# Nurses' Fear of Contagion:

## A Functional-measurement Analysis

CHRISTINE S. RUNDALL, RN, MA, DAVID J. WEISS, PhD

The amounts of fear of contagion aroused in nurses by 15 unnamed diseases were examined. The diseases were chosen to allow factorial arrangement according to their degrees of transmissibility and the severities of their prognoses. Concern about contagion was hypothesized to increase as transmissibility increased and as prognosis worsened, in accord with a multiplicative model. The model was tested with functional measurement procedures, because this method allows simultaneous evaluation of the descriptive accuracy of the proposed model and validation of the rating scale. The model was supported graphically and statistically. Nurses' worries were found to have the regularity prescribed by a multiplicative process. Although one of the diseases was constructed to simulate the characteristics of AIDS, no magnification of fear was found in relation to other deadly and infectious diseases. *Key words*: fear of contagion; functional measurement; multiplicative model; nurses.
**(Med Decis Making 1994;14:40–45)**

Fear of infectious diseases is an ancient phenomenon. In this century, the flu epidemic of 1912 brought about widespread concern. Health care workers might be expected to have accentuated concerns because their work would necessarily expose them to infection. Polio epidemics during the 1930s and 1940s troubled nurses until a vaccine appeared.[1] Currently AIDS generates great anxiety, perhaps because it is a prominent, fatal, epidemic disease with no vaccine or cure available. In particular, some nurses have stated they would not treat AIDS patients.[2,3]

Other diseases that are usually not fatal may also generate fear of contagion. One might expect increasing severity and degree of infectiousness to produce more intense apprehension. The judgmental process underlying this reaction has not been explored. The present study examines fears of contracting a range of infectious diseases from patients.

In choosing to study attitudes toward hypothetical patients rather than to observe behavior with real patients, the researcher hoped to be able to evaluate responses to a wide range of diseases in a short time period. However, the validity of an expressed attitude cannot be presumed.

One approach to validation is to examine the correspondence between attitude and action. Not only does this entail enormous practical difficulties when a range of diseases is studied, but lack of correspondence does not necessarily imply invalid assessment of attitude. The constraints governing a written response in a laboratory setting and a face-to-face interaction with a patient are quite different. In addition, behavior toward patients is governed by administrative and professional pressures. One might argue, then, that the laboratory measure, which allows greater freedom of expression, yields better insight about the nurse's reaction to the disease.

The other approach to validation operates entirely within the attitudinal system. Valid responses must exhibit consistency; the pattern observed in a set of responses provides the leverage to validate the individual members. This philosophy underlies the functional measurement analysis[4] employed here.

In contrast to studies that ask series of questions and rely upon experimental constraints to induce valid responses, the functional-measurement approach regards validity as a testable issue. Significance statements rather than large samples lend credence to the results. Cogent expression of the value of this methodology in a health context has been given by Froberg and Kane.[5,6]

The heart of a functional-measurement analysis is the cognitive model, an algebraic statement of the integration process proposed to govern a judgmental response. Cognitive determinants play a fundamental role in emotion.[7] The goal of the analysis is to use the set of judgments to make inferences about the subjective counterparts of the stimuli and the ways in which these values are combined.

The specific model proposed here is a multiplicative model. In previous functional-measurement studies, such models have been used to describe judgments in a wide range of contexts. For example, in the psy-

Received September 29, 1992. Revision accepted for publication May 4, 1993. This report is based on a thesis submitted by the first author, supervised by the second, to the Department of Psychology, California State University, Los Angeles, in partial fulfillment of the requirements for the MA degree.

Address correspondence and reprint requests to Prof. Weiss, Department of Psychology, California State University, Los Angeles, CA 90032.

chophysical domain, subjective area was proposed to be the product of subjective length times subjective width.[8] An experimental analysis of phobias found fear of snakes to be the product of how similar the test stimulus was to a real snake and the likelihood of exposure of the subject to it.[9] Correspondingly, in the present study the proposal is that fear of contagion is the product of subjective transmissibility (how likely am I to catch the disease) and prognosis (how badly will I be affected if I catch the disease).

