53. Baverstock, K., et al.: Thyroid cancer after Chernobyl. [letter] Nature 359: 21-22, Sept. 3, 1992.
54. Kazakov, V. S., Demidchik, E. P., and Astakhova, L. N.: Thyroid cancer after Chernobyl. [letter] Nature 359: 21, Sept. 3, 1992.
55. Goldman, M.: Chernobyl: a radiological perspective. Science 238: 622-623, Oct. 30, 1987.
56. Kondrusev, A. I.: Sanitary and health measures taken to deal with the consequences of the Chernobyl accident. *In* Medical aspects of the Chernobyl accident. Proceedings of an All-Union Conference organized by the USSR Ministry of Health and the All-Union Scientific Centre of Radiation Medicine, USSR Academy of Medical Sciences, Kiev, May 11-13, 1988, International Atomic Energy Agency, Vienna, 1989 (IAEA-TECDOC-516), pp. 39-45.
57. Romanenko, A. E.: Protection of health during a large scale accident. *In* Medical aspects of the Chernobyl accident. Proceedings of an All-Union Conference organized by the USSR Ministry of Health and the All-Union Scientific Centre of Radiation Medicine, USSR Academy of Medical Sciences, Kiev, May 11-13, 1988. International Atomic Energy Agency, Vienna, 1989 (IAEA-TECDOC-516), pp. 65-78.

Cirrhosis Hospitalization and Mortality Trends, 1970–87

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Synopsis

The decline in cirrhosis mortality in recent years in light of increases in cirrhosis morbidity, as reflected in hospital discharge data, is examined. Although there does not appear to be a single explanation for the decline in mortality, it is suggested that increased identification and treatment, as measured by substantial increases in the rates of hospitalization involving cirrhosis, may be a contributing factor.

If, as suggested by hospitalization data that indicate a decreasing proportion of patients with cirrhosis die during their hospital stay, a major portion of the increase in cirrhosis admissions was for patients with less severe cases, these patients would be more responsive to treatment and would have a relatively better prognosis.

The identification of contributing factors that may be responsible for the decline in cirrhosis mortality can provide support for the continuation of early diagnosis and treatment in already identified populations. The same kind of support can be extended to other population subgroups that have yet to show the same decline in cirrhosis mortality.

THE RATE OF DEATH from cirrhosis of the liver rose steadily in the United States after prohibition was repealed until it peaked in 1973 at an age-adjusted rate of 15.0 deaths per 100,000 population. Between 1973 and 1983, cirrhosis mortality declined by about one-third (32 percent) to 10.2 deaths per 100,000. The decline continued through 1987, when the death rate was further reduced to 9.2 per 100,000 (*1*) (see chart).

Although the downward trend in cirrhosis mortality is clear, there is no single adequate explanation. A number have been suggested, including advancements in medical treatment and the success of prevention programs (*2,3*). After reviewing some of these explanations, we present data that address the decline in cirrhosis mortality by showing that increasing detection and hospital treatment of persons with cirrhosis may be one contributing factor. We also analyze data on trends in cirrhosis diagnoses and outcomes of hospital stays.

Our review of the explanations for the decline in cirrhosis mortality focuses on two areas: (*a*) trends in alcohol consumption and (*b*) changes in cirrhosis case management. The link between chronic alcohol consumption and cirrhosis is well established, although other factors, such as lifestyle and genetic predisposition, also influence this relationship (*4*). At the aggregate level, national trends show some

evidence of the association between alcohol consumption and cirrhosis, with higher levels of alcohol consumption typically accompanying higher cirrhosis mortality rates (*5*). In the United States, however, a decline in apparent per capita consumption of alcohol did not occur until after the decline in cirrhosis mortality occurred.

