

The Role of Surveillance in the Hierarchy of Prevention

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Surveillance is the collection, analysis, and dissemination of results for the purpose of prevention. Surveillance tells us what our problems are, how big they are, where the solutions should be directed, how well (or poorly) our solutions have worked, and if, over time, there is improvement or deterioration. Surveillance is essential to successful sustained public health intervention for the purposes of prevention. Surveillance systems must be tailored to the specific disease or injury that is to be prevented. Surveillance should not be limited to the occurrence of death, disease, or disability. Public health is a multilevel cascade of activities involving recognition, evaluation, and intervention. Public health should include elements of experimentation as well as field implementation with evaluation. Surveillance is the mechanism to modify any element in the cascade based upon that element's contribution to prevention or lack thereof. Any element in the causal or intervention pathway is appropriate for surveillance as long as the monitoring of the element is useful in improving the prevention system. These elements include the occurrence of hazard and intervention as well as disease, death, or disability. Examples will be provided that demonstrate the roles of surveillance in the recognition of new diseases, the evaluation of the persistence of recognized problems, the estimation of the magnitude and trends of public health problems, and the provision of information to motivate intervention. © 1996 Wiley-Liss, Inc.*

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PRINCIPLES AND GOALS

The goal of this article is twofold. The first is to provide a framework for integrating basic concepts concerning prevention from three disciplines: public health, occupational health, and total quality management. The second is to demonstrate the relationship of surveillance to intervention.

The first principle is from public health. There are three levels of prevention: primary, secondary, and tertiary [Last, 1988]. Primary prevention involves prevention of disease before its initiation. Immunization is an example of primary

prevention, as is providing sound housing and sanitary facilities. Secondary prevention is the early detection of asymptomatic disease and prompt intervention when the disease is preventable or more easily treatable, such as in screening for cervical cancer. Tertiary prevention refers to measures to reduce long-term impairment and disability.

Occupational health, particularly industrial hygiene, provides the second principle, that of the hierarchy of controls. In the hierarchy of controls, the elimination of hazards through substitution is the most desirable option. Less desirable is the use of administrative or engineering controls. The least desirable alternative is the provision of personal protective devices, such as respirators and hearing protection [Cralley et al., 1978]. The concept of a hierarchy of controls can be extended to include the activities of toxicologists, occupational physicians, and others who are also intrinsic players in the prevention of occupational disease and injury. A continuum of measures that range from primary prevention to tertiary prevention, and also from toxic

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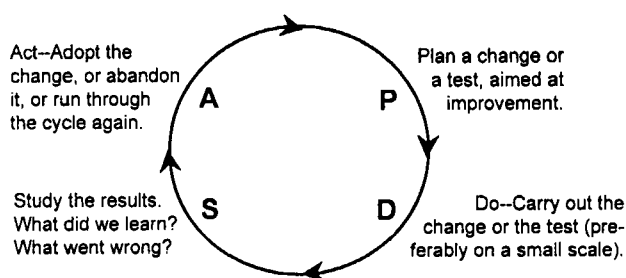


FIGURE 1. The Shewhart Cycle for learning and improvement: The PDSA cycle.

cology (i.e., testing of potential toxicants in laboratory animals), to clinical medicine (i.e., the care of workers exposed and suffering from occupational disease), is a fairly basic concept of occupational medicine [Schilling, 1973; Halperin et al., 1986]. In essence there is a continuum of prevention that incorporates two concepts: a hierarchy of controls and a continuum of preventive measures spanning diverse disciplines.

The third concept is that of surveillance. Surveillance in occupational health is defined as the systematic collection and analysis of information concerning hazards, disease or injury for the purpose of prevention of occupational disease or injury [Thacker and Berkelman, 1992]. Surveillance can be either rate based or case based. In case-based surveillance, the occurrence of a case, a Sentinel Health Event (SHE) [Rutstein, 1983], signals a failure of prevention. Investigation of cases leads to the recognition of the prevention failures and their amelioration. Rate-based surveillance is a parallel concept in which the rate of occurrence of an outcome is compared with an expected rate, and excesses are viewed as cause for investigation of the failure of prevention.

The concept of public health surveillance bears a strong resemblance to the "Shewhart Cycle for learning and improvement" which is a basic element of total quality management (TQM) (Fig. 1). TQM is an industrial philosophy thought essential to the rejuvenation of industry in Japan after the second world war. The Shewhart Cycle consists of four stages. *Plan*: a change or a test aimed at improvement. *Do*: carry out the change or the test (preferably on a small scale). *Study*: the results. What did we learn? What went wrong? *Act*: adopt the change, or abandon it, or run through the cycle again.

