7 | The Automated Clinic: Past Futures of Digital Health

> It is predictable that the computer probably will have the greatest technological impact on medical science since the invention of the microscope. The combination of automation and computers is already producing complex systems with speed and precision unmatched by even the most highly trained personnel: systems which can tirelessly perform routine repetitive procedures day after day, faster, more accurately, and in a manner not humanly practical, nor even possible.
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> *--Morris Collen (1966) "Computer Medicine: Its Application Today and Tomorrow"*[1]

This chapter turns towards computers. Specifically, I want to describe an early manifestation of computers in medicine: large, clunky mainframes, vast magnetic tape reels, stacks of punched cards, a computer moment that seems quite discontinuous with our own. This is not an origin story or a complete arc of the computer in medicine. One could find many origins even in North America alone: Homer Warner's work in Utah to build a diagnostic aid (Health Evalutaion through Logical Processing, or HELP). Vladimir Zworykin's efforts at Rockefeller to build an international association of medical electonics (Medical Electonics). Warner Slack's work at Wisconsin to take patient histories by computer terminal, Keeve Brodman's work at Cornell to use computing to build diagnostic programs (Computing Diagnosis), G. Octo Barnett's medical records at MGH (MUMPS) or the rise of medical computing in the VA hospital system. All of these stories are worth telling; but their sum would be a book in itself, if not several books

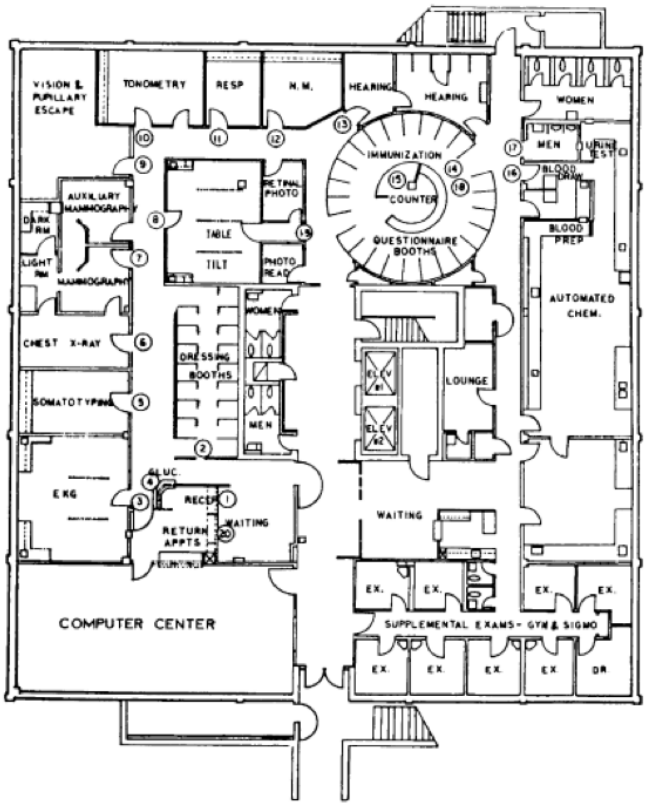
Instead, this chapter will discuss a particular clinic, built in a particular space with a particular task at hand for specific set of stakeholders, that would unexpectedly become the fulcrum for imagining the digitalization of human life in all applicable medical respects—for a brief window in the late 1960s and early 1970s—and then be largely discarded, at least in the American scene.

[1] Collen, Morris F. "Computer Medicine: Its Application Today and Tomorrow." *Minnesota*, no. 11 (1966): 1705–7., quote p 1705.

I first learned about this project through a series of artifacts. Poking around in a the archive of papers left by the former Johns Hopkins University chair of medicine, A. McGehee Harvey, I opened a folder labeled 'medical histories' with great interest, but was surprised to find that it contained not papers but a stack of specialized punch cards: a pink one to hold the contents of a urinalysis, a blue one to record the relevant results of a chest x-ray, another for a basic physical examination. They were part of a bold project by Kaiser Permanente to redesign of the primary care clinic into a series of spaces—each of which corresponded to one of the computer cards. The patient started at reception (station 1) moved through the clinic until their record was complete—and the punch cards could then make an electronic medical record of the patient's health. A sample patient would be issued a master identification card at reception, then undress for EKG, glucose tolerance test, somatotyping (here you see the punch card), chest x-ray and mammography if indicated, followed by a tilt-table test, visual acuity/pupillary escape, tonometry, spirometry, retinal photography, and audiometry, before entering the history chamber, and exiting that for blood and urine sampling. Supplemental exams—including gynecological examination and sigmoidoscopy, for example, could be administered as needed in a separate section if a patient's prior answers or findings triggered a flag. Each of these stations generated a punch card, which fed into a central mainframe computer. the final data was computerized (at station 20) as a total health report of the patient, printed out, and then sent to the patient's physician.

"I have to admit" noted a science writer whose account of the clinic "Better Health Through Automation", appeared in *Readers' Digest* in July of 1966, "that when I first heard about the center, I didn't know much about it, and some of the terms that go with it—"automated" "computerized" "multitest" and so forth—stirred some rather interesting images. But actually, in the experience itself, I don't think it is emphasized enough that you are really dealing with people. And these

people give you the tests. You are not connected into machines any more than you ever would be in a physical examination. They use equipment, and it is equipment that almost anyone may have experienced if he has had a number of physical examinations." "The computer" he continued, "is something that the typical patient in the center never sees, and I don't think he is even aware that the data is being processed as it is taken from him."[2] Indeed, the space of the clinic was specially designed so that a patient enter the clinic and emerge roughly 2 hours later with a fully computerized health profile.[3]



1. Design of facility for automated multitest laboratory.

[2] Leonard A. Stevens, statement before Senate Special Committee on Aging, *Detection and Prevention of Chronic Disease Utilizing Multiphasic Health Screening Techniques*, p. 223.
[3] Stevens, Leonard A. "Now — The Automated Physical Checkup." *Readers Digest* July 4 (1966): 95–98.

The computer clinic at 3772 Howe Street in Oakland was the brainchild of the physician-engineer Morris Collen. By the close of the 20th century, Collen would become towering figure in the history of medical computing and medical informatics, but a half-century earlier he had found himself struggling, over the course of the 1950s, to manually manage the data collection of health screenings for a series of employers, especially the International Longshoremen's and Warehousemen's Union. By the early 1960s, Collen began to think that the new media of digital mainframe computing offered a means to not only rationalize health screenings but extend their use into a new, broader, more all-encompassing approach to the delivery of health care. Ultimately his designs at automating the clinic helped to produce a vision of what his boss at Kaiser-Permanente, Sidney Garfield, eventually named "total health care": the use of data systems to build a new model of healthcare formulated along lines of personalized protocols of prevention rather than sudden episodes of cure.

A decade after it opened its doors in 1965, more than half a million Americans had their health status digitized in the Bay Area multiphasic clinics of Kaiser-Permanente alone; a single clinic could process more than 200 patients a day. By the early 1970s, the clinic-as-computer seemed an almost inevitable eventuality of American healthcare, especially favored in plans to extend Medicaid and Medicare programs to a broader "Preventicare" model of maintaining health reather than merely treating disease. If Collen's dreams did not turn out as planned, his computerized nonetheless had This chapter explores the many stages on which the future of Collen's computerized clinic played out against the backdrop of a shifting presents, in which the computerization of health care could alternately be viewed with both anticipation and anxiety.

Automating health.

Collen's entry into medical computing was prompted by a call from Lester Breslow, an old classmate from the University of Minnesota School of Medicine. Working within the California State Department of Public Health in the late 1940s, Breslow had become broadly interested in the role of screening in the detection of chronic disease, a subject of increasing concern to employers. By the middle decades of the 20th century employers, as the leading cause of mortality in the United States shifted from infectious diseases to more indolent chronic conditions like heart disease, cancer, and stroke, several insurance companies, public health agencies, and employers hoped that earlier detection of asymptomatic conditions might lead to prevention and better outcomes.[4] A suite of new screening tests: portable chest X-rays to detect hidden tuberculosis, Pap smears and mammograms to detect hidden cancers, urine tests and blood tests to detect hidden diabetes, provided an increasing array of means to scan the bodies of the overtly health to seek hidden signs of disease.