The multiplicative model makes a dramatically different prediction from an additive model, which would have the two elements operate independently. In an additive process, each component separately contributes its value to a cognitive sum. Thus, a large response can result if *either* component has a large subjective value.

The intuition behind a multiplicative formulation is that *both* aspects must have high values to generate a large response. In the present situation, no matter how terrifying the prognosis, if the perceived likelihood of catching the disease is low then there is likely to be little worry. Similarly, if the disease is perceived as harmless, then no matter how easily it is transmitted, little fear is likely to be aroused. A test of the model will be available if we present as stimuli a set of diseases chosen to vary systematically in these two respects.

Stated formally, the multiplicative model is:

$$F(i, j) = T(i)P(j) + C(0) \tag{1}$$

In this cognitive equation, $F(i, j)$ is the subjective fear response to the disease stimulus generated by combining the $i$th row and the $j$th column of a factorial design. $T(i)$ is the subjective value inspired by the $i$th level of transmissibility, and $P(j)$ is the subjective value corresponding to the $j$th level of prognosis. $C(0)$ is merely a constant that allows an arbitrary zero point for the interval scale.

If the proposed model is correct, then the responses should follow a multiplicative pattern. This pattern may be evaluated in two complementary ways.* The graphic requirement is that the data plot as a linear fan, and the statistical requirement is that a significance test of bilinearity be satisfied.[4]

Whether the data will be consistent with a proposed model is an empirical question. Confirmation of the model provides three major benefits.[10] First, the proposed view of the integration process has been verified. Second, marginal means for each factor provide interval scale representation of corresponding subjective values. Third, the response instrument has been shown to be a linear scale. The justification for this claim is that if overt responses are not a linear function of the corresponding internal judgments, then the model will not appear to be supported even if it is true at the internal level.

Algebraic models have also been tested within another research tradition. Adherents of conjoint measurement prefer to rely upon ordinal judgments rather than ratings, using scale-free tests to evaluate the proposed model rather than analysis of variance.† In the health domain, a test of a multiplicative model of the judged utility of survival duration and health status[13] illustrates this methodology.

## Method

### SUBJECTS

The volunteer subjects were ten registered nurses who provided care to hospital inpatients. All nurses asked agreed to participate. Seven of the nurses, employed at a Los Angeles County hospital, were accessed through their enrollment in classes at California State University, Los Angeles. Three additional nurses were recruited from a private, nonprofit hospital, also located in Los Angeles. The nurses' levels of education ranged from two years of college to graduate school.

At the time of the study, each nurse worked in one of the following units: medical–surgical, critical care, recovery, emergency pediatrics, and AIDS specialty. A criterion for recruitment was their experience in providing care to patients with contagious diseases.

### DESIGN

The nurses were asked to rate 15 hypothetical patients for whom they would provide care. All patients were described as needing the basic nursing care customarily provided in an acute inpatient setting. While additional protective garb might be needed while car-

*Factorial construction of the stimuli allows two perspectives on the success of a model. The standard factorial plot affords a qualitative test. Mean response is graphed against the levels of one factor, with the other factor as the parameter of the graph. A multiplicative model implies a fan of lines diverging from a common origin at the subjective zero. An additive model, on the other hand, leads to a plot of parallel lines. The quantitative test employs analysis of variance. A multiplicative model predicts an interaction, localized in the linear-by-linear component, whereas an additive model predicts no interaction.

†The question of appropriate methodology for evaluating algebraic models has been the subject of some controversy. One issue is the argument that the response scale is validated by a successful model. It is true that an incorrect model and a nonlinear scale might combine in just the right way, so that the nonlinearities fortuitously canceled the model deficits. Such indeterminacy is discussed elsewhere.[11,12] Adherents of functional measurement view the coincidence as unlikely and a worthwhile risk in order to gain the analytic power of analysis of variance. The best way to validate a response instrument is through cross-task usage, and in this regard the graphic rating technique has been quite successful.[7]

**Table 1** • Factorial Structures of the (Unnamed) Diseases Used as Stimuli

| Transmissibility (Isolation) | Prognosis | | |
|---|---|---|---|
| | Excellent | Serious | Fatal |
| Not contagious (None) | Gallbladder surgery | Diabetes mellitus | Liver cancer |
| Minimal (Blood and body fluids) | Malaria vivax | Yellow fever | AIDS |
| Moderate (Respiratory) | Erythema infectiousum | Pulmonary tuberculosis | Pulmonary anthrax |
| High (Contact) | Rubella | Staphylococcal pneumonia | Rabies |
| Most (Strict) | Varicella | Lassa fever | Pneumonic plague |

ing for some patients, the essential tasks to be performed for the 15 patients were comparable.