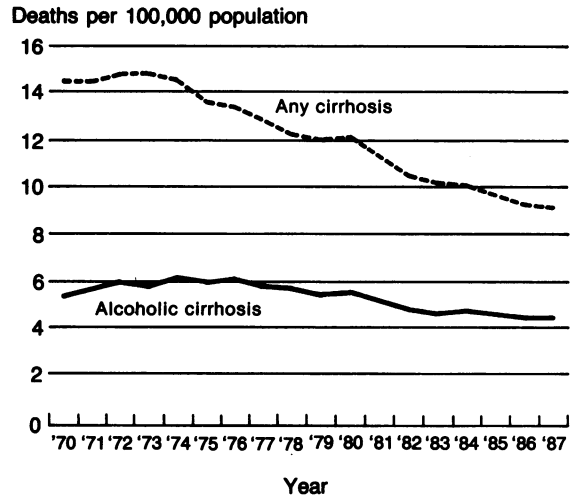
As with cirrhosis mortality, annual per capita consumption of alcohol increased steadily following the repeal of prohibition until 1981, when consumption of ethanol reached 2.76 gallons per capita. Since 1981 there has been a gradual decline in consumption of alcohol; by 1987 it was down to 2.54 gallons per capita (*6*). Thus, the observed sharp decline in cirrhosis death rates cannot be explained by trends in alcohol use as measured by apparent per capita consumption. Other alcohol consumption measures based on cross-sectional samples of the U.S. population drawn as late as 1984 indicate that, in general, drinking patterns and drinking levels have not increased or decreased notably (*7*).

Another potential explanation for decreasing cirrhosis mortality may be changes in the medical management of the disease. These changes could include new technology for treating the cirrhotic liver or the development of pharmacological or surgical treatments for the consequences of cirrhosis that were previously fatal, thus delaying mortality. No major treatment breakthroughs have been implemented in the last few decades, however, other than orthotopic liver transplantation. This procedure remains relatively rare because of the limited number of institutions capable of performing it, the limited availability of donor organs, and the high cost, estimated at $150,000 to $259,000 per case (*8*).

We also reviewed the first through the eleventh editions (1950 through 1987) of the standard reference for internal medicine entitled, "Principles of Internal Medicine." We found no radical changes in pharmacologic or other medical and surgical interventions for the treatment of cirrhosis and its complications. We did find a gradual change, however, in the recommended treatment of cirrhosis. This change has a bearing on hospitalizations for cirrhosis that will be discussed subsequently, followed by an analysis of hospitalization data.

The earliest editions of "Principles of Internal Medicine" (1950, 1954) considered nutritional deficiency to be the principal factor in the etiology of cirrhosis (*9,10*). The third edition (1958) was the first to recognize explicitly the link between cirrhosis and alcoholism, based on animal studies that

Age-adjusted cirrhosis mortality rates, 1970-87



showed the development of cirrhosis even with an adequate diet and concluded that alcohol itself was a causative factor (*11*). Hence, the third edition recommended that alcohol be strictly prohibited for cirrhosis patients.

The fifth edition (1966) emphasized early treatment for the first time and implied that patients with cirrhosis be hospitalized, as indicated in the following excerpt (*12*):

> Prognosis: There is no doubt that the modern therapeutic attack on Laennec's cirrhosis is effective in restoring many patients to good health, provided vigorous treatment is begun at an early stage of the disease.... The mortality rate is still distressingly high, however, in patients with advance hepatocellular failure or bleeding esophageal varices. Thus of patients with ascites, approximately 35 percent are dead in 1 year, 50 percent in 2 years, and 70 percent in 5 years.
>
> The improvement in the outlook for the cirrhotic patient is based on the maintenance of alcohol abstinence, dietary therapy, and the effective control of coma, hemorrhage, and infection. Nearly all patients will show improved hepatocellular function within 6 to 8 weeks following hospitalization. Such improvement may continue for 6 to 18 months to a degree sufficient for the patient to return to employment. Such an outcome is based on adequate diet and sustained abstinence from alcohol.
>
> The importance of continued abstinence from alcohol is so great that this more than

any other feature of treatment determines the long-term prognosis. Recognition of this in the early stages of the disease and the undertaking of appropriate measures will result in more survivals.

In the sixth edition (1970) and the editions that followed, emphasis on careful diagnosis and evaluation of the patient explicitly recommended hospitalization, as follows (*13*):

> Laennec's cirrhosis is a serious chronic illness that usually requires prolonged medical supervision and management. In most instances it is desirable to hospitalize the patient for initial study and assessment of his response to therapy as well as for dietary and medical instruction.

These medical guidelines suggest that there may be an increase in the number of hospitalizations for cirrhosis. The rest of our report will involve data that address the magnitude and outcome of cirrhosis hospitalizations over an 18-year period (1970 to 1987) to assess what could be an important factor contributing to the recent decline in cirrhosis mortality.

