Health Risk Appraisal

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With degrees in philosophy and math, a concomitant mania for detail, and a willingness to question anything, Geoff builds and uses tools in many disciplines. A co-founder and the Chief Science Officer of Eris Survey Systems, he and his partners designed a software toolbox for implementing Health Risk Appraisals. In 1987, he used an early version of the toolbox to create the Carter Center's Healthier People Health Risk Appraisal. A member of the Society of Prospective Medicine's Board of Directors, Geoff has spent the last 13 years shepherding the creation of several dozen different HRAs, other health assessments, and related instruments for a wide array of clients in the public, private, and corporate sectors. In his dotage, he plans to manufacture sawdust.

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Introduction

As originally conceived, health risk appraisal (HRA) is a technique for estimating the odds that a person with certain characteristics will die from selected causes within a given time span. The concept of HRA was developed by Lewis C. Robbins, MD, as a health education tool. HRA provides physicians with a compelling tool to help communicate disease prevention information to their patients. In 1970, Dr. Robbins and Jack Hall, MD, published the first book on HRA, *How to Practice Prospective Medicine*. It directed private physicians in the application, calculation, and interpretation of a complete HRA.[1] Now, nearly 30 years later, HRA continues to evolve rapidly, and is an increasingly frequent component of health promotion programs in a variety of settings, such as worksites, clinics, and hospitals. The number and types of appraisals available also have increased dramatically. In 1981, 12 HRA instruments were generally available.[2] Now there are over 50 vendors, many of whom offer more than one appraisal.

Dr. Robbins' keen insight that quantifying the relationship between current risk factors and their future outcome would be a useful tool has now spawned a broad range of health assessments. Thus, instead of just HRAs, this *Handbook* now includes instruments that quantify many aspects of an individual's health. This chapter will use the term "HRA" to refer to an instrument that measures the impact of a broad spectrum of risk factors on a broad spectrum of health outcomes. Other chapters in this section of the *Handbook* discuss instruments that narrow the spectrum to specific risk factors (lifestyles, behaviors) or to specific outcomes (conditions, diseases).

HRA Variations

Traditional HRAs estimate the probability of death, or mortality. There is also widespread interest in using the techniques of HRA to estimate the likelihood of morbidity, or the presence of disease. Additionally, some vendors describe their instruments as HRAs even though they don't calculate odds or probability of mortality or morbidity. Such instruments may use a simplified scale or a stratification of risk level. While this chapter focuses on instruments that calculate mortality-based risks, many of the considerations also apply to other HRAs. For more information, see the discussion later in this chapter entitled *Mortality and Morbidity*.

Thus the HRA field has become increasingly complex and sometimes confusing. The goal of this chapter is to provide the potential user with enough background about HRA to make informed choices from the plethora of available instruments and vendors. Persons seeking more detailed knowledge about the scientific or technical aspects of HRA are encouraged to become involved with the Society of Prospective Medicine.

Potential Benefits of HRA

HRA is widely used for a variety of reasons, including the following:

1. It is relatively inexpensive and easy to use.
2. It is popular with clients and employees and may increase participation in health promotion programs.
3. It provides a systematic approach to organizing preventive health information and tends to emphasize modifiable risk factors.
4. It provides group data which summarizes major health problems and risk factors.

5. It may, particularly when integrated into a broader health promotion program, increase motivation to make positive behavior changes.

Limitations of the HRA

As popular as the HRA is, it has a number of limitations that the consumer should understand. The HRA does not diagnose disease. It does not provide a complete medical history, nor is it a substitute for a medical exam. Despite common misperceptions, the HRA is not a predictor of an *individual's* medical future, chances of death, or most likely cause of death. Rather, it is a description of the odds or likelihood of death occurring in a group of people with certain characteristics. It is not an assessment of social or environmental risk factors, and most certainly, it is not a health promotion program in itself.

For Whom is the HRA Appropriate?

Health risk appraisal is usually intended to be used with persons who are free from chronic illnesses such as cancer or heart disease, since the risk calculations will probably be incorrect for persons with such conditions. HRA has been used most widely with middle-class, middle-aged, white populations.[3] This use reflects the limitations of the databases used for most of the calculations, i.e., most of the studies on which the HRA is founded have been studies of middle-class white populations. Thus, it is appropriate to use caution when applying standard, adult HRAs to certain age groups, such as the young or elderly, to persons from lower socio-economic status groups, or to non-white populations. While HRAs are sometimes available in languages other than English, such HRAs are commonly merely translations of an English HRA, and may not adjust the risk calculations to the epidemiology of other cultures.

How Does the HRA Work?

The three basic building blocks for any HRA are: 1) the questionnaire, 2) the risk calculation, and 3) the educational messages or reports. Although the majority of HRAs are computerized, there are self-scored HRAs in which calculations are done by hand by either the participant or a health professional. This section will focus primarily on computerized HRAs which produce mortality-based risk estimates.