Breslow's, as a newly appointed public health official tasked with the management of chronic disease in the State of California, noted that the increasing number of screening tests available were beginning to pose a problem for physicians (who did not like being told to use them, and often objected to the conflation of "screening" and "diagnosis"). His solution was to create a separate space in which a series of screening tests could be done at onece, outside of a clinical visit, to enhance the ability to detect occult pathology. Breslow called this process "multiphasic screening," and first tested the concept in a San Jose, California in a demonstration project in 1948. "In the interest of economy and of better service to persons examined," he later described, "the project

[4] Breslow, Lester, and Malcolm H Merrill. "Chronic Disease: The Chronic Disease Study of the California Department of Public Health." *AJPH* 39 (1946): 593–97.

combined screening tests usually done separately and applied them in a single procedure to 945 employees in four industrial establishments."[5] This included chest x-rays (for pulmonary tuberculosis), blood and urine samples (pulmonary disease, heart disease, syphilis, kidney disease, diabetes), as well as personal and medical histories. Any abnormal values could be referred to physicians—Breslow was very conscious of the need to separate screening and diagnosis.[6] He repeatedly stressed the point—especially as the American Medical Asssociation took increasing interest in his work over the 1950s—that "the multiphasic screening procedure is not a substitute for a visit to a physician," who should be visited annually whether symptoms were present or not.[7] In his efforts to build chronic health screening programs for the state of California, Breslow began to collaborate with the Kaiser Permanente Health Plan, an innovative new approach to employer-based medical insurance initially tied to the Bay Area shipping industry. After receiving a contract from the San Francisco International Longshoremen's and Warehousemen's Union in 1951, Breslow reached out to Collen to join him on the project.

From June to November, 1951, nearly 4000 men passed through an expanded 12-test screening process which Collen and Breslow set up the International Longshoremen's and Warehousemen's Hall. The tests (height and weight, vision, hearing, chest X-ray, electrocardiogram, blood pressure, VDRL for syphilis, hemoglobin, urine sugar, urine albumin, and a formatted medical history derived from Keeve Brodman's Cornell Medical Index, resulted in more

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6 "Multiphasic Screening." *AJPH* 40, no. 3 (1950): 324–25; Breslow, Lester. "Multiphasic Screening Examinations An Extension of the Mass Screening Technique *," 1950. See also Statement of Dr. Nemat O. Borhani, *Detection and Treatment of Chronic Disease*, p. 176. "Multiphasic Screening." *AJPH* 40, no. 3 (1950): 324–25.

7 Breslow L. Multiphasic Screening Examinations An Extension of the Mass Screening Technique. *AJPH*. 1950;40:274–8, p. 278.

than 1,000 new diagnoses in a population previously considered to be fully healthy.[8] Follow up studies in 1956 and 1960 indicated that while these screenings had been helpful, far more could and should be detected by adding still more screening modalities to the mix: electrocardiograms, phonocardiograms, table-tile testing, anthropometry, mammography, lung function testing, visual acuity, ocular, tension, retinal photography, audiometry, pain reactions, personality appraisals (modified MMPI), and a growing number of blood and urine tests.[9] Each new test added to a screening portfolio increased the sensitivity for detecting unseen disease, early enough, one hoped, to prevent poor outcomes. Yet each also added dramatically to the computational challenges of screening, storing, retrieving, and analyzing data produced for populations and individuals—especially when this work was being done manually using paper forms.

[8] Weinerman, E. Richard, Lester Breslow, Nedra B. Bellocc, Anne Waybur, and Benno K. Milmore. "Multiphasic Screening of Longshorement with Organized Medical Follow-Up." *AJPH* 42 (1952): 1552–67.

[9] Statement of Dr. Nemat O. Borhani, *Detection and Treatment of Chronic Disease*, p. 179-80.

Results of the Tests

The Permanente Medical Staff will examine the results of all the tests. The doctors will notify each man by **confidential letter** that either:

- **The tests show a warning sign of illness and the person should see his doctor.**
- **That the results of these tests are normal.**

The results of the tests are available *only to you and the doctor.* (By law, no one but the patient has the right to release medical information.)

Follow-up Medical Care . . .

We can have this program for disease detection because we already have coverage for Hospital-Medical-Surgical care in the Permanente Health Plan. If these tests show the need for examination and treatment, we can get it without worrying about big bills. Those who wish to consult doctors outside of Permanente can easily arrange to have the results sent to their doctors. (However, expenses for outside doctors are not covered by the Permanente Plan.)

What's in it for . . .

The U. S. Public Health Service and the State Dept. of Public Health?

It's their full-time job to promote good health. To do this, they must operate programs to find disease and to control it, once found. They have done these same group health tests elsewhere in the U. S. and in California, and have proved the value of them. Therefore, these Public Health Agencies are giving their experience, technical assistance, personnel and equipment to our program.

The Permanente Health Plan?

Since we've been in the Permanente Plan, many of our members have not been to the doctor until they practically collapsed on the job. Then they've had to have costly emergency service and long and expensive hospitalization. Permanente is providing these tests now to detect serious diseases in their earliest stages, when treatment can be more effective and less complicated.

YOU?

This is a program to find the early and otherwise unknown signs of certain illness. These illnesses are the leading causes of death and disability in the United States. The beginning of these illnesses are not always known or even suspected by the individual. . . When they are discovered early, they can be effectively treated.

Whatever you learn from your tests, it's good to know.
If your tests show no sign of trouble, that's good news.
If they show hidden trouble, that's also good to know.
It means that you and your doctor can go right to work for your health and well being.

Are You ship shape?

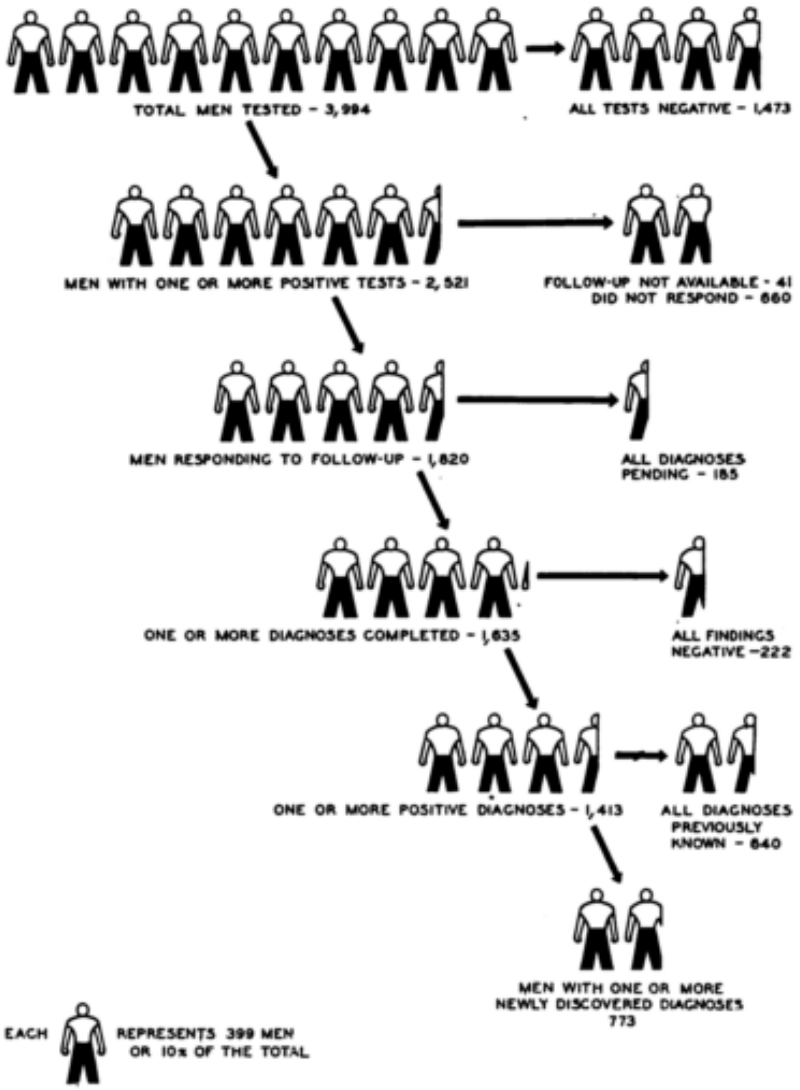

FIGURE 2—Results of Diagnostic Follow-up of Longshoremen, June 18, 1951 to November 30, 1951. (Source: Table 4.)

FIG X. Weinerman, E. Richard, Lester Breslow, Nedra B. Bellocc, Anne Waybur, and Benno K. Milmore. "Multiphasic Screening of Longshorement with Organized Medical Follow-Up." *AJPH* 42 (1952): 1552–67.

Enter the IBM 1440. By 1961, Collen was enthusiastic that the excess amounts of information through an increasing number of screening tests could benefit from the capacity of new minicomputers (such as the Kaiser-Permanente's new IBM 1440) to automate the collection and processing of data. After receiving a small grant from the Public Health Service in 1963 Collen, as Director of Medical Methods Research of KP, reached out to the IBM Oakland Branch Office to make plans for more specialized data processing requirements for this task. IBM proposed a novel configuration of an IBM 1440/1311/1050 system, a computer with 12K of operating memory.[10] Collen also used the opportunity to rethink the space of the screening itself, transforming the architecture of preventive screening from the prior "health fair" model, (which batch-processed thousands of workers in a great hall before they shipped out to sea) into a new sort of clinic: an automated multiphasic health clinic, purpose-built to sample the everyday American population and more effectively shift the gaze of medicine towards prevention as well as cure.

