

This Week's Citation Classic

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Mantel N. Evaluation of survival data and two new rank order statistics arising in its consideration. *Cancer Chemother. Rep.* **50**:163-70, 1966.

[Biometry Branch, Natl. Cancer Inst., NIH, Public Health Service, US Dept. Health, Education, and Welfare, Bethesda, MD]

The Mantel-Haenszel procedure is adapted to the comparison of survival or time-to-response curves. Separate 2 x 2 contingency tables are formed by considering the numbers at risk and responding in each time interval. For infinitesimal time intervals, the method becomes a ranking procedure. The two rank order statistics described include the final chi square and the maximal interim chi square. Philosophical aspects of the problem are discussed, including the need for having a value function. [The SC[®] indicates that this paper has been cited in over 500 publications since 1966.]

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"A footnote in this paper indicates that it was presented at a Conference of Regional Statisticians in Bethesda in May 1965. That actually was not the case—I had presented another paper but submitted the instant one for publication, a case of false pretenses.

"Sometime in 1964, I followed through on a suggestion in my 1963 extension¹ to the original 1959 Citation Classic by myself and Haenszel.² The methodology I suggested was extremely simple—just treat the data arising in each time interval as constituting simply a separate fourfold contingency table. Also, by allowing the durations of the time intervals to become infinitesimal, it was apparent that I was dealing with a ranking procedure.

"Philosophical considerations, often over-looked by others, also arose, which I brought out. If we could not decide which was the better of two survival curves which we knew exactly, but which crossed each other, then how could we decide which was the better if we had only estimates of those curves?

"Shortly after having prepared my own draft, I got involved in a competitive procedure. Ed Gehan had, in press or in preparation, two manuscripts on generalizing the Wilcoxon procedure for censored data, which he brought to my attention.^{3,4} Subsequently, I saw how Gehan's apparently complex procedure could be greatly simplified, and my own resulting manuscript was a tour de force.

"It was this alternative manuscript which I presented at the conference. It was a manuscript with much more substance than the one I had previously prepared, and would make for a much better presentation. Yet, also, it was one which I had little doubt about getting published. But I had misgivings about getting my future Citation Classic published, and it was that one which I did submit in connection with the conference. (At the actual conference, I made clear the existence of the two manuscripts.)

"My tour de force, however, did not have clear sailing. Gehan wanted very much to see it in print, but his own editor judged otherwise. I had recourse to another journal and, after a year of waiting, inquired Apparently, the reviewer, Wilcoxon, had died in the course of the year and the paper had been forgotten. The repentant editor then accepted it for publication without changing a word—he apparently recognized its special merits.⁵

"Substantial impetus for the popularity of my original work on survival data has come from the 1972 publications of Cox⁶ and of Peto and Peto.⁷ For one thing, the method I gave could be recognized as a special simple case of an ingenious procedure by Cox for avoiding time model assumptions. Also, Peto and Peto gave a name, log ranks, to the method provided, with the first of the Petos continuing to give the method publicity in his writings. But it is the general usefulness of the method, its applicability' to a wide range of important problems, and its theoretical appeal which have mattered in the long run."

1. **Mantel N.** Chi-square tests with one degree of freedom: extensions of the Mantel-Haenszel procedure. *J. Amer. Statist. Assn.* **58**:690-700, 1963.
2. **Mantel N & Haenszel W.** Statistical aspects of the analysis of data from retrospective studies of disease. *J. Nat. Cancer Inst.* **22**:719-48, 1959. [Citation Classic. *Current Contents/Life Sciences* **24**(26):19. 29 June 1981.]
3. **Gehan E.A.** A generalized Wilcoxon test for comparing arbitrarily singly-censored samples. *Biometrika* **52**:203-23, 1965. [Citation Classic. *Current Contents/Life Sciences* **22**(39): 12. 24 September 1979]
4. A generalized 2-sample Wilcoxon test for doubly censored data. *Biometrika* **52**:650-3, 1965.
5. **Mantel N.** Ranking procedures for arbitrarily restricted observation. *Biometrics* **23**:65-78, 1967.
6. **Cox D.R.** Regression models and life tables. *J. Roy. Statist. Soc. Ser. B Metho.* **34**:187-220, 1972.
7. **Peto R & Peto J.** Asymptotically efficient rank invariant test procedures. *J. Roy. Statist. Soc. Ser. A Gener.* **135**: 185-206, 1972.