Methods

The National Center for Health Statistics (NCHS) has generated annual machine-readable files since 1970 from its National Hospital Discharge Survey (NHDS). Our study is limited, however, to the 1970–87 period because a change in sample design in 1988 meant that more recent data are not strictly comparable to the previous years.

In this continuing survey, a representative sample of hospital discharge episodes is drawn from non-Federal short-stay hospitals with six or more beds and an average length of stay less than 30 days (*14*). Data on a sample of discharged patients then are abstracted from hospital records on a continuing basis by local hospital personnel or by Bureau of the Census staff members working on behalf of NCHS. Abstracted data are then coded and entered centrally by the NCHS staff. From 1985 to 1987, about 17 percent of all sampled records were received annually in machine-readable form from abstract services.

Definition of cirrhosis. Between 1970 and 1978, inpatient diagnoses were coded according the Interna-tional Classification of Diseases, 8th Revision-Clinical Modifications (ICD-8-CM). For this period, the following codes were used for cirrhosis: alcohol cirrhosis of the liver (code 571.0), other specified cirrhosis of the liver without mention of alcohol (code 571.8), and unspecified cirrhosis of the liver without mention of alcohol (code 571.9) (*15*). Since 1979, cirrhosis has been coded according to the International Classification of Diseases, 9th Revision-Clinical Modifications (ICD-9-CM). Between 1979 and 1985, cirrhosis included any diagnosis of chronic liver disease and cirrhosis (code 571) or portal hypertension (code 572.3) (*16*).

Alcoholic cirrhosis is the subset of all cirrhosis diagnoses that explicitly mention alcohol and includes alcohol cirrhosis of the liver (ICD-8-CM code 571.0) before 1979. Thereafter, it includes the following ICD-9-CM categories: alcoholic fatty liver (code 571.0); acute alcoholic hepatitis (code 571.1); alcoholic cirrhosis of the liver (code 571.2); and alcoholic liver damage, unspecified (code 571.3).

Identification of hospital discharges with cirrhosis. Between 1970 and 1978, each hospital discharge episode in the sample included up to five diagnostic codes in the abstract. Since 1979, up to seven diagnoses have been recorded. For each sample record, all listed diagnoses were inspected for any mention of a cirrhosis diagnosis. When such a diagnosis was mentioned, regardless of whether it was the first listed diagnosis, the discharge episode was considered cirrhosis-related.

Sample weights were used to calculate national estimates of annual hospital discharges involving a cirrhosis diagnosis as well as associated demographic distributions and hospitalization outcomes. In addition to estimated incidence, annual rates of hospital discharge for cirrhosis were calculated using population denominators obtained from census enumerations for 1970 and 1980, and from intercensal population estimates for all other years (*17,18*).

Excluded from this analysis because cirrhosis rarely occurs in these categories were discharged patients younger than age 15, and patients discharged with diagnoses related to pregnancy, childbirth, or the puerperium (ICD-9-CM codes 630–676). In interpreting these data, it is essential to recognize that our findings are based on cirrhosis discharge episodes and not necessarily on individual patients diagnosed with cirrhosis, since it is possible for a person to be hospitalized for cirrhosis on more than one occasion in any given year or

over a period of several years. It is essential also to recognize that for the episodes of cirrhosis identified, the impetus for hospitalization may or may not have been cirrhosis.

Results

Overall discharge rates for all diagnoses fluctuated slightly during the 18-year study period but remained under 2,000 hospital discharges per 10,000 population. Hospital discharge rates with mention of cirrhosis increased 22 percent between 1970 with 13.4 cirrhosis discharges per 10,000 population and 1985 with 16.4. For alcoholic cirrhosis in particular, discharge rates show a 72-percent increase over the same period, from 4.7 to 8.1 discharges per 10,000 population (table 1).

Over the study period we also examined the number of patients with cirrhosis who were classified as "dead at discharge." A patient's survival status at discharge can be considered an indicator of treatment outcome as well as of disease severity. Over time, the number of patients with cirrhosis who were dead at discharge remained fairly stable, in contrast to the total number of all cirrhosis hospitalization episodes, which steadily increased during the same period. This contrasting pattern is more readily apparent among hospital discharge episodes for alcoholic cirrhosis, as shown in table 2.

