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The occupational stress index—an approach derived from cognitive ergonomics applicable to clinical practice

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The occupational stress index is an additive-burden model that incorporates key aspects of the leading sociological work-stressor models, but was developed from a cognitive ergonomics perspective. The index bridges the gap between two divergent approaches in occupational psychosocial research via occupation-specific instruments (for professional drivers, physicians, teachers, and the like). These are mutually compatible within the theoretical framework of the index, allowing between-occupation comparisons, but are more operationalized than generic instruments. They are thereby especially helpful for identifying key modifiable stressors in a given work environment. Among the salient empirical findings using the index are significant within-group associations between work-stressor burden and cardiovascular disease (CVD), as well as lifestyle-related risk factors for cancer and CVD. The index is of clinical value, helping physicians incorporate the workplace into diagnostic and management strategies. The perspectives via the index are presented for developing evidence-based return-to-work guidelines for patients with cancer, CVD, and neuropsychiatric disorders.

Key terms additive burden model; health work; level of information transition; occupation-specific questionnaire; physician; professional driver; teacher; threat-avoidance vigilance; work stressor.

Etiologic research has demonstrated a strong relationship between workplace stressors and adverse health outcomes, notably cardiovascular disease (CVD) (1, 2) and mental health disorders (3). In these studies, deleterious job exposures were mainly assessed through generic instruments from the job-strain (4) and effort–reward imbalance (5) models, based heavily upon sociological theory. The very success of this line of research, coupled with global trends towards deteriorating work conditions, oblige us to sharpen our tools, so that efforts to create more flexible and healthier work environments are maximally effective.

Occupational stress index—an approach derived from cognitive ergonomics

Complementary to constructs such as job strain and effort–reward imbalance are approaches derived from cognitive ergonomics, which address how human beings process information, make decisions, and carry out actions (6). The occupational stress index (OSI) (7) is an additive burden model that incorporates key aspects of the leading work-stress models, job strain and effort–reward imbalance, but was developed from this cognitive ergonomics perspective. Assessment is made of factors such as the nature and temporal density of incoming information, how information is processed on the basis of complexity, completeness, and coherence. Thereby, OSI analyzes work in terms of demands on mental resources and how these demands are controlled by the individual, in the context of energy–regulation theory (8). This theory demonstrates the indelible coupling between the two job-strain dimensions; in other words, with sufficient decision latitude, or control, a person can modulate even fairly onerous, although not overwhelming, psychological workload to meet his or her needs and capacities. At the same time, the imperative to rigorously define and guard against exposure to

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overwhelming psychological demands becomes that much greater. Via cognitive ergonomics, the burden of work processes upon the central nervous system is described in more objective terms. Such a description is particularly important for psychological job demands, allowing us to go beyond queries about "working fast" and "working hard". Thus, in many ways, OSI is akin to theory-guided observational approaches such as the RHIA/VERA method (German abbreviation for "regulation barriers at work / methods to investigate regulation requirements at work"). These approaches examine the mental structure of worktasks (9, 10). However, OSI can be applied in epidemiologic settings and does not require onsite observation. On the other hand, insofar as the latter is available, it can be effectively used to improve the precision of OSI (11).

Within OSI, the work environment is viewed as a whole, including task-level issues, work schedule, and physical, chemical and broader organizational factors that can all contribute to total burden. OSI (figure 1) is arranged as a two-dimensional matrix, the vertical axis being composed of levels of information transmission (6) and the stressor aspects being placed along the horizontal axis. The elements are equally weighted, scored from 0 to 2 (maximum) and summed to yield aspects (underload, high demand, strictness, external time pressure, aversive physical exposures, symbolic aversiveness, and conflict or uncertainty). When summed, these aspects yield the total OSI score.