Collen presented the abstract of his program to the 5th IBM Medical Symposium in Endicott, New York, in October of 1963. By this point Kaiser-Permanente had been offering "Multiphasic Health Checkups" for local employers for more than a decade, with more than 25,000 patients screened annually. As the name "checkup" suggested, Morris worked consciously to blur the line between screening and diagnosis. The Automated Multiphasic Screening Program, in which every station would be recorded on a punch card and sent to a computer, was the first in a three step sequence, followed by a physical examination by the patient's internist, and then concluding with a group of specialty physician examinations, (e.g., Pap Smear/sigmoidoscopy, depending on patient demographics) as determined by preventive care algorithms built into the clinic computer. For

[10] "An Online, Teleprocessing, Random Access, Medical Physical Check-Up System" [n.d. memorandum] MFCC box 5.1 f 3.

Kaiser-Permanente, the automated clinic was to be the gateway into the health care system for all newly-insured patients. For IBM, it was to be much more.

"The recent advent of electronics and automation into medicine offers the opportunity to improve and augment screening technics and instrumentation," Collen told the crowd at Endicott,, "so that not only more tests, but more accurate and quantitative measurements can be performed, and permits the introduction of new and expanded concepts into multiphasic screening."[11] Working with the statistician Jerzy Nyman at Berkeley, and Lou Davis, a systems engineer at IBM/Oakland, Collen's team from Kaiser Permanente deipcted the integration of computers into the design of new clinics as a constructive step in further blurring the lines between screening and diagnosis, prevention and care "Since diagnosis is defined as the identification of a specific disease," Collen concluded, "then as screening becomes more comprehensive, precise, and quantitative, disease detection approximates disease diagnosis and automated multiphasic screening approaches automated diagnosis."[12]

By 1963, Collen's automated clinic contained separate stations for EKG, spirometry, anthropometrics, chest Xray, mammography, visual acuity, ocular tension, retinal photography, audiometry, urinalysis, CBC and CMP. At each station, results were recorded on pre-punched or mark-sensed cards and fed into the central IBM computer.[13] Jerzy Nyman's new method of calculating likelihood statistics for various conditions could then be used to merge populational and individual decision making in diagnosis. As Collen continued,

The only data necessary for this method are the determinations (for each disease to be

[11] Morris F. Collen. "Machine Diagnosis from a multiphasic screening program" *5th IBM Medical Symposium, October 7-11, 1963* Endicott NY, International Business Machines, 1963, pp 131-153, quotation p. 131.
[12] Morris F. Collen. "Machine Diagnosis from a multiphasic screening program" *5th IBM Medical Symposium, October 7-11, 1963* Endicott NY, International Business Machines, 1963, pp 131-153, quotation p. 132.
[13] Morris F. Collen. "Machine Diagnosis from a multiphasic screening program" *5th IBM Medical Symposium, October 7-11, 1963* Endicott NY, International Business Machines, 1963, pp 131-153.

> screened) of the proportions of individuals with the disease who have certain selected combinations of symptoms, and the proportions of individuals without this disease who have identical combinations of symptoms. On the basis of a patient's response to questions and tests directed towards eliciting these specific symptoms, the individual is placed into one of two categories: either he warrants further testing, since he is likely to have the disease, or he does not warrant further testing or the disease. The degree of likelihood of the patient falling into the disease category is determined by criteria previously established by the physician and will vary according to the disease under consideration. [14]

Collen noted that this method avoided some of the problems of Bayesian logic that had limited other attempts to computerize diagnosis, since Neyman's method did not require a prior knowledge about the prevalence of a disease, or when prevalence was changing over time. [15]

The experimental automated screening clinic was originally located in the Oakland Hospital campus at 3779 Piedmont Ave. As it attracted more interest inside and outside of Kaiser-Permanente, the clinic moved into new, specially designed space at 3772 Howe St, expanded to 20 stations, could handle roughly 4000 patients monthly. Between 1965 and 1975, more than half a million Americans were digitized in the Bay Area multiphasic clinics of Kaiser-Permanente alone; a single clinic could process more than 200 patients a day.[16] While the results of tests requiring physician interpretation, such as EKGs, X-rays, and retinal photographs required further processing time, for the bulk of information, "at the completion of the collation procedure, the computer will process the patient's data through a diagnosis computer program by means of an IBM 1440 system and print out a 'provisional diagnosis'."[17]

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[14] Morris F. Collen. "Machine Diagnosis from a multiphasic screening program" *5th IBM Medical Symposium, Octonber 7-11, 1963* Endicott NY, International Business Machines, 1963, pp 131-153, quotation p. 136.

[15] Note that a team of IBM researchers continued to work on the deficiencies of Bayesian models and the importance of developing self-improving processes (machine learning?). R. E. Bonner, C. J. Evangelisti, H.D. Steinbeck, and L. Cohen,. from the Medical Information Systems, Advanced Systems Development Division, IBM. Paper titoed "DAP—A diagnostic assistance program" in *Proceedings of 6th IBM Medical Symposium, October 5-9, 1964* Poughkeepsie NY, International Business Machines, 1964, pp 81-108.

[16] Use Collen's 1966 article as a basis for walking the reader through the 20 steps. Collen, Morris F. "Periodic Health Examinations Using an Automated Multitest Laboratory." *JAMA: The Journal of the American Medical Association* 195, no. 10 (1966): 830–33

[17] Collen, M F, L Rubin, J Neyman, G B Dantzig, R M Baer, and A B Siegelaub. "Automated Multiphasic Screening and Diagnosis." *American Journal of Public Health* 54, no. 5 (1964): 741-50, p. 743.

By revisiting the entire clinic as a man-machine interface, Collen's project to automate prevention via a digital medical record broke down the barriers that Breslow had previously insisted separated the public health act of screening from the medical act of diagnosis. The new analytic potential of the IBM 1440, in Collen's hands, served as the nidus for a new clinical space in which the computer did not merely store and tabulate data but would be willing to hazard a diagnosis through algorithms of its own. "Periodic inventory will be taken of internist's diagnoses stored in the computer," Collen explained in the *American Journal of Public Health* the following year, "so as to continually enlarge and improve the diagnostic ability of the program."[18] The machine could learn, and the vast troves of medical data it produced could also produce new norms, new pathways for differentiating pathology, normality, and the spaces in between. Drawing on the statistical comuting method of Jerzey Neyman, Collen saw a means to use improve on Bayesian logic to improve diagnostic computing in his Oakland clinic.

Extending the computer network

On September 20, 1966, a mobile screening unit was set up outside of the New Senate Office Building, and Senator Harrison A. Williams of New Jersey emerged just before 10am as the first member of Congress to have his health status digitalized. Reporting back to fellow members of the Senate Special Committee on Aging, which oversaw the management of Medicare, Williams noted that "I only went through part of the tests…the glaucoma test, and I will say right now that I am a

[18] Collen, M F, L Rubin, J Neyman, G B Dantzig, R M Baer, and A B Siegelaub. "Automated Multiphasic Screening and Diagnosis." *American Journal of Public Health* 54, no. 5 (1964): 741-50, p. 743.

little bleary from the drops that are necessary for the proper testing."[19] Nonetheless, as he led other colleagues on Senate Aging not only in participating in automated health testing themselves but in investigating the broader value of new computerized algorithms in health testing as a feature of the American healthcare landscape, Williams was confident that mobilizing multiphasic screening techniques could help transform the new Medicare and Medicaid programs, from reactive to a proactive arms of a health system focused on prevention instead of merely treatment.

"We can and must believe" he continued, "that a great nation, in an age of technological marvels, can enter an age of health maintenance, rather than relying almost solely on health repair." Calling on experts from "medicine, biochemistry, sociology, and automated equipment," he sought to develop over three days the evidentiary basis to pass a new bill—titled the Adult Health Protection Act, or "Preventicare"—to extend Medicare coverage to include automated multiphasic health screening. Morris Collen's computer clinic in Oakland was cetnralto these hearings.[20] As Willaims' House co-sponsor of the bill, Representative John Fogarty (RI) noted on the opening day of the hearings, "one pioneering development I had the privilege of observing not long ago is an imaginative program being carried out by the Kaiser Permanente Health Foundation in California":

> There we saw a health testing program which utilizes automated equipment and computer techniques for providing a comprehensive battery of tests to large numbers of persons with a minimum of time and cost…Recent advances in the field of automation clearly present us with most welcome opportunities to make medical testing services more widely available, to heighten their effectiveness, and I hope, to bring down costs."[21]

Over three days the Committee interviewed deans of medical schools, heads of hospitals, commissioners of public health, the eminent cardiovascular surgeon Michael DeBakey, and many

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[19] *Detection and Prevention of Chronic Disease Utilizing Multiphasic Health Screening Techniques.* Hearings Before the U.S. Senate, Subcommittee on Health of the Elderly of the Special Committee on Aging, September 20, 21, and 22, 1966. Washington: U.S. Government Printing Office, 1966. P.1.