The estimated number of alcoholic cirrhosis discharges increased steadily and more than doubled between 1970 and 1987. There were approximately 69,000 discharges with alcoholic cirrhosis at the beginning of the period and 163,000 discharges at the end of the period, an overall increase of 150 percent. Of these discharge episodes, fewer than 9,000 were dead in 1970, compared with about 11,000 dead in 1987, for a net increase of 22 percent. When the number of patients dead at discharge is expressed as a percentage of all cirrhosis discharges in each year, however, these figures also show a declining trend. The percentage of all patients with cirrhosis that were discharged dead decreased from about 1 in 7 (15.3 percent) in 1970 to 1 in 11 (9.1 percent) in 1987. Among alcoholic cirrhosis discharges, the corresponding decline was from 1 in 8 (12.6 percent) in 1979 to about 1 in 15 (6.8 percent) by 1987.

Data on age at discharge, summarized in table 3, provide additional information on changes in cirrhosis discharge episodes. Average age at discharge involving any cirrhosis diagnosis appears stable, slightly fluctuating in the range of ages 54 to 56 during the 17-year period from 1970 to 1987. For discharges diagnosed with alcoholic cirrhosis, a similar stability is observed at a younger average age, 50 to 52 years. Standard deviations around the mean (SD) for both cirrhosis series show change over time, in the direction of increasing variability. For any cirrhosis and for alcoholic cirrhosis, variability appears to increase over time, with SD for any cirrhosis fluctuating upwards from 13.4 years in 1970 to 15.9 years in 1987. Corresponding SDs for alcoholic cirrhosis changed from 11.6 in 1970 to 15.5 in 1987.

Table 1. Hospital discharge rates per 10,000 population for cirrhosis, 1970–87

Year	Any cirrhosis	Alcoholic cirrhosis
1970	13.4	4.7
1971	13.4	4.8
1972	15.2	5.5
1973	15.8	6.3
1974	16.8	6.8
1975	17.6	7.5
1976	16.5	7.8
1977	17.1	8.0
1978	17.6	8.9
1979	17.2	7.9
1980	17.9	7.8
1981	18.2	8.5
1982	17.1	8.2
1983	17.4	7.7
1984	16.5	7.7
1985	16.4	8.1
1986	16.5	8.4
1987	15.5	8.6

Table 2. Number and percent of cirrhosis hospital patients who were dead at discharge, 1970–87

	All cirrhosis			Alcoholic cirrhosis		
		Dead at discharge			Dead at discharge	
Year	Total	Number	Percent	Total	Number	Percent
1970	196,133	29,935	15.3	69,172	8,695	12.6
1971	199,868	26,099	13.1	71,654	7,432	10.4
1972	232,041	28,761	12.4	84,071	8,221	9.8
1973	245,195	27,465	11.2	97,526	8,316	8.5
1974	266,209	27,805	10.4	108,171	11,411	10.5
1975	283,783	27,656	9.7	121,562	7,538	6.2
1976	270,940	26,668	9.8	128,064	11,525	9.0
1977	285,444	28,649	10.0	134,505	11,347	8.4
1978	299,409	23,413	7.8	150,716	8,587	5.7
1979	298,567	30,643	10.3	137,115	9,529	6.9
1980	315,193	27,631	8.8	136,805	10,845	7.9
1981	325,171	30,867	9.5	151,966	13,862	9.1
1982	309,462	27,576	8.9	148,893	10,285	6.9
1983	317,314	31,014	9.8	139,868	10,858	7.8
1984	304,259	30,127	9.9	141,832	13,479	9.5
1985	306,600	23,747	7.7	152,100	12,546	8.2
1986	313,014	25,127	8.0	158,574	10,816	6.8
1987	296,038	26,940	9.1	163,328	11,061	6.8

