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Computerised Life Chart Methods to Map Domains of Function and Illustrate Patterns of Interactions in the Long-Term Course Trajectories of Patients Who Once Met the Criteria for DSM–III Schizophrenia

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The research question of which mediating factors influence the long-term course of schizophrenia was not asked until recently because the expectation has been of uniformly poor outcome (Kraepelin, 1902; American Psychiatric Association, 1980). However, anecdotal clinical knowledge about heterogeneity in the long-term course of this severe illness has been firmly supported in the last 15 years by six recent longitudinal studies in Europe, Asia, and the USA (Blueler, 1972; Ciompi & Müller, 1976; Huber *et al*, 1979; Tsuang *et al*, 1979; Harding *et al*, 1987*b*; Ogawa *et al*, 1987). Each of these studies, more methodologically rigorous than those of the past, has found multiple indices of wide heterogeneity in the long-term outcome of schizophrenia with trends toward significant improvement or recovery demonstrated in over half of each cohort.

Investigation into just how these outcomes evolve so differently from one another becomes an important strategy to increase our knowledge about the processes involved in recompensation, just as there has been so much energy devoted to studying the decompensation processes (e.g. Arieti, 1955; Sullivan, 1962; Bowers, 1965; Chapman, 1966; Docherty *et al*, 1978).

The Life Chart method has an honorable history in research. The Chart was introduced to American psychiatry by Adolf Meyer (1919) to illustrate his ideas of psychobiological interaction with life events and time. His student, cross-cultural psychiatrist Alexander Leighton with his early collaborator Dorothea Leighton expanded Meyer's ideas and illustrated 43 years of a Navaho Indian's life in a 1949 monograph called *Gregorio, the Hand Trembler*, (Leighton & Leighton, 1949). These investigators added life context to the picture and an expanded conceptual framework. More recently Vaillant (1980) has conducted numerous research projects which have used Life Chart methods for display of long-term course. Initially he graphed the inter-relationships of episodes of manic-depressive illness within a single family across 45 years (Vaillant, 1961). He found that 12 of 13 episodes in four people in the same family were paired within a year of each other. By displaying the data in such a manner he found that. . . . "the case history provides compelling evidence that however important genetic and biochemical factors may be in manic-depressive illness, whether a psychotic reaction actually occurs can rest in some cases almost entirely upon dynamic factors" (Vaillant, 1980, p. 6). Further, he used this method for illustrating the record of a single drug addict (Vaillant, 1969) which allowed him to stand back from the data enough to discover the role of work in abstinence as well as the failure of prison terms or detoxification in the hospital to stop drug abuse.

Vaillant also used the Life Chart method to graph the patterns of aggregate samples of drug and alcohol abusers (Vaillant, 1966, 1980). He found that across the intervening years both types of addictions appear to ameliorate and that the heroin abusers generally have personality disorders antecedent to their addiction while alcohol abusers appear to have more personality difficulties after the disorder has begun. Some of these findings are in contradiction to the earlier literature which was based on cross-sectional or retrospective analyses only. Thus, this legacy of research using a cumulative record and visual format has led to much greater understanding of the intervening processes under study.

This paper reports on a method to convert course trajectories of individual subjects from the Vermont Longitudinal Research Project into a computerised visual Life Chart format as a way to advance our understanding about mediating factors in the course of schizophrenia and life which shape the long-term profiles of outcome.

Brief overview of the Vermont Project

In June of 1987, we reported the findings from the newest long-term catamnestic study of schizophrenia in the USA (Harding *et al*, 1987*a*,*b*). The Vermont Longitudinal

Research Project followed an intact cohort of 269 profoundly ill subjects (118 with DSM-III schizophrenia) from Vermont State Hospital for an average of 32 years after first admission.

These subjects from Vermont's only state hospital were once profoundly ill, chronically disabled, and considered to be primarily constituted of hopeless cases. Most of these patients had been subjects in very early phenothiazine trials from which other patients had responded and been released. However, this group remained in the hospital 2.5 years after the introduction of chlorpromazine. The staff felt that additional programming might aid in the eventual release of these patients. In a pioneering effort, both staff and patients together helped create a complex and comprehensive rehabilitation programme which supported this cohort both in and out of the hospital across the ensuing decade (1955–1965) (Chittick *et al*, 1961).