Most HRA questionnaires ask about lifestyle factors, limited personal or family health history, other risk factors, demographics, and, sometimes, attitudes and knowledge. Virtually all HRAs require some physiological data such as blood pressure, height, weight, or cholesterol levels. In some cases these data are self-reported; in other cases they are provided by a health professional. Other items included in many appraisals, such as stress scales, fitness assessments, or food intake measures, typically are used to provide qualitative information about risk reduction and are rarely used in the calculation of risk estimates.

Risk Calculation

Understanding the risk calculation process requires understanding some technical terms. *Precursors* are behaviors (such as smoking), clinical measures (such as cholesterol), or historical factors (such as a family history of breast cancer), which are known to be quantitatively related to one or more *outcomes*. The outcomes in a mortality-based HRA are causes of death; when calculating morbidity, the outcomes are diseases or conditions. The relationship between a precursor and an outcome can be calculated in many ways, but the most common is *relative risk*.

Relative risk shows the increase or decrease in risk relative to the population average. The population average risk is taken from US age- and sex-based mortality tables. If we consider population average risk to have a relative risk of 1.0, then other relative risks can be greater or less than 1.0. Table 1 is an example from the widely-used Carter Center mortality calculations.

Table 1. Relative Risks of Dying of Lung Cancer for Males under 25

	Relative risk compared to:	
	Population average	Baseline
Non-smoker	0.14	0.00
Population Average	1.00	7.14
1-9 cigarettes/day	1.02	7.28
10-19 cigarettes/day	1.23	8.81
20-39 cigarettes/day	2.10	15.03
40+ cigarettes/day	2.18	15.55

Multiplying the individual's relative risk by the population average risk yields the probability of dying of lung cancer in the next ten years. After similar calculations have been made for all precursors and all outcomes, the probabilities can be totaled to yield the total risk of dying in the next ten years, which is called *appraised risk*. It is important to remember that the appraised risk applies to the group of all individuals who share the same precursors, but should not be construed as the individual's risk of dying.

When a cause of death has multiple precursors, or when the research reveals a better method, an alternative to relative risk may be used to perform the calculation. For example, in the area of cardiovascular disease, many HRAs use logistic regression equations based on the Framingham Heart study to calculate risk. In other causes of death, such as AIDS, where it may be difficult to acquire accurate risk factor data from the respondent, or where the current level of research is not sufficient to reliably quantify the relative risk, it is common to simply use the population average death rate.

A primary goal of the HRA is to encourage the modification of unhealthy behaviors. To calculate the negative impact of each unhealthy behavior, the risks are calculated a second time based on the assumption that the individual has changed every unhealthy behavior to a target level. For example, smokers can quit, and hypertensives can bring their blood pressure below 138/88. *Achievable risk* is calculated by modifying all precursors to their target levels.

Earlier in this chapter, it was noted that other health assessments focus on a narrower spectrum of risk. Now we have seen that HRA risk calculations measure the relationship between precursors and outcomes. Combining these two concepts reveals that a disease-specific health assessment sums the contribution of all precursors for a specific outcome, while a lifestyle instrument sums the contribution to all outcomes of a specific precursor.

Mortality & Morbidity

Every individual who dies in this country is assigned a primary cause of death which is recorded on their death certificate. That allows the US to provide an authoritative starting point for research into mortality in two ways. First, the clinical definition of mortality by a particular cause has widespread agreement. Second, the US Mortality Table offers a comprehensive and reliable normative reference. Thus, mortality offers a well-defined and accessible starting point for measuring risks. Morbidity, in contrast, has a less clear definition of each outcome (disease or condition) and enjoys fewer universal reporting requirements than mortality, so it is much more challenging to produce a broad-spectrum HRA based on morbidity.

Excellent progress is being made, however, for morbidity calculations for the most important precursors and outcomes. For example, many HRAs make use of the morbidity equations for cardiovascular disease developed by the Framingham Heart Study.[4] Many of the cancers have promising morbidity calculations available.

In this era of managed care, health care providers have become interested in expanding the HRA from its primary use as a health education tool to a new use as a tool to facilitate their ability to estimate the cost of providing health care to individuals and populations. Since health care costs are much lower after dying than they are after getting sick, HRAs which estimate morbidity offer health care providers an expanded ability to project costs.

Output

A wide range of data transformations and other information contribute to the production of the final HRA output. While the types of reports and the packaging of those reports vary tremendously, virtually all HRAs include a report(s) for the individual participant, and a report(s) that summarizes groups of participants. There are some elements that are common to the individual participant reports of most HRAs. These include:

Appraised Score: Almost all HRAs include an overall health assessment score that derives in some manner from the appraised risk in the risk calculations. Risk age or health age is the most common overall score. Other options include a numerical score or a stratification. These scores are described in more detail in the next section of this chapter. Regardless of the score being used, the appraised score (or health age) is based upon the participant's current health status as reported on the questionnaire.