We would like to point out the "symbolic-aversiveness" (or "threat–avoidance") aspect that has been incorporated into OSI, but which is not a part of sociological work-stress models. For survival reasons, the nervous system selectively focuses upon threatening stimuli. It is particularly burdensome to follow a barrage of information, being ready to rapidly respond, with a momentary lapse, error, or delay having serious, possibly even fatal consequences (12). "Threat–avoidant vigilance"(13) is characteristic for, for example, physicians, nurses, professional drivers, and air-traffic controllers.

Occupation-specific instruments

OSI bridges a gap between two divergent approaches in occupational psychosocial research. One, represented by theory-based, generic approaches, is often remote from actual work experiences and, therefore, may not be helpful in assessments of within-occupation variance, the very level at which intervention strategies are developed, in practice. The other, the occupation-specific approach, provides detailed information, but, since it focuses on one occupation, often misses more generalizable conclusions that require between-group analyses. This is precisely where OSI offers a potential solution, via a

Aspects Information Transmission Level	Under-load	High Demand	Strictness	Extrinsic Time Pressure	Aversiveness/ Noxious Exposures	Avoidance/ Symbolic Aversiveness	Conflict/ Uncertainty
=Input	• Homogeneous signals • Low frequency of incoming signals • Works alone--without need for communication	• Several info. sources • Heterogeneous information • Heavy burden on visual system • High frequency of incoming signals • 3 sensory modalities • Communication essential	• Strict requirements for signal detection	• No control over speed of incoming signals	• Glare • Noise	• High level of attention (Serious consequences of momentary lapse) • Visually-disturbing scenes • Listens to emotionally-disturbing occurrences	• Signal/noise conflict • Signal/signal conflict
Central Decision-Making	• Decisions automatic from input	• Complex decisions • Complicated decisions • Decisions affect work of others • Rapid decision-making	• Strict problem-solving strategy • Strictly defined correct decision	• Decisions cannot be postponed		• Serious consequences of a wrong decision	• Missing information needed for decision • Contradictory information • Unexpected events change work plan
Output/ Task performance	• Homogenous tasks • Simple Tasks • Nothing to do	• Heterogeneous tasks • Simultaneous task performance • Complex tasks • Rapid task performance	• Work must meet a strictly defined standard	• No control over rate of task performance	• Isometric lifting • Vibration	• Hazardous task performance	• Conflicting demands *Task performance hampered by:* • Extrinsic problems • Interruptions from people
General	• Fixed pay • Inadequate pay • No chances for upgrade • Lack of recognition of work	• Piece rate work • Long work hours • Holds 2+ jobs • Lack of rest breaks • Night shift/irregular work hours • Lack of paid vacations	• Fixed body position • Confined, window-less, workspace • Lack of autonomous workspace • Limited in taking time off from work *Low influence over*: • Schedule • Tasks • Policy • With whom one works	• Deadline pressure • Speed-up	• Heat • Cold • Noxious gases, fumes, dusts	• Work Accident • Witnessed work accident • Suicide occurrence • Work-related litigation/Testifying in court • Lack of functioning emergency system	• Emotionally-charged work atmosphere • Lack of help with work-related difficulties • Opposition to career advancement • Violations of behavior norms/abuses of power • No grievance redress • Threat of job loss • Job lacks coherence

Figure 1. The occupational stress index (version 2003). [Reprinted with permission from *The Occupational Stress Index: an Approach Derived from Cognitive Ergonomics and Brain Research for Clinical Practiice* by Belkić (7, p 40)]

series of occupation-specific instruments that are mutually compatible within the theoretical framework of OSI since it allows between-occupation comparisons. These occupation-specific instruments are more operationalized than a single generic instrument, and, therefore, are especially helpful when key modifiable stressors are to be identified in a given work environment.

Development of occupational-specific instruments. The process of developing occupational-specific OSI instruments is a labor-intense process. Workers in the occupation first complete the generic OSI. Invaluable insights can be gleaned from qualitative data provided by workers willing to put in the extra time to comment and explain their answers in relation to their actual work environment. This process is facilitated by the use of open-ended questions. Together with a review of the literature on the occupation in question, expert observers can also be of help.