Each patient had an unnamed actual disease. There were two experimental reasons prompting this decision. One issue was possible variation among the subjects in immunization history, knowledge about the disease and the individual's likelihood of encountering it, or emotional reaction to the name itself. The other concern was that the nurses would remember the labels and strive for consistency in their responses. This artificial consistency would violate the statistical requirement of independence. Of course, it was possible that a nurse might recognize (perhaps incorrectly) a disease from the description; the instructions emphasized the importance of basing the judgment solely on the information provided.

From a pragmatic perspective, omitting disease names does not make the task artificial for nurses. Not infrequently, care must be provided in situations in which the cause of a particular set of symptoms is not known.

Each disease was chosen so that it could be characterized by a particular combination of transmissibility and prognosis. Diseases fitting into the factorial structure were selected from *The Merck Manual of Diagnosis and Therapy*.[14] The 15 diseases constituted a 5 × 3 factorial design (table 1).

Five levels of transmissibility were designated. Assignment of disease to level was based on hospital infection-control isolation procedures. Noncontagious diseases comprised the first level of transmissibility; diseases requiring strict isolation comprised the fifth level of transmissibility. The isolation hierarchy was: 1) no isolation; 2) blood and body fluids; 3) respiratory; 4) contact; 5) strict. Isolation categories 2–5 were delineated by the Centers for Disease Control.[15] The more contagious an illness, the more safety precautions are needed. We anticipated that diseases calling for more protection for the nurse would generate higher values of subjective transmissibility. Three prognostic levels were employed, as indicated by disease severity. These were 1) excellent; 2) serious; 3) fatal.

Standard technique for functional measurement studies includes selection of stimulus levels designed to achieve broad coverage of the continua. With numerical independent variables, smooth spacing is easy to achieve. Here, however, we used levels occurring naturally in the disease context. The subjective counterparts of the designated levels were not known in advance, but estimates would be available if the model were confirmed.

The patient descriptions included names and ages as distracting elements. All patients were described as men between the ages of 20 and 40. The intent of these distracting elements was to inhibit discovery of the factorial structure. To the same end, the stimulus set also included two patient descriptions that were not part of the factorial design.

PROCEDURE

The experiment was conducted (by the first author) with nurses individually or in small groups of two to five. Immediately preceding data collection, each participant was given a written description of the experimental task, followed by detailed verbal instructions, including a brief summary of the isolation procedures. Two practice patients were then rated, and task-related questions were answered. Each subject completed two replications in one sitting, which took about 30 minutes.

Each patient description was presented on a separate sheet of paper; an example using a yellow fever patient is given in the appendix. Each page also contained a graphic rating scale.[16] Worry about contagion

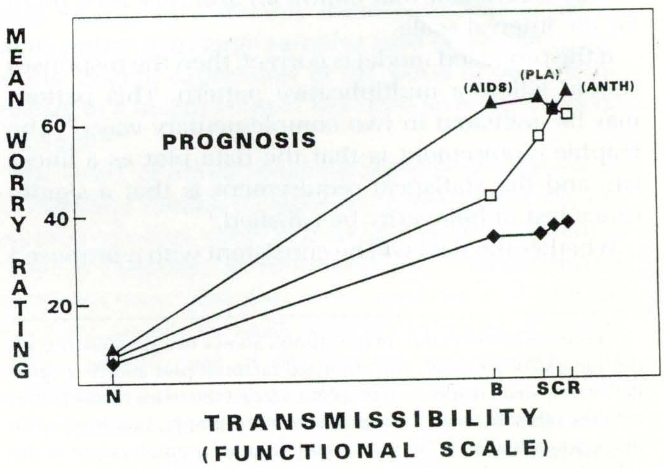


FIGURE 1. Factorial plot of group mean responses. The lowest curve is for diseases with excellent prognoses, the middle curve is for those with serious prognoses, the highest curve is for fatal diseases. Letters along horizontal axis denote isolation conditions.