[20] *Detection and Prevention of Chronic Disease Utilizing Multiphasic Health Screening Techniques* P.2

[21] *Detection and Prevention of Chronic Disease Utilizing Multiphasic Health Screening Techniques* P.2-3

others. During his questioning by Committee Chairman Sen. Maxine Neuberger, Dr. Arthur E. Rappaort, of the American College of Pathologists, related the hopes but also the concerns of many physicians in the face of increasing health data emerging from automation protocols:

> DR. RAPPAPORT: We have a great many tests, we have thousands of tests that would be useful. How shall we perform it? Do we have the people to do it? Well, automation promises to give us some relief but what we gain in the relief of the performance of tests we lose by the flood of information. We literally get overwhelmed by the data that is being produced by these multichannel testings. So we have to come up with better means of handling that information and I think computers serve a very useful purpose to do so
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> SEN. WILLIAMS: If you depend on the IBM card you might come up with cancer you don't have.
>
> DR. RAPPAPORT: If you put garbage in you get garbage out. This is an old cliché in the computer trade, as you know. Instead of making it easier it is going to require more and more critical professional evaluation of the data being produced in such enormous quantities.[22]

Rappaport was very supportive of Collen's work at Kaiser-Permanente. "Dr. Collen—I will not steal his thunder—has done an enormous job."[23] Yet he did wonder aloud whether to the successes of Collen's program might be due to the generally healthy—and relatively homogeneous—employed of patients who had joined the Kaiser-Permanente plan through their employers. Would similar results be found in the impoverisged Medicare and Medicaid populations were the program to be expanded nationwide?

Collen's testimony was joined by other innovators in medical computing of the late 1960s. This included Duke University Medical Center's clinical laboratory director Ralph E. Thiers, Wisconsin professor medicine and computer sciences, Warner V. Slack of the University of Wisconsin, and Cesar Caceres of George Washington University and the U.S. Public Health Service.

[22] *Detection and Prevention of Chronic Disease Utilizing Multiphasic Health Screening Techniques,* p. 54-55.
[23] *Detection and Prevention of Chronic Disease Utilizing Multiphasic Health Screening Techniques,* p. 57.

Slack had just published a paper in the *New England Journal of Medicine* introducing the direct recording of patient histories into computer terminals.[24] Caceres, who headed a PHS program that evaluated the role of new electronic instrumentation in preventing chronic disease, and had recently developed a computer program to analyze EKGs and pulmonary function tests. Thiers had already been celebrated for his efforts to provide automatic analysis of chemistry results through the Technicon SMA 12 autoanalyzer. Their work collectively helps to frame Collen's Oakland clinic as one of many visions of transforming clinical spaces through punch-card computing.

"Medical history is a very time-consuming process," Slack told the committee, "and incomplete or inadequate histories are often the result of time limitations beyond the physician's control. As a corollary to this, the medical history process is very expensive. Actually talk is one of the most expensive commodities in clinical medicine." The value of paper records were further limited by the "traditional illegibility of the physician's handwriting" which coupled with the nonstandardization of the order of material in clinical notes made "retrieval of this information for patient care and clinical research difficult and often impossible."[25] Using the MIT-designed LINC digital computer newly available at the University of Wisconsin Medical Center to automate this process of history taking, Slack constructed set of questions that would expand and contract, accordion-like to capture a past medical history, chief complaint and history of present illness.[26]

Senator Ralph Yarborough of Texas interrupted Slack at one point to ask if such systems might discriminate against the many Americans that did not know how to type. Slack dismissed the

[24] Slack, Warner V, Phillis Hicks, Charles E. Reed, and Lawrence J. Van Cura. "A Computer-Based Medical-History System." *New England Journal of Medicine* 274, no. 4 (1966): 194–98. doi:10.1056/NEJM199308123290707.

[25] *Detection and Prevention of Chronic Disease Utilizing Multiphasic Health Screening Techniques,* pp. 90-91.

[26] The LINC (Laboratory INstrument Computer) was an important forerunner of the personal computer. First developed at MIT in 1962 in collaboration with the NIH.For more on the history of LINC, as well as the brader development of computers as research tools in biomedicine, see Joseph November, *Biomedical Computing: Digitizing Life in the United States*. Baltimore: Johns Hopkins University Press, 2012.

concern. "With an eighth-grade education, people have been able to use our system quite well."[27] Indeed, Slack testified, "With proper technological development (using such means as mobile medical history units and regional health center), low-cost, high quality computer-based medical interviewing can be made available to large groups of people who might not otherwise seek medical care as well as those patients whose physicians need help in their task of medical history taking.

Caceres, in turn, used his testimony to document how computers could aid in the analysis of digitized versions of physiological tests. Once digitized, tests of lung function or electrocardiograms could be sent via telephone lines to mainframe computers and analyzed using an ever-adapting set of algorithms. Caceres also praised Collen's work in Oakland as part of a larger vision of the computer as a vehicle to streamline the quality and value of health care. "We have seen in Kaiser-Permanente, in California" Caceres argued, "which has studied the logistic flow of people through a clinic and through many laboratory tests, that periodic health evaluations are useful, not just to the elderly, but of course to others."[28] "In short, automation of medical and laboratory tests is the essential backup to the physician for the economical delivery of health services."[29]

Collen agreed. "What we have done is to put together the largest-coordinated program that functions on line with a computer," Acknowledging that Slack's work was key to the way that his clinic automated the patient history, and that Caceres' work was key to how the Oakland clinic automated the EKG results, the overall aims of the Kaiser-Permanente program were synthetic.[30]

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[27] *Detection and Prevention of Chronic Disease Utilizing Multiphasic Health Screening Techniques,* p. 33.
[28] *Detection and Prevention of Chronic Disease Utilizing Multiphasic Health Screening Techniques*. P. 106.
[29] *Detection and Prevention of Chronic Disease Utilizing Multiphasic Health Screening Techniques*, p. 111.
[30] Asked about the work that Warner Slack's team had been doing in Wisconsin to get patients to interact directly with computer terminals (instead of punch cards), Collen noted that "his work on the matter of history taking is more advanced than ours, and we have been following his work with great interest…Dr. Slack has gone one step further, in that not only can the patient communicate with the computer, but he can go on through branching questions. In our program, if a patient answers "yes" we present that "yes" to the doctor and the doctor goes through the branching process of: If yes, so what? and so forth. Dr. Slack's program permits the computer to ask: "If yes, so what?" And it can pursue history taking all the way to the ultimate, the same as the doctor." Given more financial resources, Collen suggested that the Oakland clinic would be very interested in pursuing this line. But for now, he concluded, "The boxes we have made with the cards are very cheap. They only cost us $1.17 to make, and cards are only $1 per

"Perhaps that is our contribution," he told the panel, "to develop a larger package, so to speak"[31] Collen described the many aspects by which the Oakland clinic permitted the direct digitalizatioj of relevant information from physiological testing, physical examination, and even the patient history:

> At station 14, a self-administered medical questionnaire form, which the patient received at the first station, and which was completed while waiting between stations—this questionnaire is now audited by the nurse. The patient is then assigned to one of 24 questionnaire booths in accordance with the sequencing number which was assigned to the patient at station 4.
>
> Here the patient receives a box which contains a deck of 207 punched cards, each having a separate question printed on a card. The questions have been selected which are adjudged medically to be of value in discriminating patients with specific diseases from nondiseased persons. The patient responds to each question by taking the card from the top section of the divided letterbox and dropping the card into the middle section if his answer is "Yes," or into the bottom section if the answer is "No." This procedure automatically sorts yes responses for direct input into the computer by means of a card-reading machine.
>
> …By the time the patient turns in this last questionnaire, the on-line computer processing has been completed and supplemental tests and appointments are advised by the programmed rules of the computer, and these are arranged for the patient.[32]

Asked about physician resistance to automated screening by Committee Chair Sen. Maxine Neuberger, Collen replied that while he understood the skepticism, "I think that the physicians cannot possibly criticize the fact that automated equipment usually performs tests more accurately than people. Automated equipment not only improves the quantity, but also improves the quality of tests. The utilization of automated equipment and computers also permits us to produce more information on more people and more information on each individual."[33] This approach to data, he suggested, allowed time with physicians to become more, rather than less, personalized. Eventiually, rather than comparing a patient's lab values to the norm of the population, the computers would

1,000. In order for us to install cathode-ray tubes for our 24 stations open at San Francisco and do what he is doing would, of course, involve $100,000 or more." *Detection and Prevention of Chronic Disease Utilizing Multiphasic Health Screening Techniques*, p. 226-7

[31] *Detection and Prevention of Chronic Disease Utilizing Multiphasic Health Screening Techniques*, p. 214.

[32] *Detection and Prevention of Chronic Disease Utilizing Multiphasic Health Screening Techniques*, pp. 215-16.

[33] *Detection and Prevention of Chronic Disease Utilizing Multiphasic Health Screening Techniques*, p. 220.

ideally be able to compare a patient's given measurements to their own personal norms, established while they were in a state of good health and stored in the data banks of the Kaiser-Permanente system.

Patients also reported favorable experiences with the automated clinic, and Collen pointed to the long waiting list of patients trying to get appointments at the Oakland facility, which by 1966 still had a waiting list of over a month. Several patients had returned again and again to repeat their multiphasic testing. Asked whether multiphasic testing increased the workload of physicians, Collen answered to the contrary: the testing offloaded busy-work from physicians and freed up more time to have meaningful conversations with each patient, sicne the routine testing was already out of ther way.