There are three major ways in which generic and occupational-specific OSI differ. First, the unchanging characteristics of a given occupation can be assigned a fixed score. For professional drivers, these unchanging characteristics include, for example, the need to make and carry out rapid, nondeferrable, but somewhat automatic decisions (a combination of decision-making underload and high demand), no possibility of ignoring incoming signals (strictness on the input level), and no chance to influence the rate at which new signals are received (extrinsic time pressure on the input level)]. These and other factors contribute to the high demand and low control of professional drivers, but because they are invariant, queries in this regard would be superfluous. Furthermore, their work epitomizes threat–avoidant vigilant activity, with potentially fatal consequences from a momentary lapse or even a slight judgment error. Again, there is no need to ask about these invariant elements.

The variable features can be operationalized according to the specificities of the occupation. With respect to the example of professional drivers, some of the variable elements are operationalized in relation to the traffic environment (eg, road and vehicle conditions, type of routes, passengers, accidents, work schedules, timetable stringency, rest breaks, etc). The queries are presented in a neutral manner so that reporting bias is minimized. One example of how the queries are presented for elements of high demand at the input level versus underload is the scoring of the frequency of incoming signals according to where the worker's driving predominantly takes place—within a city signifies rapid incoming signal speed (high demand), whereas driving mainly on long, intercity routes represents a low frequency of incoming signals (underload). Heterogeneous signals (high demand) are encountered when a person drives on various routes, while, when driving takes place on the same route day after day, relatively homogeneous signals are experienced (underload).

The range of possible scores can also be narrowed within an occupational-specific OSI. For example, there is some variation in the degree to which professional drivers perform hazardous tasks (eg, carrying explosive cargo, driving on winding narrow roads, or driving in areas in which the threat of violence is high). However, even without these extra dangers, there is a certain amount of underlying hazard inherent in driving itself. Therefore, the possible range for threat avoidance on the task performance level is from 1 to 2 in the occupational-specific OSI for professional drivers.

Theory-guided observational approaches such as the RHIA/VERA instrument (9, 10) can be particularly useful for identifying objective measures of, for example, workload, hindrances, and the like, that best coincide with the elements of an occupational-specific OSI for a given occupation.

Available occupational-specific instruments. Thus far, we have fully tested specific OSI instruments for physicians, teachers, professional drivers, and those who work daily with computers. In addition, occupational stress indices for nurses and control panel workers are being tested, and, in development, are occupational-specific OSI for factory workers, airline pilots, and scientific researchers.

Salient empirical findings from occupational stress indices

Professional drivers

Professional drivers are at very high risk of hypertension, CVD, and cerebrovascular disease; the relation of this risk to their occupational activity is well recognized (14–16). However, the generic work-stressor models have not succeeded in explaining this relationship. With generic instruments, professional driving is not consistently classified as an occupation with high job strain (14, 17). In contrast to nonsignificant results obtained for the demand and control dimensions with a questionnaire based on the job strain model, the OSI scores for total high demand were nearly three times greater for professional drivers [16.1 (SD 2.1)] than for referents with a similar socioeconomic status [6.4 (SD 3.8)] ($P<0.001$) (18). Moreover, professional drivers in Belgrade and Stockholm had approximately twice the mean total OSI scores [67.2 (SD 4.3) and 63.6 (SD 4.0), respectively] of heterogeneous groups of workers with a similar socioeconomic status [33.0 (SD 7.9) and 34.8 (SD 6.1), respectively] ($P<0.001$) (11, 18, 19).