In the early 1980s, our long-term follow-up study was able to obtain information on 97% of the cohort. The average catamnestic time of follow-up was 32 years after first admission. Each proband was interviewed twice within a week at his or her own home with a structured interview that combined 15 standard scales and schedules currently used in the USA. Field interviewers were blind to any previous medical record information. Two sets of prospectively written medical records were abstracted by a rater blind to field interview information. We conducted inter-rater trials twice 6 months apart and the raters were found reliable and consistent across time as reported earlier (Harding *et al*, 1987*a*). Further, two of us (Strauss and Breier), who were new to the project, reliably rediagnosed all the cases by the new DSM-III criteria. Hospital records were stripped of their previous diagnostic assessments and all outcome materials. Kappa levels of 0.78 were achieved after jointly and independently reviewing 40 records (Harding *et al*, 1987*b*).

Using multivariate outcome measures, we found that by the 1980s over one-half to two-thirds of this cohort were leading much better lives than we had predicted both in 1955 and 1965. These findings held true for those subjects who were diagnosed as meeting the criteria for schizophrenia of either the DSM-I or DSM-III systems (American Psychiatric Association, 1952, 1980). Thus we agreed with Bleuler (1972), Ciompi (1980), Huber *et al* (1980), and others that the long-term outcome for schizophrenia is very heterogeneous. The Vermont data suggest that heterogeneity of outcome is possible even for patients who were once very chronic.

In the Vermont data base each person has a current Global Assessment Scale *outcome score* (Endicott *et al*, 1976), a Strauss-Carpenter Levels of Function Scale *outcome score* (Strauss & Carpenter, 1977), a Community Adjustment Scale *outcome score* (Harding, 1986). In fact, each subject has almost 2600 individual pieces of information on the computer. The question is: What happened to these people during the last 22 or more years since their discharge from Index Hospitalisation? How did they get to where they are today? Therefore, Life Charts may provide an important systematic method to sort out mediating factors which alter course and reveal significant patterns within and across a life lived.

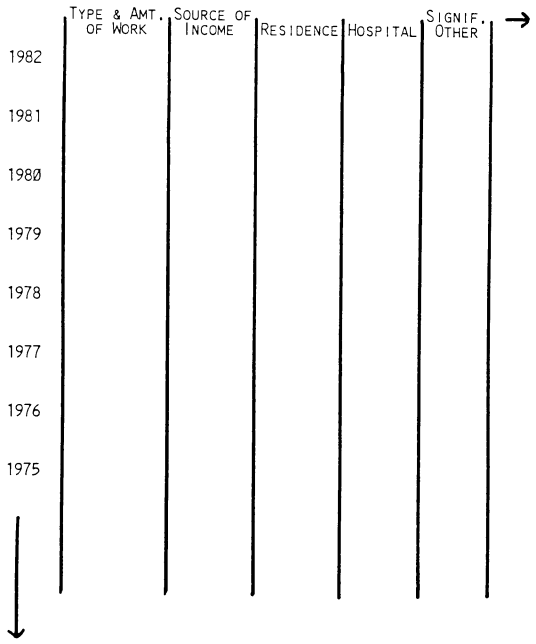

FIG. 1 The Life Chart format.

Computerised individual life trajectories

In the last decade, Ciompi, Bleuler, and Huber have all proposed various typologies for subgroups demonstrating similar courses in schizophrenia. For example, Ciompi (1980) illustrated eight course trajectories combining two types of onset (acute or chronic), two types of course (simple or undulating), and two types of end state (fair/good or poor). Subgrouping subjects by such course types has given us a more detailed picture of the hidden underlying heterogeneity within cohorts. However, because the Vermont Project data were prospectively gathered and retrospectively anchored year by year in a structured longitudinal format, we have been able to chart *individual* life trajectories in the form of Life Charts for 231 of our total 269-member cohort and 79 of 82 subjects for the DSM-III schizophrenia subgroup.

Our study incorporated a newer version of a Meyer-Leighton Life Chart into its interview protocols (Harding *et al*, 1987*a*). Experienced and trained clinician/raters conducted the interviews usually around the proband's kitchen table. Using a set of structured probes, codes, and procedures, the interviewer and the subject worked together in a mutual participation model and filled out a large sheet of paper which had been subdivided into a grid by lines* (see Fig. 1).

*The full protocol, coding, and training are available from the authors.