was recorded on a 100-mm continuous line. The neutral term "worry" was used for the response scale, rather than "fear," because fear might connote cowardice to some respondents. The left end of the line represented no worry; the right end represented extreme worry. The response was scored by measuring from the left end to the point at which the respondent had marked the line. Ratings were measured to the nearest millimeter, so that a response was a number between zero and one hundred. Within each factorial set, the patient descriptions were randomly assorted. An extraneous description was added to each set, and the two sets were combined. Subjects received identical packages of 32 pages.

**Table 2** • Functional Scales (Marginal Means)

| Transmissibility (Isolation) | Mean | Prognosis | Mean |
|---|---|---|---|
| Not contagious (None) | 6.17 | Excellent | 25.12 |
| Minimal (Blood and body) | 47.40 | Serious | 46.67 |
| Moderate (Respiratory) | 55.78 | Fatal | 54.06 |
| High (Contact) | 54.33 | | |
| Most (Strict) | 52.72 | | |

## Results

The success of the multiplying model as a description of the judgments may be seen in figure 1. The graph largely shows the linear-fan characteristic of a multiplicative process, although for the three upper transmissibility levels there are minor deviations. These three levels proved to be subjectively equivalent, so the lines do not continue to diverge as might have been expected.

The labels shown in parentheses highlight the amounts of dread inspired by three of the deadly diseases. It may be seen that the fatal, moderately transmissible disease (ANTH) yielded the highest mean response (68.1), followed by the fatal, most transmissible disease (PLA), and the fatal, minimally transmissible disease (AIDS). It is noteworthy that fatal diseases that are more contagious than AIDS generate more worry. Whether this result would have been obtained if names had been attached to the diseases is unknown.

The data presented are for the group of ten subjects, with the points representing group mean ratings. Spacing on the horizontal axis reflects group subjective values (marginal means). Quantitative analysis was carried out with the computer program FM#1, a successor to Group-Individual POLYLIN.[17] The program derives trend coefficients from group subjective values. The statistical test supported the model, in that the $F$-ratio for the bilinear component of the transmissibility × prognosis interaction was significant ($F(1, 9) = 13.62$, $p < 0.01$), and the remainder was nonsignificant ($F(7, 63) = 1.39$).

The decision to examine the data at the group level is in contrast to the usual functional-measurement analytic procedure. Customarily, the model is defined for the individual, with perhaps idiosyncratic subjective values entering the cognitive equation. However, if a model is correct for the individuals then it is correct for the group as a whole. In the present study, the group analysis was dictated by the relatively small number of scores collected from each participant. Having only two replications in a small factorial design limits the statistical power of an individual analysis, and therefore does not allow a stringent test of the model. It was deemed inadvisable to have more replications, though, because even without disease labels, the stimuli were so distinctive. Realistic disease descriptions tend to be recognized and remembered by medically trained participants. Additional replications would probably not have generated independent responses, and therefore we made a prior decision to use the group design.‡

The statistical support for the model demonstrates the efficacy of the group design. While those unfamiliar with functional measurement might consider ten subjects to be a rather small group, the model approach is searching for algebraic structure rather than for differences between means. Assessment of this structure uses hypothesis-testing logic in an unfamiliar way. Here, one planned comparison (the bilinear component) must be significant and another (the remainder) must be nonsignificant. The test would not have succeeded if the group design had not generated sufficient power to confirm the bilinear component of the multiplying model.

Success of the model validates the response instrument and the extracted subjective values. The functional scales in table 2 are interval scale values for the sets of $T(i)$ and $P(j)$ specified in equation 1.