The detection of within-occupation effects, which is often problematic with, for example, the job strain model (1), is also achieved with OSI. For example, the mean total demand levels of various driver subgroups are clearly distinguishable [city bus drivers [21.0 (SD 2.0) versus truck drivers 17.2 (SD 2.1), P<0.001], and the nature of these demands can be delineated for each subgroup (11, 19). In a multivariate analysis, the total OSI scores were significantly associated with smoking intensity. This finding further indicated the within-occupation criterion validity of the occupational-specific OSI for professional drivers (20). Pressure to stay on schedule and long workhours were identified through OSI as key modifiable stressors within this occupational group, associated respectively with professional drivers having hypertension and ischemic heart disease (18).

Physicians

The occupational-specific OSI for physicians was created and tested among our colleagues from various clinical specialties, as "by-physicians-for-physicians" (7, 21) within the framework of a "participatory action research" approach (22). The initial results showed good reliability and face validity (7, 21, 23). The mean total OSI scores were very high for physicians [78.1 (SD 11.9)] (23), over twice as high as that of the worker-based groups of men in the building trades (11, 19), of subway guards (18), or of a population-based sample of working women (24). The mean total demand levels were about 1.5 times greater for physicians than for professional drivers.

The occupational-specific OSI for physicians has been applied in a case–control study design among 208 physicians employed at clinical institutions in Novi Sad (23). The cases were comprised of physicians with one or more of the so-called acquired (potentially stress-related) CVD (myocardial infarction, angina pectoris, arterial hypertension, certain arrhythmias) (25). The referents included physicians without manifest acquired CVD. The total OSI score was significantly higher for the cases than for the controls, and two dimensions, high demands and threat avoidance, were dominant in showing higher exposure among the cases. The most consistent and significant stressors that distinguished physicians with acquired CVD from referents were long workhours, speed-up, and threat of job loss. It was concluded that physicians are a heavily burdened occupational group, and several occupational stressors are significantly associated with case status. Improvements in work conditions, coupled with early diagnosis, are essential for preventing further increases in these disorders among physicians. The need for multidisciplinary intervention studies aimed at the work environment was underscored, with the goal of determining the scientifically based strategies that will be the most effective in preventing acquired CVD among physicians (23, 26).

Another study (27) examined the relationship between work stressors using OSI and lifestyle-related risk factors for cancer and heart disease (smoking, obesity, sedentariness, and alcohol consumption) among 112 female physicians in Novi Sad, a region in which the prevalence of lifestyle-related risk factors for cancer and heart disease is very high. The total OSI score and several aspects of occupational stress, particularly threat avoidance alone or in combination, showed significant multivariate associations with the lifestyle-related risk factors for cancer and heart disease, as did individual elements of OSI. The latter included long workhours, restricted problem-solving strategies, insufficient help with clinical difficulties, supervisory responsibility (obesity or sedentariness), and problems hampering patient care (smoking). It was concluded that there is an urgent need to lower the lifestyle-related risk factors for cancer and heart disease among female physicians in this high-risk region and that diminishing the work-stressor burden should be considered when intervention strategies aimed at these risk factors are developed (27).

The occupational-specific OSI for physicians has been applied in a wide range of surgical and nonsurgical clinical specialties, as well as in several diagnostic and preventive branches. It captures both the within- and between-group variation in work conditions. Thus the occupational-specific OSI for physicians is helpful in formulating and implementing strategies to ameliorate work stressors for these various branches of medical practice. Studies along these lines are on-going.

Clinical utility of the occupational stress index

The OSI instrument for physicians has been a bridge that helps physicians incorporate the workplace into diagnostic and management strategies. The OSI can serve as a hands-on tool for taking an occupational history, especially for clinicians, who have heretofore been relatively isolated from the rapidly growing field of occupational psychosocial research. Physicians are clearly in a pivotal position with respect to the work environment and health outcomes. Namely, they are often called upon to make decisions about fitness for work and can potentially have an impact on patients' work conditions by making informed recommendations. At the same time, physicians increasingly face an infringement of decision-making latitude and increased demands, especially within the context of managed care. The underlying burden of the work of physicians is heavy. Documenting and quantifying this burden is important for many reasons. We are

engaged in efforts to improve the work conditions of our own profession using OSI as an empowerment tool. Moreover, OSI has helped to translate this process for physicians so that they have better insight into the work conditions of their patients.