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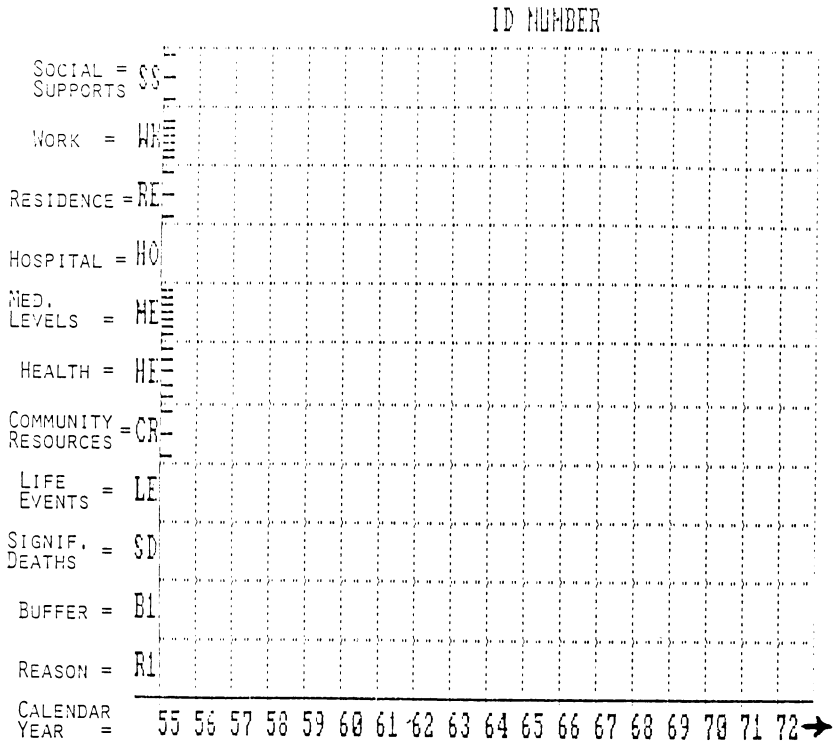

FIG. 2 Computerised Life Chart format (McCormick *et al*, 1986).

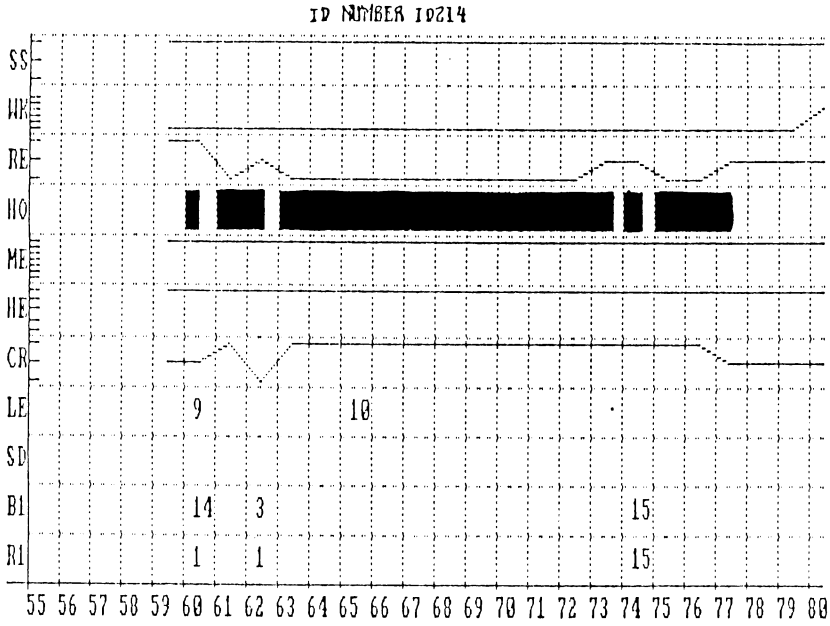

FIG. 3 A sample of a computerised Life Chart.

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The rows on the left-hand side were given the year-by-year dates from the mid-1980s to 1955 when the hospital programme began. The columns across the top were itemised with 10 separate outcome domains (residence, hospitalisation, work, source of income, significant others, life events, deaths of significant others, use of medications, health problems, and the use of community resources by each subject). A specific set of probes was asked for each year beginning with the most recent and working back to earlier years. Each answer had a corresponding code which was added to each cell of the chart.

The Life Chart was subjected to two sets of inter-rater trials, each 6 months apart. Raters took turns interviewing succeeding subjects and being the silent observer. Each rater scored the interview independently and pairs of ratings were then compared. The first trial ($n = 20$) produced a kappa coefficient of 0.98 ($P < 0.001$) and the second trial ($n = 20$) 0.78 ($P < 0.01$). All of these longitudinal data were verified by informants who knew the subjects well, as well as the two sets of prospectively gathered records mentioned earlier in this report. We noted that the subjects tended to give good accounts of their own current status and histories, a phenomenon noted earlier by others such as Glazer *et al* (1982). The mechanism of this structured and guided form of recall appeared to be very helpful. It enabled a person to start with current levels of functioning across domains and build up cues to help remember more accurately the previous year. Last year's data in turn reminded a subject of the previous year and the chart eventually becomes filled. This strategy appeared more successful than those of a police detective who suddenly asks, "Where were you on the night of December 16, 1958?"