The functional scale for transmissibility, displayed as the spacing on the horizontal axis on figure 1, was

‡Since the decision to evaluate the model on a group basis was made in advance on the basis of expected low power for individual analyses, the individual data were not relevant to the model's success. However, in response to a reviewer's query, individual data were inspected. As anticipated, individual factorial plots were highly irregular. Such variability is to be expected when respondents are initially performing a complex judgmental task. The lack of power inherent in variable data led to the model's being deemed successful for only two of the ten subjects, using the (inappropriate in this case) individual counterpart of the bilinear analysis.

surprising. The three strictest isolation categories yielded virtually identical subjective values, in contrast to the separation implied by the verbal descriptions. In fact, the observed subjective ordering of the levels was not consistent with anticipated subjective transmissibility. We offer an ad hoc explanation for this unexpected outcome.

More serious diseases call for more stringent safety precautions, which was the rationale for the expected transmissibility ordering. However, more severe illnesses also require more protective garb, and this garb apparently provides a sense of security. Subjective values for transmissibility may incorporate the protection associated with the precautions, so the fear that would be expected for a more contagious disease is automatically mitigated. The three highest levels of transmissibility were essentially equivalent. Thus, the design should perhaps be viewed as a 3 × 3; the linear fan looks nearly perfect for the first three transmissibility levels.

## Discussion

The establishment of a rational model for fear of contagion is the main contribution of the present study. The multiplying model is scarcely a surprising one. Its application was inspired by the subjective expected utility model used in decision-making studies. In that model, the utility of a risky outcome is the product of subjective probability and subjective value.[18] The models for fear of contagion and subjective utility have the same form. Transmissibility and subjective probability both refer to likelihood; prognosis and subjective value both refer to worth. The product in either case—fear of contagion or attractiveness of the gamble—represents an integrated response to the particular combination presented. Still, although the multiplicative model is appealing for fear of contagion, descriptive accuracy can hardly be presumed without evidence. Functional measurement methods offer a viable approach to validation.

From an experimentalist's perspective, the difference between the two situations is that the researcher in the typical gambling study can assign numerical values to the stimulus components, whereas no such control is available when real diseases are used as the stimuli. This difference was highlighted by our inability to predict the subjective ordering of the levels of the transmissibility factor. Apparently isolation garb is quite comforting, in that diseases that are more transmissible in their own right do not generate higher fear of contagion. Surprisingly, the maximum mean worry response was less than 70. As the scale extended to 100, considerably higher dread was envisioned by our nurses. However, extreme worry was not generated even by fatal, contagious diseases when presented with specified isolation procedures.

A pragmatic implication is that possible apprehension among practicing nurses can be allayed by following the Centers for Disease Control isolation guidelines. When nurses knew that they would be following infection-control procedures, subjective transmissibility was independent of the transmissibility characteristics of the disease. In addition to the infection control benefits of incorporating the guidelines,[15] cognitive benefit to nurses can be expected in terms of anxiety reduction. Updating knowledge of disease transmission and of available safety techniques may mitigate unreasonable concerns that might otherwise interfere with professional responsibilities.

In the interest of simplicity, two aspects of realistic nursing assignments were ignored. Length of stay and amount of care called for may vary among diseases as well as among individuals with a given disease. The worry generated might depend upon exposure. Our instructions implied a standard quantity of care independent of the disease. The nurses envisioned basic care generally provided in an acute inpatient setting.

The other inspiration for this study was the abundance of recent attention to the attitudes of health care workers towards AIDS patients. While nurses have been shown to have biases,[19,20] concern regarding contagion also needs to be considered as influencing attitudes towards their professional responsibilities.[21] The present research has placed fear of AIDS contagion into a broader context; fear is a response to the possibility of contracting disease. Fear has been shown to follow an orderly process, which does not require the imposition of a special mechanism to account for the reaction to a particular disease.

Given our interest in the reaction to AIDS, it is worth re-emphasizing that no disease names were presented in the study. It would scarcely be surprising if a study in which names were attached to the diseases yielded an extreme response to AIDS. Such a result would perhaps tell us that AIDS was currently more prominent than other deadly diseases, but it would not show us how inherent characteristics of diseases generate fear of contagion.

The authors thank Nancy Cobb and Loretta Birckhead for their insights. They also thank Raymond A. Ulmer for editorial suggestions.