Return to healthy work for patients with cancer, hypertension, heart disease or neuropsychiatric disorders—efforts aided by the occupational stress index

Return to work is recognized as an important component of the quality of life among patients with illnesses such as cancer and heart disease, as well as neuropsychiatric disorders. It not only helps maintain economic stability, but often also emotional stability. Unfortunately, little systematic attention has been paid to the type of work environment to which the patient is returning (ie, a healthy job or one that adds yet another major burden to the patient's already heavy load of stressors). Still, thus far, the effect of modified work upon return to work has been only limitedly examined, and what work has been done has mainly focused upon musculoskeletal disorders (28, 29). With regard to CVD, most of the clinical guidelines relevant to the interface between the workplace and the patient's cardiovascular system continue to be focused upon levels of physical exertion (1). There are a few published anecdotes of good return-to-work outcomes among patients with cancer in association with modified work (30).

Within the clinical setting, OSI is suitable for obtaining information about the work environment and identifying potentially modifiable stressors. A comprehensive evaluation of the work environment, viewed together with clinical status, can help avoid the pitfall of oversheltering patients by preventing them from performing challenging, but not untowardly taxing tasks. That is, to guard not only against job overload, but also against underload, which further reinforces the debilitating view that the diagnosis of cancer or other major illness has irretrievably changed one's role in vital aspects of life, such as the workplace.

The strategy calls for the following actions: (i) the application of OSI in identifying work stressors and quantifying the overall burden, (ii) the determination of which of these are readily modifiable, (iii) the planning of return to work together with the patient and, if possible, the workplace supervisor, (iv) the implementation of the proposed modifications to lower the burden, and (v) the evaluation of the clinical outcome, a key diagnostic modality being ambulatory monitoring of physiological parameters during work, together with feedback from the patient.

Initial experience with individual patients, within the clinical setting of burnout, depression, CVD, and cancer is that this strategy, which uses OSI, is effective in helping to identify and ameliorate occupational stressors during the process of return to work (7, 19, 31).

Pedagogical cases: initial step for implementation

In order to facilitate the implementation of this strategy in actual practice, we formulated a special pedagogical approach. The initial step is to design a series of teaching cases appropriate for a given specialty. These cases are based upon clinical experience, although they do not correspond to any single patient. In the book by Belkić(7), the following four such cases are presented within the realm of cardiology: (i) a physician with paroxysmal supraventricular tachycardia and postarrhythmic ST depression triggered by hypoperfusion, (ii) a truck driver with electrocardiographic and hemodynamic abnormalities indicative of occult (hidden) workplace hypertension with signs suggesting transient myocardial ischemia together with possible cardiac electrical instability, (iii) an administrative clerical worker who works daily with computers and has syndrome X and the cardiovascular metabolic syndrome, and (iv) an automobile assembler who has suffered an acute inferior myocardial infarction.

The clinician reader is then guided as to how the insights gained from the use of OSI can inform various diagnostic and management scenarios, using the outlined strategy.

Within the area of oncology, the first teaching case was an oncologist with breast cancer. Using OSI, we targeted modifiable and potentially clinically important work stressors or exposures (eg, night shift work, long workhours, insufficient rest breaks, responsibility for patients with terminal-stage cancer). The stressors or exposures were distinguished from work activity that can, and usually should be continued (eg, most routine patient care, teaching, and diagnostic procedures) and can bolster a sense of competence and provide task alternation. Continuing these activities helps avoid underload and feelings that work capacity is compromised. We also presented the pros and cons of the "gray" modifiable areas (eg, care of patients with breast cancer, emergency room work, in-patient versus outpatient load and work schedule). In this respect, decisions can be informed by ambulatory monitoring, other clinical markers, and individual preference, on a case-by-case basis. This was also one of the pedagogical cases recently presented within a continuing medical education program in which comorbidity issues were highlighted (International Conference on Occupational Health, Varese, Italy) (31). After the physicians have studied such cases, in which the work conditions are entirely familiar (ie, from their own profession), pedagogical cases using the occupational-specific OSI for other occupations are presented.