The status in each box was given a preset numerical code and computerised. One of us (RMcC) from Medical Biostatistics of the University of Vermont used 'GW-BASIC' (MICROSOFT, 1983–84), a standard computer language to design a program method for an IBM PC which could convert the data and draw visual charts.

The first glimpse of these charts is shown in Fig. 2. For the computerised version, we reversed the original format and thus had the domains on the vertical column and the years on the horizontal axis. Status in each domain was converted to good, fair, poor, or high, medium, low with the corresponding height of the line in each quadrant drawn out. An asterisk meant data in that domain were missing for that year. These charts do not have the early life or pre-Index Hospitalisations captured in the visual format as yet, however subjects' lives have been illustrated from index hospitalisation to current status across two-plus decades of recompensation processes and lives lived.

This particular Life Chart illustrated in Fig. 3 represents Case No. 214. Mr S. was first admitted to Vermont State Hospital in 1958 aged 24. He received a rediagnosis of DSM-III Schizophrenia, Disorganised Type. The primary pattern shown on his chart is one of heavy chronicity (row-HO). He has always had at least two significant others to provide him linkage with the outside world (row-SS). The subject was unemployed (row-WK), took his medications (row-ME), and his health was excellent across the time from 1959 to 1980 (row-HE). His significant life events (row-LE) (by his own subjective choice) were separation (no. 9) with his wife in 1960 and his divorce in 1965 (no. 10). His buffer to the first event was work (B1–14), but his own vulnerability (R1–1) was overwhelmed and sent him into another major episode. Just prior to his rehospitalisation in 1963, welfare payments helped him and his family as a buffer (B1–3), but again he succumbed to his vulnerability (R1–1). In 1965 his wife divorced him (LE-10). In 1974 he used alcohol (B1–15) as a self-medication buffer but he eventually succumbed to its effects (R1–15) and was rehospitalised.

There is no question that this stylised format loses most of the eloquent life history behind the chart, but it does represent in a gross fashion an overall pattern of 21 years in a life lived across multiple domains. Our interest is not in replacing the richness of life histories and all that they have to teach us, but in providing a structured computerised method of comparing 231 lives lived. It will then be possible to subgroup patients by the patterns of their trajectories. This strategy will allow us to investigate any common underlying aspects such groups might share and may provide a new perspective on mediating factors impinging on the long-term course of schizophrenia and other severe psychiatric illnesses.

Eight of these charts were randomly selected and are shown together in Fig. 4 to illustrate a wide variety of individual patterns obtained in the cohort. The charts show evidence of Strauss & Carpenter's 'open-linked' systems (1972) in which social and work functioning and symptoms can be at very different levels within the same person at the same time as well as over time. Patterns begin to emerge, giving us a much clearer understanding of process than do multiple or the classical two cross-sectional assessments found in past longitudinal research. These charts provide a glimpse of how a person reached his or her outcome status.

Discussion

Now that we have the methodology and data collection/display mechanism in place, we can begin to learn and report about interactions and subgroups of people who took similar trajectories.

An ideal objective of statistical analysis of Life Charts would be to cluster the charts objectively into 'similar' groups. Once this has been accomplished, a profile of each subgroup could be drawn as well as a search for predictors of these life patterns undertaken.

Ten variables were charted in the present attempt. One method that could be used to cluster the charts into groups, if all ten of the variables were measured at least at the interval level, would be an Euclidean clustering. With this procedure, each subject would be represented analytically by a point in a ten-dimensional space. This is simple enough, but for each of the ten variables there are 22 or more years of observations which may be used on the Life Charts. In this case a 22×10 or

