

# Radiation dose prediction using time to emesis data in the case of nuclear terrorism

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Because time to emesis is frequently advocated as a major criterion for triage following an irradiation event, we have re-examined the uncertainties involved in its use. Since one of the most important uses of triage after a large incident is likely to be to minimize the rate of false positives to prevent overload of the limited medical system, we have particularly focused on this aspect. We carried out a rigorous statistical analysis of the retrospective estimation of radiation dose received using time to emesis and its uncertainty using the data base that is usually cited, 108 observations associated with accidents with significant exposures to ionizing radiation in the period 1956-2001. The standard error, confidence interval, specificity and sensitivity, and receiver operating curve (ROC) are used to characterize the uncertainty of the dose prediction. The relative error of the dose prediction using time to emesis data alone is about 200%. Consequently, if  $D$  is the dose assessment, the 95% confidence interval is approximately  $(D/4, 4D)$ .

To the right, we show the ROC curve for discrimination of subjects receiving greater than or less than 2 Gy. For example, if a time to emesis of <2 hrs is used for discrimination, the method identifies 60% of individuals who received >2 Gy with a false positive rate of about 10%. On the other hand, using <4 hrs as the discriminant, more than 80% of the individuals receiving >2Gy are identified, but the false positive rate goes up to more than 50%.

We also note several other variables that indicate that there are additional factors that provide additional uncertainty beyond that provided by our statistical analysis. These include a lack of consideration of individuals that do not vomit at all, differences between the conditions under which the data were obtained and the conditions under which they are likely to be used, and the potential for the incidence of vomiting to be altered by factors not directly related to the radiation dose such as psychogenic factors and the use of emetic agents. In summary, while time to emesis is a rapid and inexpensive method for estimating the radiation dose, it should be used with caution because it is imprecise and may lead to a very high false positive rate. More reliable methods for after-the-fact assessment of radiation dose are needed to complement the use of time to emesis.