Collen was joined by Leonard A. Stevens, who as a science writer put his own body through one lap of the Oakland automated clinic and wrote about the experience for *Readers' Digest*. Stevens compared the experience in Oakland with his most recent checkup with his family doctor in New Milford, CT a few months earlier. Stevens had showed up in his physician's office for an 8:30pm appointment but was told his doctor had been called to the hospital. The harried physician emerged at 10pm and did not finish the history and physician until midnight, after which Stevens still had to go to the local hospital the next day to complete basic screening tests. By comparison, Stevens was in and out of the well-oiled Oakland machine in just a few hours. Before visiting Oakland, Stevens had discussed the idea of the automated clinic with his doctor, who felt that "anything automated and computerized would certainly lack the personal, intuitive, human qualities" that are so important to a doctor in annual checkups. Yet when he received the results of Stevens' "computer read-out sheet" the physician admitted that he was wrong. "He saw this more as I think it really is," Stevens told the committee, "as a laboratory, that could relieve him of time that he would be spending asking

questions and doing such tests."[34]

Stevens' article in *Readers' Digest* was republished and circulated widely. "Dr. Collen has told me it created almost too much interest" he told the committee, "he has had so many people there to see his center." Pausing on the story of the "conversion" of Stevens' skeptical doctor, Sen. Neuberger asked about reforming medical education altorgehter. "Shouldn't our graduates in 1966 and so on be made aware that they can make use of automated equipment and computers, so that they wouldn't even question it? Do you know if that is being done, Dr. Collen?"[35] In his reply, Collen noted:

> To come back to the previous problem, it is our experience that the physician goes through three stages. The first one is skepticism and distrust. Later, when the physician has an opportunity to participate, to receive patients who have received these reports, they become open minded. Then after it becomes evident that it provides more and better services to their patients, they demand it. I think it is only a matter of time before patients and physicians will both demand it.[36]

Collen returned from Washington sanguine about the possibility of deploying automated multiphasic clinics on a national scale. In November of that year he began a model "Training Program in Automated Multiphasic Screening" to develop a cadre of automated clinic leaders to take the concept to all regions of the country. Transcripts of this event contain his advice to those who would start up their own computerized preventive medicine clinics. Prior to the advent of the computer, Collen noted, routine health screening was limited in part by its own tedium:

> When we first started the program fifteen years ago at the end of the line we had a doctor…well, after a month and we'd set up all our procedures we had another doctor do it and he lasted about three months and at the end of the year I couldn't buy a doctor for love or money who would sit at the end of that line and go over these routine repetitive tests and so or the next fourteen or fifteen years we didn't have any physicians at the end of the line. Now you will see that the computer does that. Look over all the tests that have been done. The

[34] *Detection and Prevention of Chronic Disease Utilizing Multiphasic Health Screening Techniques*, p. 224.
[35] All quotes *Detection and Prevention of Chronic Disease Utilizing Multiphasic Health Screening Techniques*, p. 225-6.
[36] *Detection and Prevention of Chronic Disease Utilizing Multiphasic Health Screening Techniques*, p. 226

> computer has been programmed by the physician to do what the physician used to do but can't stand any more. The computer here functions as a slave to the doctor and does exactly what the doctor wanted him to do and it does it over and over and this little computer you will see functioning the next few days has looked over the results on one hundred thousand people the last three years and is still not tired or bored and does exactly the same job it does on the one hundred thousand as it did on the first thousand.[37]

That same month Collen gave a lecture the Minnesota Medical Association on "Computer Medicine: Its Application Today and Tomorrow, "[38] in which he expanded his prediction that "the advent of automation and computers will undoubtedly introduce a new era of medical practice.":

> It is predictable that the computer probably will have the greatest technological impact on medical science since the invention of the microscope. The combination of automation and computers is already producing complex systems with speed and precision unmatched by even the most highly trained personnel: systems which can tirelessly perform routine repetitive procedures day after day, faster, more accurately, and in a manner not humanly practical, nor even possible."[39]

Cybernetic approaches to medicine, Collen insisted ,not only allowed for simultaneous increases in the quantity and quality of clinical work while lowering costs, but also contributed to fundamental changes in the nature of clinical thought and practice.[40] As a result of this optimism he often seemed surprised that physicians might be resistant to the rise of cybernetic systems in the clinic. As a clinician and a computer scientist himself, he saw the two domains as mutually constituitive. After all, he explained to the crowd in Minneapolis, "[t]he physician who is skilled in diagnostic evaluation of the complex physiological systems in the human body is probably the best trained systems analyst in present society."[41]

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[37] P. 9. "Training Program in Automated Multiphasic Screening: Phase 1—For Project Directors" November 1966, unpublished transcript, box 4.3 5509, MCP.

[38] Collen, Morris F. "Computer Medicine: Its Application Today and Tomorrow." *Minnesota*, no. 11 (1966): 1705–7; see also Collen, Morris F. "The Multitest Laboratory in Health Care of the Future." *Hospitals, J.A.H.A* 41 (1967): 119–25.

[39] Collen, Morris F. "Computer Medicine: Its Application Today and Tomorrow." *Minnesota*, no. 11 (1966): 1705–7., quote p 1705.

[40] "The introduction of a cybernated system not only speeds up the quanityt of work, improves the quality, and lowers the cost, but usually produces changes in thinking and philosophy related to the functional aspects of the work. Collen, Morris F. "Computer Medicine: Its Application Today and Tomorrow." *Minnesota*, no. 11 (1966): 1705–7., quote p 1705.

[41] Collen, Morris F. "Computer Medicine: Its Application Today and Tomorrow." *Minnesota*, no. 11 (1966): 1705–7., quote p 1707.

A follow-up conference at the National Academy of Engineering, held in Andover, NH, in August of 1968, appeared to confirm this belief. For the 175 elite and excited audience members packing the Proctor Academy in Andover, witnesses recalled the "mood was electric." Participants in this meeting recall that they "felt that they were participating in the birth of an explosive new health-care industry, geared to the accomplishments of the space age and aimed at revolutionizing the health-care delivery process of the United States." The United States Public Health Service reported that new clinics based on the Oakland model in Milwaukee, Brooklyn, New Orleans, and Providence were already proving to be highly effective. The "soaring high point of the conference" according to one participant, was Morris Collen's keynote address, which was met with "resounding applause."[42]

Shortly before Collen addressed the Senate Aging Committee in 1966 Carruth J. Wagner, Chief of the Bureau of Medical Services of the U.S. Public Health Services, had also praised his work as central to the future of delivering public health to underserved populations, and held up the Oakland clinic as a model with the US Public Health Service was already working to replicate in other states "A giant step forward was taken a few years ago," Wagner added, "when the Public Health Service provided some assistance in research and development support to the periodic health appraisal program being conducted by the Kaiser Permanente Health Foundation in California…In June of this year, the Public Health Service negotiated contracts for the establishment of two health protection centers for the aged adult, based on the techniques developed in the Kaiser-Permanente program. One of these will be in Milwaukee, and will be conducted by the Milwaukee City Health Department. The other will be in New Orleans, and conducted by the Department of Tropical

[42] H.R. Oldfield, Jr. (President, Mediquip Coporation, Rockville Maryland) "Automated Multiphasic Hatleh Testing: A Diagnosis in Three Parts" *Journal of Clinical Engineering.* 1978; 3(2):1-5, p. 2.

Medicine, Public Health, Tulane University."[43]

A third was being already being planned in Brooklyn, and its director, Dr. Leo Gitman, was enthusiastic about the applicability of Collen's automated clinic to an inner city community health center in Brooklyn through the Brookdale Health Center. While the Brookdale population was differed greatly from the Kaiser-Permanente population in age, ethnicity, race, and socioeconomic class, Gitman was enthusiastic about the potential for "an adaptation of the Kaiser-Permanente model" for an inner city, African-Black and Latino population recently gaining expanded access to physicians chiefly through Medicaid.[44] "Until several years ago," Gitman noted, "I was extremely pessimistic over the solution of the problem of preventive medicine, especially in our high-density, low income, multi-ethnic population:

> The large numbers of people to be evaluated, the poor health orientation of the poor, the lack of adequate numbers of health professionals to handle the problem, the enormous expense of a sophisticated examination—all of these were difficulties which appeared overwhelming and the problem insoluble. ..The publications of the Kaiser-Permanente Group caused tremendous excitement for those of us struggling with this problem. It appeared to provide a solution…[with the support of the USPHS], we, at Brookdale, are developing a similar program. We are no longer pessimistic."[45]

Gitman was convinced that the automation of clinical intake was important as "as a means of entry into a health-care system for persons who have had little or no medical attention."[46]

"At Brookyn's Brookdale Hospital Center," a *Look* magazine account gushed in 1968, "which serves an area crowded with 500,000 or so of New York's poorest people, Dr. Leo Gitman has opened a multiphasic center where the biggest challenge is to bring the most elementary concepts of