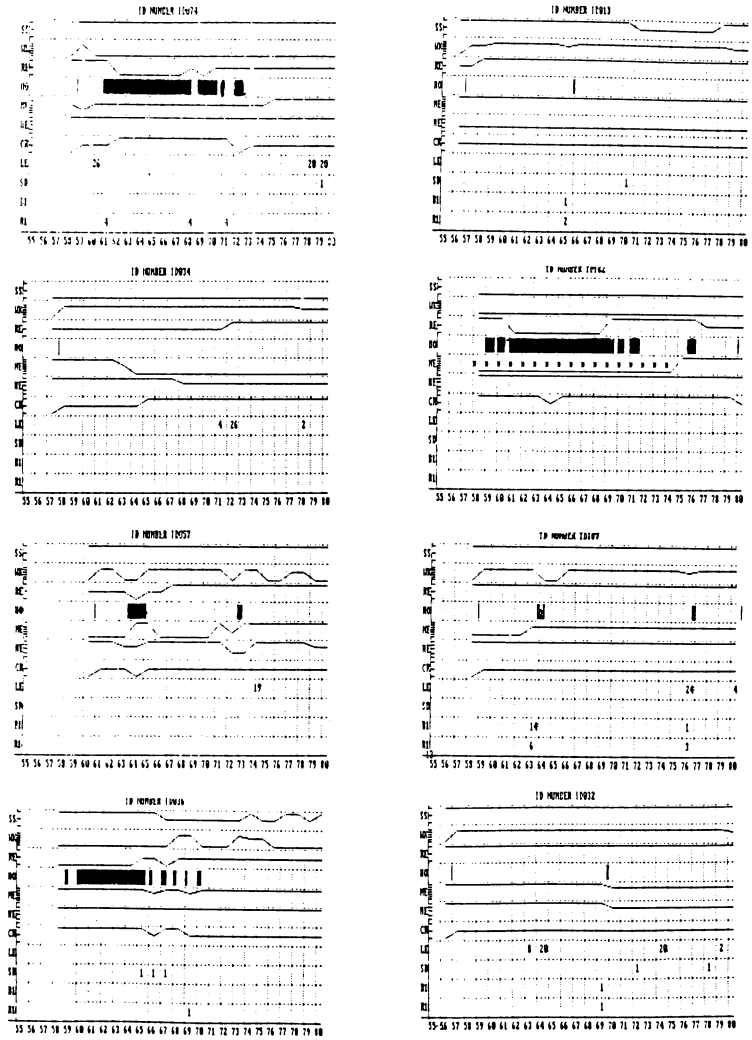

FIG. 4. Some patterns of recompensation and decompensation in schizophrenia.

220-dimensional space would have to be used. Depending on one's choice of the number of groups desired, the algorithm would cluster subjects according to the Euclidean 'distance' between subjects. However, few of the ten variables were measured at the interval level; most are either nominal or ordinal in nature.

Another procedure briefly entertained was a 'pattern recognition' computer device to cluster objectively the charts into groups. To accomplish this, however, we need new computers with simultaneous processing capabilities since our data collection procedures have currently outstripped the state-of-the-art computers available

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to universities. The only such simultaneous processing 'device' in existence is the human brain, and there is a long history in behavioural sciences of subjective rating scales, as well as established methods of determining inter-judge reliabilities on such scales. A future paper will report on the efforts of several leading longitudinal investigators to cluster the Vermont charts independently according to 22 *a priori* course types. In addition they have clustered the charts by gestalt appearance using a method similar to the one suggested by Meehl *et al* (1971) in order to add some reliability into the grouping and naming of the subsets.

It should be noted that completing the chart was sometimes a very powerful experience for the subjects because the patterns in their lives were often quite striking. Our interviewers, although trained clinicians, were not to undertake clinical work. Thus, they spent time debriefing subjects at the end of interview sequence and emphasised the good events that had occurred to the subject as a way of restoring some sense of equilibrium. From this experience we came to the conclusion that the Life Chart might be a strong therapeutic tool as well and suggest its use in the clinical arena in addition to being a helpful research mechanism.

To summarise, we would like to emphasise three major points. Firstly, there is a growing body of literature which supports the notion of wide heterogeneity in the long-term outcome of schizophrenia as defined by any diagnostic system. Secondly, longitudinal research begins to illustrate the rich complexity underlying a seemingly homogeneous subsample such as those with DSM-III schizophrenia (Harding *et al*, 1987*b*). Life Charts appear to provide a means of collecting such complex multivariate data in a systematic and reliable manner to illustrate a vivid image of patterns, processes, and interactions across a life course as well as the possibility of providing a powerful therapeutic tool for clinical practice. Lastly, the development of computerised Life Charts allows clustering of subjects into new homogeneous subgroups and permits energetic inquiry into mediating mechanisms which shape the long-term outcome of schizophrenia. It should be noted that in a recent chapter Vaillant (1987) has provided a thoughful critique of the major contribution made by such longitudinal efforts and the limitations which constrain these studies.

Sam Novey (1968, p. 3) once declared that "Psychiatric disorders do not lend themselves to consideration as disease processes relatively divorced from the normal constitution and development of the individual. They are to be understood only in the context of the life history of the individual, and the personal biography becomes an essential facilitative device in the process of treatment" – to which we would add "and research".

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