Recommended changes: Based on the preventive health protocols of the survey designer, the HRA will suggest changes that the participant could make in specific health behaviors or in the use of preventive services (i.e., precursors) that would result in the

reduction of risk. These target levels are used in the calculations of achievable risk. Often, these recommended changes are accompanied in the report by an indication of their relative contribution to the individual's appraised score. For example, if risk age is used for the appraised score, the risk attributable to each precursor might be reported as the number of "risk-years" that could be gained by modifying that precursor to its target level.

Target Score: The same overall scoring mechanism that was used for reporting the appraised score is usually then applied to the behavior profile that would result if the participant is successful in making all of the recommended changes. If the participant's questionnaire showed compliance with all of the targets of the HRA, then there would be no recommended changes, and the target score would be the same as the appraised score.

Summary of high-risk outcomes: Whether the HRA is mortality-based or morbidity-based, it usually includes a recitation of the causes of death or disease conditions for which the individual is at greatest risk, together with a description of which changes would reduce those risks.

Qualitative information: The risk calculations tell only part of the story, and the HRA will usually augment the information that is based upon the risk calculations with additional information and recommendations. To an ever-increasing extent, the tools of the psychologist are supplementing the tools of the epidemiologist in the creation of HRA reports. Many HRAs make extensive use of concepts such as stages of change, outcome expectancy, and confidence in self-efficacy.

Health Age and other scoring methods

Risk calculations yield a probability (a decimal number between 0 and 1) as their result. Mortality calculations generate the probability of dying, so 0 = eternal; 1 = dead. While these two endpoints are relatively well understood by most of the population, the points in-between usually generate confusion, boredom, and angst, none of which are frames of mind effective for learning. Thus, HRAs need a more accessible method of expressing the probabilities. Here are descriptions of some of the more common scoring methods, described using the terms that were explained in the earlier section of this chapter titled *Risk Calculation*.

Health age or risk age: Health age is the age of the average man or woman who has the same total appraised risk as the HRA respondent. To arrive at health age, the respondent's appraised risk is compared to the population average risk for the same age and sex. If the appraised risk equals the population average, then health age will be the same as chronological age. Higher appraised risk yields an older health age, lower appraised risk yields a younger age.

Achievable health age is derived by comparing achievable risk to the population average. The difference between the appraised health age and the achievable health age represents the gain that is possible for the HRA respondent. Often, the HRA report will apportion these "risk years gainable" among the precursors for which changes are recommended.

Wellness Scores: Various methods have been used to convert the results of the risk calculations into a numerical score. Such scores often use a range of 1 to 100, with 100 representing the best possible score. The simplest such score, which we'll call the modifiability ratio, was used in some reports generated by the Carter Center HRA and its descendents. The modifiability ratio is simply the ratio between achievable risk and appraised risk, multiplied by 100:

Modifiability ratio =100 x achievable risk/appraised risk

Note that when all of the recommended changes are made (or the respondent is already perfect), that the appraised risk will equal the achievable risk, and the modifiability ratio is 100.

More sophisticated wellness scores can improve on the modifiability ratio in two ways. First, a better distribution of values can be achieved by using a more complex statistical ranking than the simple ratio. Second, by comparing the values, however achieved, to a normative database, the score can provide a more meaningful ranking of the individual. One example of such a score, the Good Habits Index, positions the individual on a spectrum from worst to best, then compares that value to a national database of HRA respondents.

Non-probability based scores: Some HRAs use scores that assign a value to each precursor or behavior, and then add up the values to create a weighted scale. Such a scale can either add points for good precursor values or subtract points for bad precursor values. In any case,

such a scale relies heavily on the clinical judgment of its creator, and can be designed to reflect any set of health philosophies or beliefs. Regardless of the methodology used to create such a scale, comparison to a normative database will almost always make the scale more useful.

Appropriate Use of the HRA

Ethical use of the HRA encompasses several principles: confidentiality, voluntary participation, appropriateness for the population, and quality assurance. Since 1981, the Society of Prospective Medicine has published guidelines for appropriate use of the HRA in a health promotion program. These can be found in the chapter "Ethics Guidelines for the Development and Use of Health Assessments."

Questions for Wise Consumers

The most important questions to be answered by the potential HRA user concern the target audience. Sufficient information should be obtained from the vendor or source to allow the potential user to answer such questions as "Is the HRA appropriate for this population in terms of its scientific base, types of risks included, reading level, comprehension level, and type of report?"

Using the directory in this handbook will allow consumers to compare and contrast the features and costs of various HRAs. In addition to the basic questions of appropriateness for the audience, Jonathan Fielding outlined a series of questions to assist consumers in selecting a quality HRA program:[5]

1. Where do the databases and risk calculation equations come from?
2. Does the feedback focus primarily on modifiable risks?
3. What quality control mechanisms are in place to protect against errors in entering information, printing out implausible results, and delivering a health profile to the wrong recipient?
4. What are the safeguards for privacy and confidentiality?
5. How clear are the instructions and the feedback information for individuals from a variety of educational backgrounds?
6. What is the background of the individual responsible for the database? How often is a full review of database, computational programs, and feedback content and format performed?
7. Does the feedback form contain caveats to minimize misinterpretation of the information?

References

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