We have also developed a series of teaching cases using the index for the domain of neuropsychiatry, the

specialty of the second author of this paper. These cases are based upon his clinical experience and include (i) a neuropsychiatric specialist with burnout and depression, (ii) a teacher with panic attacks and migraine headaches, (iii) a professional driver with posttraumatic stress disorder after a severe accident, (iv) a computer programmer with epilepsy and agoraphobia, and (v) a scientific researcher with bipolar (manic–depressive) disorder.

In each of these teaching cases, work stressors that were readily modifiable on an individual level were targeted. For the physician, for example, with these measures, the most striking decrease was in the high demand dimension, in which the overall workload was lowered by decreasing the amount of in-patient and emergency work and by lowering exposure by limiting workhours, ensuring rest breaks, and eliminating night calls. These changes are coherent with the patient's own suggestions. In addition, the strictness burden was substantially ameliorated by an increased possibility to take time off when needed and by some increased influence on the work schedule. It was also possible to lower the threat avoidance–symbolic aversiveness load by limiting work with the most acutely psychotic patients. Conflicts due to interruptions and simultaneous demands on attention were lowered in part by improving the patient's coping capacities (learning how to make stronger limits rather than always being accessible). Thus, together with the patient, and with the use of OSI, a realistic plan can be drawn up to preserve work capacity by making workplace changes. Thereby, the total burden of occupational stressors was lowered [total OSI score from 93 to 76.75 (ie, a reduction of 17.5%)]. These cases are part of a book, soon to be published, in which a proactive clinical approach for neuropsychiatry is presented, aimed at a healthier work environment for patients suffering from psychiatric disorders or neurological disease.

Occupational sentinel health events and work stressors—identification via the occupational stress index

OSI is not only used to identify work stressors that are readily ameliorated on an individual level, but also those stressors that would require intervention at the organizational level. In the case of the OSI for physicians that has already been described, some of the measures included the need for financial resources allocated to diagnostic equipment, patient care and improved salaries, relief of heavy patient loads by having backup staff available, hiring more physicians, and the like.

Systematic investigation at the patient's workplace revealed several other clinicians with depression and burnout, albeit of a milder degree. This occurrence is suggestive of sentinel health events related to exposure to an inordinately stressful work environment among this group of physicians. The need to incorporate the concept of occupational sentinel health events into the realm of stress-related disorders such as CVD has been underscored earlier (32).

The mean total OSI scores were 77.3 (SD 11.8, range 46.8–103.3) for female physicians in our empirical study (27) from the same region, such that some were even higher than those of the presented case. As noted, the prevalence of lifestyle-related risk factors was also high (27) and these, together with cases of acquired CVD, showed a multivariate association with work stressors when assessed by OSI (23, 26, 27). In both of these studies, it was concluded that there was an urgent need for intervention studies that identify the most effective strategies (with the aid of OSI) for lowering the risk of the work-stressor burden in relation to the health status of physicians.

Outlooks—clinical intervention studies within a larger public health framework

Intervention studies can provide a key link in etiologic research and also suggest new modalities with which to improve patient care and well-being. In that light, the long-term goal is to formulate and implement randomized clinical trials, whenever possible, to examine the impact of ameliorating exposure to job stressors upon patients with cancer, heart disease, and neuropsychiatric disorders who are returning to work, as well as upon markers and behaviors of importance in disease progression, and upon risk per se. These trials would be used to develop evidence-based return-to-work guidelines for specific clinical situations within various clinical settings.