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[43] *Detection and Prevention of Chronic Disease Utilizing Multiphasic Health Screening Techniques*, p. 137.
[44] *Detection and Prevention of Chronic Disease Utilizing Multiphasic Health Screening Techniques*, p. 270-1.
[45] *Detection and Prevention of Chronic Disease Utilizing Multiphasic Health Screening Techniques*, p. 272-3.
[46] Gitman, Leo. "Automated Multiphasic Health Screening: A Conceptual Model and Description of a Program." *Journal of Occupational Medicine* 11, no. 12 (1969): 669–73.

preventive health care to people who have never known any." Again, this reporting repeated Gitman's languge of the Brookdale population as a medically-naïve group:

> Dr. Gitman and his physicians and health aides are willing to try any technique, no matter how unorthodox, to bring patients in for screening. They sign up patients in Laundromats and bars—the social centers of the neighborhoods; they recruit in groceries and drug stores. They pass our health quizzes and offer drawings for color TV sets and radios as prizes. Opened only this winter, the Brookdale multiphasic screening program hopes to bring in 25,000 new patients a year and to persuade them to take the all-important step from screening to regular health care.[47]

In rural settings, too, the computerized clinic was seen as a vehicle for rapid expansion of access to care in tune with the expanding ranks of new Medicaid and Medicare patients. The Tennessee Valley Association, for example, had begun using mobile health clinics for periodic health examinations in the 1940s, but by the late 1960s they became interested in adapting Collen's techniques to rural health care . Their mobile clinics began to collect punch-card data that could be integrated into a mainframe computer system. Beginning in 1968 the TVA's mobile units began screening and collating data of rural communities across Northeast Mississippi and Appalachia, finding abnormalities and sending full printouts of data to relevant area physicians. Many more clinics seemed eager to build clinics with computers at their centers to re-define access.

Enthusisam: the expanding market for automated medical machines

By 1969, Collen was increasingly confident about the future of computerized health testing, even expansively so. "In the next 10 years," he observed in an editorial in the *New England Jounral of Medicine,* "it is likely that every community of 100,000 or more will have an automated multitest laboratory affiliated with one or more of its larger hospitals and medical centers…It is reasonable to

[47] The computers that will keep you healthy" Unpublished MSS, *Look Magazine*, MFCC, box 4.1, f 7, p. 10.

project that once automated multiphasic screening programs become generally available, the practicing physician will not only readily accept and adjust to them but will soon consider these services as indispensable for his patients."[48] Within the next year, in Collen's home state of California, the automated multiphasic screening clinic had spread outward from Kaiser to include 12 different organizations, stretching from San Diego to Los Angeles to multiple spots in the Bay Area and a mobile version as well.[49]

Enthusiasm for the automated clinic was not limited to audiences of physicians, public health officials, and health system planners. Several manufacturers of medical electronics took special interest in the dissemination of Collen's model for automating multiphasic health screening. If the computer would be central to the coming wave of technological clinics, many manufacturers vied to position themselves to dominate the new market for mainframe medical computing and their specialized interfaces into clinical realms. IBM, from the moment that Collen first contacted them, noted "to IBM, this project initiates a first step into a large potential market for automated mass screening."[50] Correspondence files preserved by Morris Collen are overflowing with letters and pamphlets from newly-hatched companies who banked on a rise of government spending in this area.

In May of 1971,Dr. Emerson Day, Vice President and Medical Director of the Medequip Corporation of Park Ridge, Illinois wrote to Collen describing the new "history-taker" machine which his firm had developed to replace the paper Mark-Sense cards. Collen employed at the Oakland clinic. "The Interex 1024™" he noted, "is a free standing console with television-like

[48] Collen, Morris F. "Value of Multiphasic Health Checkups." *New England Journal of Medicine* 280, no. 19 (1969): 1072–73, p. 1073.
[49] "Multiphasic Testing, 1971," *Socio-Economic Report,* Bureau of Research and Planning, California Medical Association, 9(1), January 1970.
[50] "An Online, Teleprocessing, Random Access, Medical Physical Check-Up System" [n.d. memorandum] MFCC box 5.1 f 3, p. 10.

display that interacts with a patient for self-administered medical history taking"—questions could be translated into several languages and tailored to a given clinic's needs.[51] Collen had shared a podium with Day at the 9th IBM Medical Symposium in 1968; By the early 1970s, Medequip was rolling out a suite of products for different stations in automated clinics: hearing testing, vision testing, anthropometry, blood pressure, EKG, tonometry, multiplex blood and urine testing, radiology, and even physician examination interfaces—all programmed directly onto magnetic tape without need for punch cards.[52] After the company installed a full system at Doctors Hospital in San Diego, the *San Diego Union* reported that "Medequip is part test tube, part doctor, part nurse, and part laboratory technician":

> It spends one hour and 45 minutes with each patient who comes in, and this is what it does: First, a computer bank the size of a dresser drawer lights up and makes noises like the sound effects from a James Bond movie. Then, a petite nurse—Mrs. Jerry Dix—picks up a tape cassette—about half the size of a Tom Jones album. "On this tape we will record your physical: the machine will do the work." One of the three parts of the machine starts printing up the medical records, his test labels, and then records a complete patient biography on the cassette. Next the patient, the laboratory assistant, and the cassette move to a whirring machine the size of a standing china closet. Here is the heart of Mediquip."[53]

As market forecasters predicted that the market services for such firms would reach nearly $1 trillion dollars by 1980, engineers, entrepreneurs, and investors lined up to ply their wares and predict the next innovations in computer diagnostics that could occupy this intersection of public health and private wealth.

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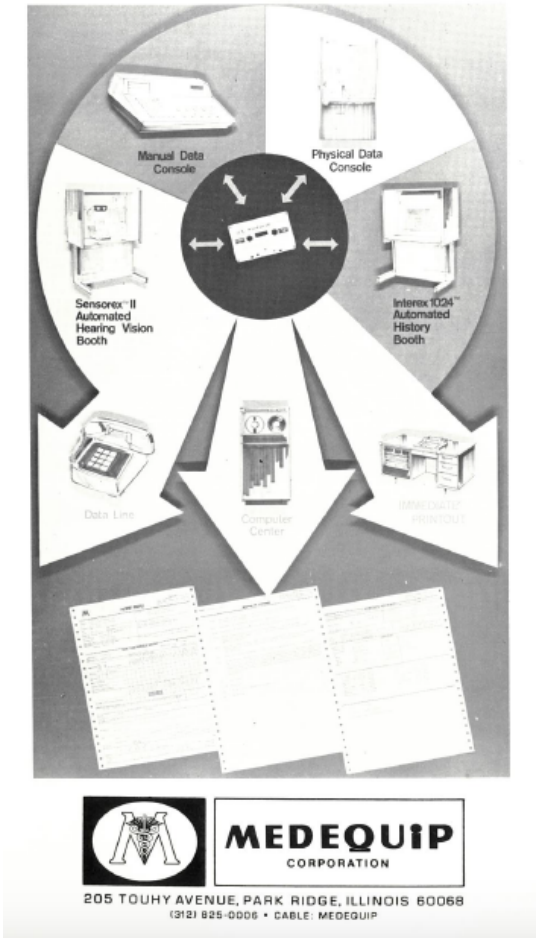
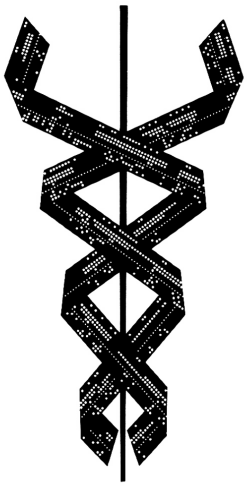
[51] Emerson Day to Morris F. Collen, May 10, 1971. MFCC, Box 3.1 f 1.
[52] Emerson Day, "Automated health services—reprogramming the doctor" *9th IBM Medical Symposium*. Poughkeepsie: IBM, 1968, pp. 105-112.
[53] Peter Brown, "Computer gives you a physical: Patient provided a complete medical profile in 2 hours." *San Diego Union*, March 5, 1971.





Our Symbol

The symbol of the Shepherd Foundation shows the staff and serpents of Aesculapius (Asklepios in Greek), who in Greek mythology was the God of Healing and whose daughter was Hygieia—"she who dispenses health". However to denote the growing importance of the computer in modern medicine, and its vital role in Automated Multiphasic Screening, the serpents have been depicted in computer tape.