Table 3. Average age of cirrhosis patients at discharge from hospital, 1970–87

Year	Any cirrhosis		Alcoholic cirrhosis	
	Average age	Standard deviation	Average age	Standard deviation
1970	55.0	13.4	51.8	11.6
1971	53.8	13.4	51.8	11.5
1972	53.6	13.7	51.1	11.4
1973	54.4	13.7	51.1	11.9
1974	53.8	13.4	52.1	12.0
1975	54.4	13.7	52.3	11.7
1976	53.9	14.1	51.1	12.9
1977	54.1	14.3	52.1	12.8
1978	53.5	14.5	50.9	13.1
1979	53.7	14.1	51.3	12.7
1980	54.3	14.9	50.9	13.8
1981	54.3	14.5	50.6	13.4
1982	54.0	14.8	49.9	13.6
1983	54.9	15.2	50.6	13.9
1984	56.0	15.0	51.5	13.5
1985	55.9	14.5	52.1	13.1
1986	55.5	14.9	51.2	13.5
1987	55.3	15.0	52.0	13.4

Discussion

These data demonstrate a clear increase in hospital discharge episodes with a cirrhosis diagnosis during the study period while the percentage of cirrhosis patients that were dead at discharge declined. Increasing variability of average age at discharge for episodes with cirrhosis diagnosis is consistent with the hypothesis that cirrhosis is being detected and treated earlier, presumably, as well as indicate an increasing survival period that might in part be attributed to treatment. If, as suggested by hospitalization data, a major portion of the increase in cirrhosis admissions was for cases of less severity, these cases would be more responsive to treatment and would have a relatively better prognosis. In any case, the increasing variability in age at discharge for cirrhosis (alcoholic or not) is consistent with both earlier diagnosis and longer survival.

These data lend credence to the hypothesis that increased identification and treatment, as measured by substantial increases in the rates of hospitalization involving cirrhosis, may be contributing to the observed decline in liver cirrhosis mortality. Because these observations are based on aggregate trends, they need to be validated using case-level studies. As Hermos concludes from his review of studies of alcoholic cirrhotic patients under medical care, the mechanisms leading to apparent improvement in such patients are not yet clearly understood (*19*).

The hospitalization data we analyzed also can be interpreted in light of our earlier review of medical references over the previous four decades. Recommended treatment for cirrhosis shows a growing emphasis on hospitalization as an integral part of the diagnosis and medical management of cirrhotic individuals. Added impetus for increasing hospitalization also may be found in initiatives from the Federal Government and from professional organizations. In the 1960s, professional societies acknowledged that alcoholism is a disease and that its treatment would have a place within the health care system (*20*). In response, comprehensive legislation was enacted in the early 1970s that established the National Institute on Alcohol Abuse and Alcoholism and began large-scale funding for research, prevention, and treatment programs. The legislation also included a specific provision that stated (*21*)

> Alcohol abusers and alcoholics who are suffering from medical conditions shall not be discriminated against in admission and treatment, solely because of their alcohol abuse or alcoholism, by any private or public general hospital....

The 1970s were a decade of rapid growth in the availability of treatment programs for alcoholics (*22*). Hospitalization trends for cirrhosis appear to reflect some of these changes.

Cirrhosis is not the only disease that experienced a sharp decline in mortality in recent decades. For example, coronary heart disease deaths declined 42 percent between 1963 and 1985 (*23*). Efforts to explain the decline in coronary disease mortality have failed to account for the full extent of the reductions in mortality, since no new treatments or other major changes occurred prior to the sharp decline.

Conclusions

The increasing trend in hospital discharge rates for cirrhosis contrasts with a more stable pattern of discharge rates for all diagnoses. Of the persons hospitalized with cirrhosis, the percentage that are dead at discharge has decreased, which suggests that a growing number of cirrhosis cases are being detected earlier, are being treated in hospitals, and have better prognoses. Since standard medical advice to alcoholic cirrhosis patients forbids alcohol, early detection and subsequent treatment can forestall further progression of the illness and can possibly prevent death from alcoholic cirrhosis.

Patient status at discharge, when used as an indicator of disease severity and treatment outcome, shows a decline over time in the percentage of cirrhosis cases that were dead at discharge. This suggests that detection and implied treatment of cirrhosis is contributing to the overall decline in cirrhosis mortality. Thus, the observed increase in hospitalizations involving cirrhosis appears to be an important factor contributing to the cirrhosis mortality decline.

Identifying contributing factors that may be responsible for the decline in cirrhosis mortality since 1973 can benefit public health by providing support for the continuation of early diagnosis and treatment in already identified populations. The same kind of support can be extended to other population subgroups that have yet to show the same decline in cirrhosis mortality.