A database of qualitative experience is first necessary to provide information for the design of clinical trials. In other words, we need to know what has worked in individual cases in order to effectively choose the interventions that have the best chance for success. Thus a key step towards the long-term goal is a proactive approach, whereby clinicians, together with their patients, formulate tailored, realistic modifications in the work environment (33). The active participation of allied health professionals, particularly social workers and occupational therapists, will also be indispensable. Our experience suggests that OSI provides a valuable tool for this entire process.

Successful initiatives for improving the worklife of individual patients can provide information for wider efforts, in collaboration with other key participants (industrial hygienists, epidemiologists, labor and management) to create a healthy work environment in a broader public health perspective. This approach, outlined in figure 2, would offer a new dimension to the concept

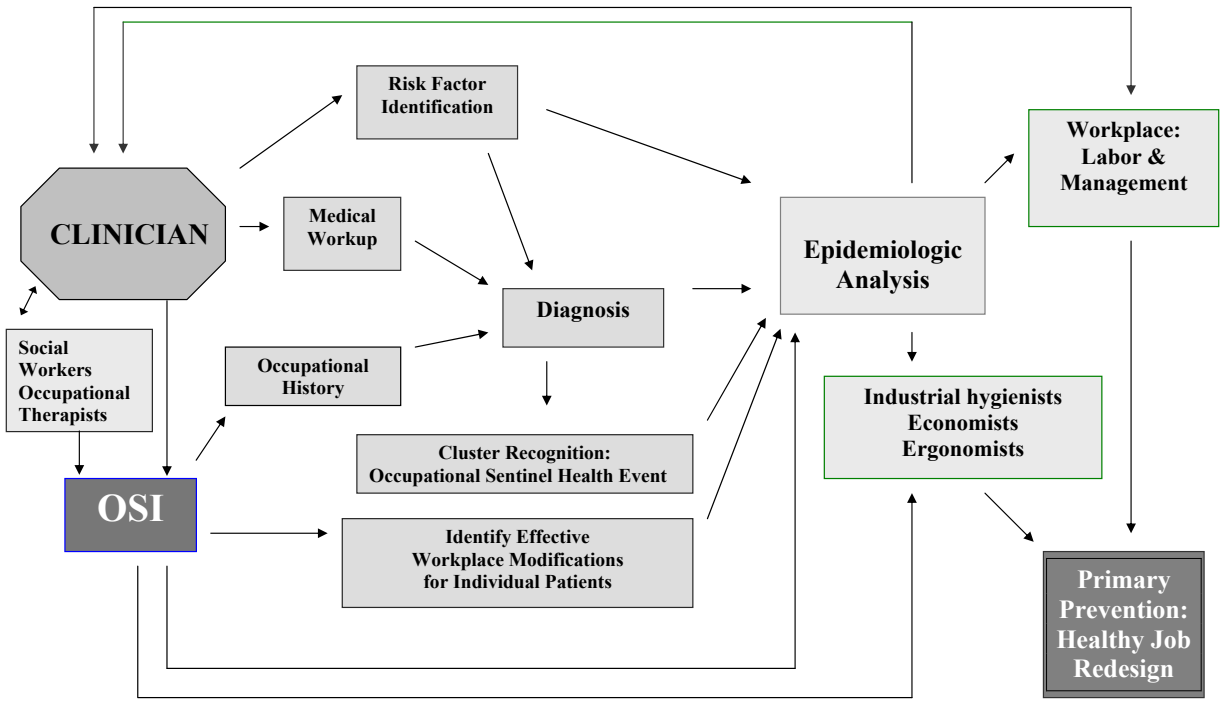

Figure 2. Role of the clinician and the occupational stress index (OSI) in the larger framework of creating healthy workplaces. [Adapted from "A Public Health Approach in Clinical Practice" by Fisher & Belkić (32)]

of occupational rehabilitation and healthy work and provide further impetus to its realization.

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