The growth of this new industry, however, fueled suspicion from rank-and-file physicians. When Searle Pharmaceuticals demonstrated the products of fully-owned subsidiary called Searle Medidata Inc. at the 1969 meetings of the American Association of Medical Colleges a panel of physicians including Kaiser-Permanente's C.C. Cutting, expressed their unease with the "startling number of what I would call hawkers of medical equipment…Is it a fad, a gimmick, or the significant innovation of preventive and predictive medicine?"[54]

Collen nonetheless collaborated extensively with domestic and international audiences who were also sanguine about the role of automation in producing a new version of preventive health in

[54] Multiphasic Health Screening: '…A Fad, a Gimmick, or the Significant Innovation" *Group Practice* March 1970, 7-11

the early 1970s. Collen was involved in consultancies that ranged from Sweden, Switzerland, England, France, Germany, Italy, Denmark, Finland, the USSR, Australia, and New Zealand. But one of Collen's first—and most durable—international collaboration was with physicians likewise eager to find a use for computers in preventive medicine in Japan. In the early 1970s, executives at the Tokyo Shibaura Company (also known as Toshiba) became interested in computerizing the facilities for a hospital it ran for its employees. Casting about for available models, their eye turned towards the employee-based programs of Kaiser-Permanente in general, and the figure of Morris Collen in particular.

Like their American counterparts, many large Japanese employers had started experimenting with multiphasic health screenings of populations of employees in the 1950s, which were called *Ningen Dokku*. The first *ningen dokku* was staged in 1954, around the same time that Collen and Breslow were developing the notion of multiphasic health testing in Oakland. The term translated into English as "human dock" or "human dry dock", suggesting that the human body, like a long-haul vessel, should be hauled out of the water at least once a year for a full inspection of all working parts. Early forms of *ningen dokku*, developed in Tokyo University Hospital in the late 1950s, took a full week of intensive testing, but by the 1960s a two-day version, called the "fast human dry dock" was developed at the American-founded St. Luke's International Hospital in Tokyo.[55] Neither form of ningen dokku, however, was not for the common man. Corresponding more closely to the "Executive Physical" developed by several elite hospitals in the United States (including the Mayo Clinic, and the Johns Hopkins Hospital)—ningen dokku were initially developed as private facilities,

[55] Miwa, Takuji. "Prehistory and Institution of Ningen Dokku in Japan." in Toshio Yasaka (ed.) *Progress in Health Monitoring (AMHTS): Proceedings of the International Conference on Automated Multiphasic Health Testing and Services, Tokyo, October 4-6, 1980*. Amsterdam: Excerpta Medica, 1981; Sasamori, Norio. "The Present Outlook of the Human Dry Dock in Japan and Its Outlook for the Future." *Japan Hospitals* 1, no. July (1982): 49–55.

for elite private paying customers. It is not an accident that the first Ningen Dokku was developed at the elite St. Luke's private hospital in Tokyo.[56] As a result, however, only roughly 0.2 % of adults who would be considered eligible for such screening received it.

"To make such a system practicable," a group of interested Japanese physicians and engineers postulated in the early 1970s, "…it should make use of systems-engineering techniques, automated devices, and the exploitation of computer technology."[57] Engineers and physicians at Toshiba—an early but growing force in the Japanese computing industry, supported avidly by government policy in the late 1960s and early 1970s—likewise saw potential for computers and automation to improve this process. Toshiba began by manufacturing light bulbs, then x–ray tubes, and latere branched into both electronics and medical equipment. By the mid-20th century, it ran its own hospital in the Tokyo area, and produced its own mainframe computers, and began to envision a system along the same lines as Collen's techniques. A team of physicians and engineers from Toshiba visited Collen's clinic in Oakland and drew up plans for an analogous system in Toshiba Central Hospital.[58]

The Toshiba automated clinic opened its doors in 1970, and began processing clinical evaluations and follow up for 115,000 employees of the Toshiba Electric Company, plus their families. A sixteen-test battery was computerized via Optical Mark Reader cards, explicitly based on Morris Collen's clinic in Oakland, with one major modification. Given the epidemiological importance of gastric cancer and other GI malignancies in Japan compared to California, a series of X-rays of the gastrointestinal tract was added to the screening program, along with tests for occult

[56] Cite to work of Naoki Ikegami on origins of Ningen Dokku, anf their private role (distinguished from public screenings)

[57] Kobayashi, Tohru, Yutaka Moriyaa, and Yoshisuke Iwai. "Health Test Systems in Japan." *Prog. Technol.* 1 (1972): 26–34, quotation p. 26.

[58] Takuji Toshio Yasaka (ed.) *Progress in Health Monitoring (AMHTS): Proceedings of the International Conference on Automated Multiphasic Health Testing and Services, Tokyo, October 4-6, 1980.* Amsterdam: Excerpta Medica, 1981, p. 146.

parasites related to a fish-forward diet.[59] The flowchart looks a bit different from Collen's schematogram in Oakland: note that "feces" for occult parasites is an early step, as is the GI preparation for barium X-ray:

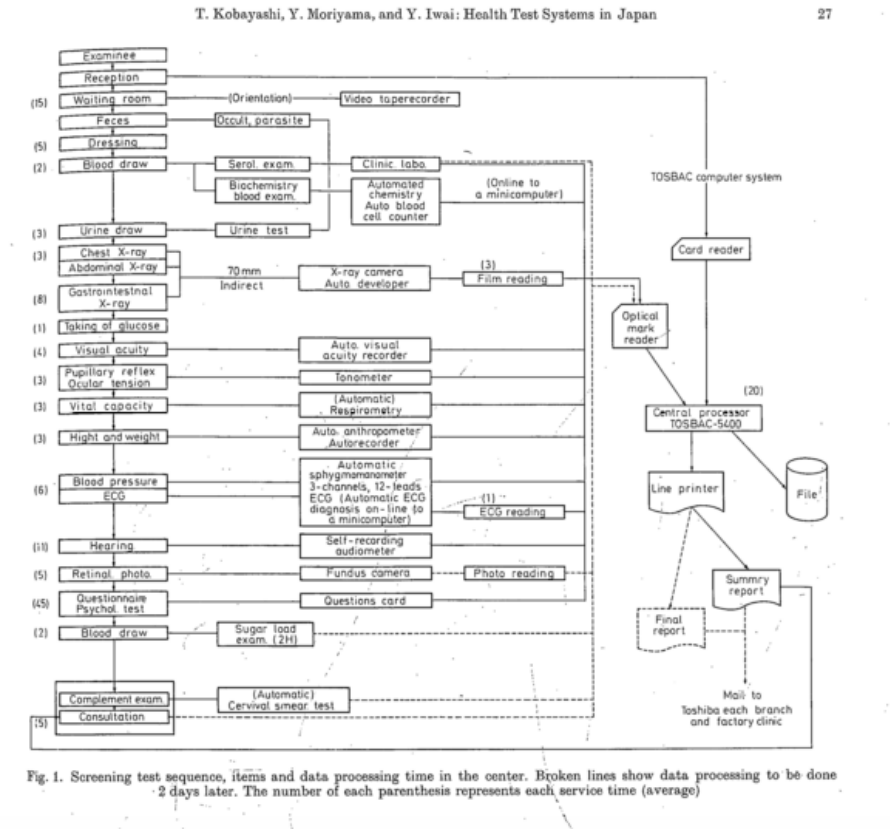


Fig. 1. Screening test sequence, items and data processing time in the center. Broken lines show data processing to be done 2 days later. The number of each parenthesis represents each service time (average)

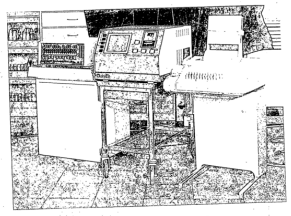


Fig. 14. Apparatus of Auto-questionnaire

[59] Leo, Wendell. "Improving Physician Acceptance of Automated Multiphasic Health Testing," 1975., pp. 16-17; Hioyuki Tohma, "Remarks by the chairman" in Toshio Yasaka (ed.) *Progress in Health Monitoring (AMHTS): Proceedings of the International Conference on Automated Multiphasic Health Testing and Services, Tokyo, October 4-6, 1980.* Amsterdam: Excerpta Medica, 1981, p. 144.

FIGURE Xa, b: from Kobayashi, Tohru, Yutaka Moriyaa, and Yoshisuke Iwai. "Health Test Systems in Japan." *Prog. Technol.* 1 (1972): 26–34, p. 27, 32

"The system," as its authors noted in a 1972 publication, "is specifically adapted to the Japanese nationality and to the needs of the Toshiba Company." As the Toshiba plan was found to be cost-effective, and apparently appreciated by both employer and employees, plans soon developed to extend to other companies within Japan. By 1974, 20 facilities had emerged at other company-based sites across Japan, and Toshiba had extended their services beyond the first hospital-based model to create effective mobile AMHT units, each of which could examine 70 people per day.[60] As Collen noted, with some appreciation (and perhaps a touch of envy?):

> They call their ambulatory health screening system a mobile "human dock". The human dock consists of five eight-ton trucks and a 15-member crew consisting of five drivers, and 10 medical personnel (doctors, technicians, and nurses). The first four cards are used for the medical examinations and the fifth truck is used to supply electrical power to the other four. An identification card is handed to each examinee in car No. 1, who inserts it into a reading device prior to the examination at each section. The result of each examination is recorded on a piece of paper tape or mark-sense card; x-ray examinations can also be provided of the stomach and the intestinal tract. Two hours is sufficient for an examinee to go through all the examinations. The x-ray photographs are sent to a central base, with recorded tapes and marked cards, and all interpretations and diagnoses are provided from the central facility. Car No. 1 provides reception blood and urine specimen collection, and chest and upper G.I. x-rays. Car No. 2 provides electrocardiogram, phonocardiogram, and glucose ingestion. Car No. 3 provides checks on visual acuity, blood pressure, height and weights, spirometry, and history. Car No 4 contains blood drawing and clinical laboratory. Car No. 5 is the power source. [61]

The 5-car mobile model and other versions of the computerized "three-hour dock" spread quickly in Japan, moving along the rails already laid down by the spread of "fast human dry docks" a

[60] Morris F. Collen, "Advanced medical systems: the international picture" talk presented at SAMS Annual Scientific Meeting, Baltimore, MD, Nov 11, 1974. Morris F. Collen Collection, Kaiser Permanente Archives, Oakland, CA (hereafter MFCC), box 2.3, f.1.,p. 21.

