performance.

For most of us, body temperature is low at night, and rises during the day until about noon or so, when it levels out. We tend to be most efficient, within broad limits, during the afternoon and evening hours. Of course, there are also those of us with speedier metabolisms--the "morning people"--who find that their efficiency peaks earlier in the day and then drops as the afternoon wears on.

Rotation, however, makes it especially difficult to match job demands, body temperature, and performance efficiency, especially since, as Colquhoun's study demonstrates, the complexity of the task is an important variable. More recent studies have also shown that the demands that the task makes on worker short-term memory capacity is also a factor in this complex relationship.

Companies that now use or that are planning to inaugurate shift systems should, in our opinion, understand that worker dissatisfaction can be intensified by the interference of work schedules with social and domestic activities. And, as any competent business manager knows, low morale is costly.

It should be possible, though, to encourage worker adaptation to shift work by maximizing worker shift preference. We feel this can be done by offering both fixed-shift as well as rotating assignments, and by offering both rapid and slow rotation intervals. An afternoon shift worker whose spouse works days may want to move to the night shift. Single employees may wish to choose any shift but the afternoon shift so as to leave their evening hours free for social pursuits.

Some individuals, such as air traffic controllers, even prefer to rotate quite rapidly from shift to shift. This leaves them with very busy work schedules in one part of the week, but a great deal of uncommitted time on other days.

It should be relatively easy to assess worker preferences and then to maximize a successful match between those choices and all the possible permutations of shift work scheduling. The complications of monitoring and assessing worker selections should be offset by what we believe would be a clear improvement in worker morale and a consequent reduction in turnover rates. We found in the NIOSH-SRI study that hospitals using only rotation systems had considerably higher turnover rates than those using only fixed shift systems. Mixing rotation and permanent assignments would, we believe, reduce turnover rates even more.

Researchers interested in studying shift work may encounter difficulty in obtaining the cooperation of management and labor. We fortunately did not, but a consultant to our project, Paul E. Mott, author of a comprehensive shift work study published in 1965, did have some trouble gaining access to certain organizations. As a result of his experience, Mott feels that union and management representatives should be approached simultaneously.

Most of the hospitals participating in our study were not unionized. Those that were offered us no obstacles.

At the food processing sites, we elected to approach management first and describe our study, explaining that it was exploratory, that we were just beginning to research the area of adaptation to shift work, and that we would appreciate their cooperation. About half of the plants we approached declined to participate. Several of these stated that they were currently involved in labor negotiations. We received very good cooperation from those that chose to participate, though none wanted to have their names disclosed in our final reports or in discussions of the study's results. This last stipulation necessitated devising an elaborate system for protecting the confidentiality of questionnaire respondents.

After management had consented to involvement in the study, we approached union representatives. In only one case did unions veto the participation of their members. In some cases, management itself handled further contact with union representatives and we were not required to explain the study a second time to union officers.

Two small factors that helped us win the acceptance and cooperation of these hospitals and food processing plants were: (1) we paid respondents five dollars for completed questionnaires, and (2) we did not intrude on work hours; questionnaires were sent directly to the worker's home address.

Future studies in this area would, in our opinion, be well advised to focus on a small number of workers from relative few firms, rather than twenty-four hundred individuals from some twenty-odd sites. Multiple measures, taken over a more prolonged time period than was possible with our one-shot design, should make it possible to considerably refine the current understanding of the health consequences of shift work.

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