The concepts of public health surveillance, and the concept of the Shewart or Plan-Do-Study-Act Cycle (PDSA Cycle) involve the collection of information after an action and the use of that information in a feedback loop to change the circumstances that lead to the effect of interest. As applied to production in industry, *planning* and *doing* are related to the methods or organization of the means of production, while from a prevention point of view, *planning*

Hierarchy	Technique for Prevention
Primary	Premarket Testing
Primary	Substitution and Elimination
Primary	Engineering Controls
Primary	Environmental Monitoring
Primary	Personal Protective Devices
Primary	Biological Monitoring
Secondary	Preclinical Medical Examination
Tertiary	Diagnosis
Tertiary	Therapy
Tertiary	Rehabilitation

FIGURE 2. The continuum of prevention and the hierarchy of controls.

and *doing* refer to the use of some technique in the continuum of prevention.

These diverse concepts of the hierarchy of prevention, the continuum of prevention, and the PDSA Cycle can be brought together in the following way. First, the industrial hygiene concept of the hierarchy of prevention is expanded to include other techniques for the prevention of occupational disease and injury. These other techniques include environmental monitoring for the presence of a hazard, biological monitoring for evidence of the absorption of a toxicant or its metabolite, medical screening for the presence of an indicator of disease at a preclinical stage, medical diagnosis when disease becomes symptomatic, medical therapy, and rehabilitation (Fig. 2). This continuum is an oversimplification of the many more detailed levels of activities that more fully describe a complete and detailed continuum of prevention. The public health paradigm of primary, secondary, and tertiary prevention can easily be applied to the continuum of prevention (see Fig. 2).

Surveillance does not fit into the continuum of prevention. The reason is that surveillance itself, in contrast to all the other techniques in the continuum, is not an intervention, but rather a technique for collecting, analyzing, and using information about the intervention techniques. In essence, information about any particular intervention or effect can be used to modify any more proximal intervention or factor in the chain leading to the outcome or intervention under surveillance (Fig. 3).

There are two major implications of this conceptualization. First, by adding surveillance to the continuum of prevention, the continuum becomes dynamic. It is no longer a set of interventions, even if the interventions are in a hierarchy, but rather describes a dynamic system of interventions, where collection of information on any one level in the continuum can be used to modify any one or more

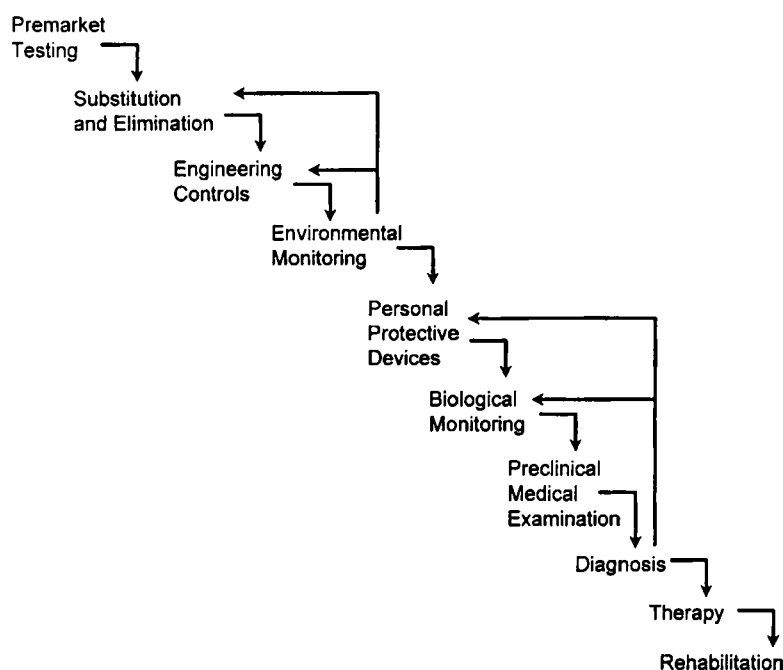


FIGURE 3. The continuum of prevention and surveillance: The cascade of prevention, with examples of surveillance.

proximal levels. Second, since the surveillance feedback loop can be used at any level of the continuum, it should be apparent that surveillance need not be limited to adverse outcomes. Rather, the techniques of surveillance can be applied to any intervention in the continuum of prevention. A cascade of prevention better describes the dynamic relationship between the continuum of techniques for prevention and the use of surveillance as a dynamic feedback mechanism that can be used to alter which techniques for prevention are implemented, and at what level.

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