References

1. Grant, B. F., Zobeck, T. S., and Pickering, R. P.: Liver cirrhosis mortality in the United States, 1973–87. Surveillance Report No. 15. Alcohol Epidemiologic Data System, Division of Biometry and Epidemiology, National Institute on Alcohol Abuse and Alcoholism, Rockville, MD, 1990.
2. Mann, R. E., Smart, R. G., Anglin, L., and Adlaf, E. M.: Reductions in cirrhosis deaths in the United States: associations with per capita consumption and AA membership. J Stud Alcohol 52: 361–365 (1991).
3. Liver cirrhosis mortality in the United States. U.S. Alcohol Epidemiologic Data Reference Manual, vol. 2. National Institute on Alcohol Abuse and Alcoholism, Rockville, MD, 1985, p. 24.
4. Grant, B. F., Dufour, M. C., and Harford, T. C.: Epidemiology of alcoholic liver disease. Semin Liver Dis 8: 12–25 (1988).
5. Skog, O. J.: Interpreting trends in alcohol consumption and alcohol-related damage. Alcohol 23: 193–202 (1988).
6. Brooks, S. D., Williams, G. D., Stinson, F. S., and Noble, J. A.: Apparent per capita alcohol consumption: national, state and regional trends, 1977–1987. Surveillance Report No. 13. Alcohol Epidemiologic Data System, Division of Biometry and Epidemiology, National Institute on Alcohol Abuse and Alcoholism, Rockville, MD, 1989.
7. Hilton, M. E., and Clark, W. B.: Changes in American drinking patterns and problems, 1967–1984. J Stud Alcohol 48: 515–522 (1987).
8. Assessment of liver transplantation. Health Technology Assessment Reports, No. 1. Agency for Health Care Policy and Research, Rockville, MD, 1990.
9. Principles of internal medicine, edited by T.R. Harrison, et al. Ed. 1. The Blakiston Co., Inc., New York, 1950.
10. Principles of internal medicine, edited by T. R. Harrison, et al. Ed. 2. The Blakiston Co., Inc., New York, 1954.
11. Principles of internal medicine, edited by T. R. Harrison, et al. Ed. 3. McGraw-Hill, Inc., New York, 1958.
12. Iber, F.: Cirrhosis. *In* Principles of internal medicine, edited by T. R. Harrison, et al. Ed. 5. Vol. 2. McGraw-Hill, Inc. New York, 1966, pp. 1061–1062.
13. Tisdale, W. A., and Isselbacher, K. J.: Cirrhosis. *In* Principles of internal medicine, edited by T. R. Harrison, et al. Ed. 6. McGraw-Hill, Inc., New York, 1970, p. 1549.
14. Graves, E. J.: Detailed diagnoses and procedures, National Hospital Discharge Survey. Vital Health Stat [13] No. 100, National Center for Health Statistics, Hyattsville, MD, 1989.
15. Hospital adaptation of ICDA (H-ICDA). Tabular list. Vol. 1. Commission on Professional and Hospital Activities, Ann Arbor, MI, 1973.
16. The international classification of diseases, 9th revision, clinical modification (ICD-9-CM): diseases tabular list. Vol. 1. Commission on Professional and Hospital Activities, Ann Arbor, MI, 1978.
17. U. S. Bureau of the Census: Preliminary estimates of the population of the United States, by age, sex, and race: 1970 to 1981. Current Population Reports, Series P-25, No. 917, U.S. Government Printing Office, Washington, DC, 1982.
18. U. S. Bureau of the Census: United States population estimates, by age, sex, race, and Hispanic origin: 1980 to 1988. Current Population Reports, Series P-25, No. 1045. U.S. Government Printing Office, Washington, DC, 1990.
19. Hermos, J. A.: Drinking by alcoholic cirrhotic patients under medical care: a literature survey. Alcohol Clin Exp Res 8: 314–318 (1984).
20. Cooperative Commission on the Study of Alcoholism: Alcohol problems, a report to the nation. Oxford University Press, New York, 1967.
21. Public Health Service Act. Public Law 91–616, as amended, 84 Stat. 1848 (1970).
22. U.S. Office of Technology Assessment: The effectiveness and costs of alcoholism treatments. U.S. Government Printing Office, Washington, DC, 1983.
23. Trends in coronary heart disease mortality, edited by M. W. Higgins and R. V. Luepker. Oxford University Press, New York, 1988.