## References

1. Lawrence SA, Lawrence RM. Knowledge and attitudes about acquired immunodeficiency syndrome in nursing and nonnursing groups. J Prof Nurs. 1989;5:92–101.
2. Blumenfield M, Smith PJ, Milazzo J, Seropian S, Wormser GP. Survey of attitudes of nurses working with AIDS patients. Gen Hosp Psychiat. 1987;9:58–63.
3. Brock RB. On a nursing AIDS task force: the battle for confident

care. Nurs Manage. 1986;17:67–8.
4. Anderson NH. Foundations of Information Integration Theory. New York: Academic Press, 1981.
5. Froberg DG, Kane RL. Methodology for measuring health-state preferences. I: Measurement strategies. J Clin Epidemiol. 1989;42:345–54.
6. Froberg DG, Kane RL. Methodology for measuring health-state preferences. IV: Progress and research agenda. J Clin Epidemiol. 1989;42:675–85.
7. Anderson NH. Information integration approach to emotions and their measurement. In: Plutchik R, Kellerman H, eds. The Measurement of Emotions. Emotion: Theory, Research, and Experience, Vol. 4. San Diego, CA: Academic Press, 1989.
8. Anderson NH, Weiss DJ. Test of a multiplying model for estimated area of rectangles. Am J Psychol. 1971;84:543–8.
9. Klitzner MD. Small animal fear: an integration-theoretical analysis. Unpublished doctoral dissertation, University of California, San Diego, CA, 1977.
10. Anderson NH. How functional measurement can yield validated interval scales of mental quantities. J Appl Psychol. 1976;61:677–92.
11. Weiss DJ. Quantifying private events: a functional measurement analysis of equisection. Percept Psychophys. 1975;17:351–7.
12. Birnbaum MH. Controversies in psychological measurement. In: Wegener B, ed. Social Attitudes and Psychological Measurement. Hillsdale, NJ: Lawrence Erlbaum Associates, 1982.
13. Miyamoto JM, Eraker SA. A multiplicative model of the utility of survival duration and health quality. J Exp Psychol Gen. 1988; 117:3–20.
14. Berkow R, ed. The Merck Manual of Diagnosis and Therapy. 15th ed. Rahway, NJ: Merck, Sharp, and Dohme Research Laboratories, 1987.
15. Benenson AS, ed. Control of Communicable Diseases in Man. 14th ed. Washington, DC: The American Public Health Association, 1985.
16. Weiss DJ. Note on choosing a response scale. Percept Motor Skills. 1980;50:472–4.
17. Weiss DJ, Shanteau JC. Group–individual POLYLIN. Behav Res Meth Instrument. 1982;14:430.
18. Anderson NH, Shanteau JC. Information integration in risky decision making. J Exp Psychol. 1970;84:441–51.
19. Douglas GJ, Kalman CM, Kalman TP. Homophobia among physicians and nurses: an empirical study. Hosp Comm Psychiat. 1985;36:1309–11.
20. Kelly JA, St. Lawrence JS, Hood HV, Smith S, Cook DJ. Nurses' attitudes toward AIDS. J Cont Educ Nurs. 1988;19:78–83.
21. Bliwise NG, Grade M, Irish TM, Ficarrotto TJ. Measuring medical and nursing students' attitudes toward AIDS. Health Psychol. 1991;10:289–95.

## Appendix

### *Sample Rating Form*

*Illness Description*: An acute viral infection characterized by sudden onset, fever, a relatively slow pulse, and headache.

*Mode of Transmission*:
1) Direct contact with infected blood.

*Prognosis*: This illness is a *serious* disease that can be mild to severe.

Mr. H. B. is a 22-year-old male diagnosed with the illness described above. He is on *blood and body fluids precautions*. He is receiving intravenous fluids and medications. His vital signs are being monitored every four hours. He requires assistance with ambulation, toileting, and bathing.

Imagine yourself providing primary nursing care to Mr. H. B., and following the blood and body fluid precautions. Indicate how worried you are about catching this illness from Mr. H. B.

Not worried ______________________________ Extremely worried