[61] Morris F. Collen, "Advanced medical systems: the international picture" talk presented at SAMS Annual Scientific Meeting, Baltimore, MD, Nov 11, 1974. Morris F. Collen Collection, Kaiser Permanente Archives, Oakland, CA (hereafter MFCC), box 2.3, f.1.,p. 22.

decade earlier.[62] By 1973, a Japan Society of Automated Multiphasic Health Testing and Services began to hold annual meetings. Collen looked with admiration and envy towards the coherence state and professional support of the Development Center for Medical Information Systems, supported by the Japanese government and the Japan Medical Association, whose "master long-range plan has as its goal the transformation of an industrial society into an information society." The Nippon Electronic Company (NEC) also joined in thethisse planning process, with health as an immediate arena to demonstrate the benefits of computing in everyday life. By 1985, it was predicted that 250,000 computer terminals would be "in the homes of professional people," and that "they plan to have automated hospitals in all major cities by 1980." The first computer was introduced to a Japanese hospital in 1961, by 1974 more than 100 hospitals were computerized.[63]

Yet even in the earliest publication s of the Toshiba group, a note of trepidation was mixed into the general chorus of enthusiasm for computerized health testing. The Toshiba group was proud to announce, in 1972, that the first results of their system showed that most of the people who underwent screening—roughly 67% of Toshiba employees—"show some abnormality in at least one of the tests," especially ab normal GI X-rays. "It is interesting to note," they concluded, somewhat cryptically, "that although the GI x-ray test finds most of the abnormal cases during screening, approximately half of these cases will be later diagnosed as normal when the detailed examinations using photofluorography and/or gastric camera photography are performed."[64]

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[62] Sasamori, Norio. "The Present Outlook of the Human Dry Dock in Japan and Its Outlook for the Future." *Japan Hospitals* 1, no. July (1982): 49–55, p. 50.

[63] Morris F. Collen, "Advanced medical systems: the international picture" talk presented at SAMS Annual Scientific Meeting, Baltimore, MD, Nov 11, 1974. Morris F. Collen Collection, Kaiser Permanente Archives, Oakland, CA
As the support for automated health clinics grew among different consti
(hereafter MFCC), box 2.3, f.1.,p. 21.

[64] Kobayashi, Tohru, Yutaka Moriyaa, and Yoshisuke Iwai. "Health Test Systems in Japan." *Prog. Technol.* 1 (1972): 26–34, quotation pp. 29-30.

Digital medicine and the new horizons of health and care

As the support for automated health clinics grew among policymakers, physicians, patients, insurers, and industry in the US and overseas, Collen and others began to describe grander visions for health and society which could be accomplished through the computerization of clinical encounters: new epistemological, social, and moral dimensions through which the automation of medical data could transform the nature of the healthcare system, the understanding of disease, and the worlds of doctor and patient. Visions total health and total data, even the ideal of a "post-physician future", were sure to follow.

Total Data for Total Health.

Already by 1968 (perhaps earlier?) Collen saw uses of a computerized system in well-care at righting wrongs and correcting biases of health information based on hospitals (and sick-care). How, for example, did we know what 'normal' values were, or how did we have confidence in generalizing the results of a set of 'normal' values generated in one place to another? Collen suggested that with an automated clinic, the computer could (a) produce true 'normal' values based on well people instead of patients, and (b) tailor them to the clinic in question, while (c) allowing for more sophisticated analysis of the results for epidemiological purposes and preventive medicine. At the 9th IBM Medical Symposium in 1968, he discussed future plans for the automated programs, including, in addition to computer diagnostic aids and broader testing (in 43000 patients) to measure the effectiveness of multiophasic screening in preventing illness and reducing morbidity and mortality, the ability to use generate 'Human Standard Reference Data." He had already calculated data based on blood pressure, serum glucose, serum cholesterol, uric acid, serum proteins, white

blood cell count, etc. [65] More data, in Collen's machine-clinic, meant personalizing the medical encounter on the data range of any individual patient, rather than comparing that individual to the average values of a population. Without as many terms being used, Collen proposed in digital medicine a new potential for precision medicine.

To Collen's supervisors at Kaiser, this data system was the key to articulating a vision of "total health", as the nucleus of Kaiser CEO Sidney Garfield's vision of "total health." In the early 1970s, Garfield used Collen's screening clinic to advocate a system of healthcare based on principles of "wellcare" rather than merely "sickcare." American medicine intervened too late, Garfield argued, when disease had already taken root, interventions were expensive and tied to inhumane experiences in hosptials with poor outcomes. Why not build a healthcare system that truly emphasized health? "The computer is the most powerful machine ever developed for information technology," Garfield argued, "[i]t even transcends the improvement of today's medical care product--the care of the sick. Actually, the great promise of computers for medicine lies in making an entirely new medical care system possible."[66]

Garfield was not the only health plan CEO arguing for the importance of health maintenance rather than disease cure. He was joined by other leaders of the first generation of health maintenance organizations, or HMOs, including the Group Practice of Puget Sound and the Harvard Pilgrim Healthcare progrsm. The concept of health maintenance, and the health maintenance organization resonated well with President Richard M. Nixon's New Federalism policy, which called on government organizations to produce greater efficiency, more tangible outcomes,

[65] Morris F. Collen, "Preventive medicine and automated multiphasic screening\" *9th IBM Medical Symposium*. Poughkeepsie: IBM, 1968, pp. 81-97.
[66] Sidney R. Garfield, "The Computer and New Healthcare Systems" **in** Collen, Morris F, ed. *Hospital Computer Systems*. New York: John Wiley & Sons, 1974. pp. 24-31, quote p. 24.

and more seamless integration with private industry. The Health Maintenance Organization Act of 1973 is perhaps Nixon's signature act of health policy.

Collen's computerized clinic also offered a technology to solve the problems of medical technology—a machine to circumvent the machine of naked capitalism and the machine of state-sponsored socialism. and as a basis for a broader, optimistic vision of what "health maintenance organizations" might do to mitigate between the reactive, technologically-intensive world of fee-for-service American medicine and the spectre of socialized medicine that most American physicians were determined to avoid. Kaiser's notions of "total health" were explicitly engineered to *prevent*, not to promote socialized medicine, and the computer was thought to be an aid in this process. Not all physicians agreed.

Avoiding the Post-Physician Future

Collen brushed off physician skepticism towards medical automation with a host of arguments, and the confident prognostication of a visionary who sees the sociology of the paradigm shift in cultural and epistemological shifts surrounding iconic medical technologies. In a letter to the editor of *Medical Economics* in 1967, he acknowledged that many physicians had dismissed multiphasic screening in its earlier, noncomputerized form, as incidental and largely detatched from clinical practice: at best an antechamber to the diagnostic space of the clinic. But with the advent of new forms of efficiency and computational analysis, Collen was confident that physicians would eventually see the value of the computer in light of the new form of medicine it would potentiate. After all, physicians had been skeptical of the value of the stethoscope when first introduced in the early 19th century, or of routine blood tests introduced in the early 20th century. "It is my opinion," he continued, "it is just a matter of time before most physicians, motivated in providing the best

care for their patients, will support such a service:"

> Just as every doctor now takes it for granted that the laboratory will use the microscope to extend examination capabilities to test specimens, so will he soon expect a good laboratory to also add and use automated analyzers and computers. Just as we now consider it good practice to order a "routine complete blood count," so shall we soon order a "routine complete blood chemistry" and eventually a "multiphasic health check-up."[67]

The computer, however, did not merely extend the efficiency of ordering and tabulating blood tests and other aspects of routine health screening: it computer offered a path to save the humanism of the doctor-patient relationship itself. In reply to journalists at the *Medical Tribune* in early 1968, Collen replied that the "automation of the physical examination" allowed for a reconceptualization of the functions of the physician in an annual checkup with their patients. "The physician's role in patient care can be divided into two broad functions;" he noted, "firstly, the gathering of information from and about the patient by history, physical and laboratory tests; secondly, the making of decisions as to diagnosis and treatment." In the first role, he pointed out, the increasing amounts of information necessary in modern medicine: all of the lab tests, vital signs, extensive review of systems, and review of prior medical records now constitutes "many routine and repetitive procedures which, in many instances, well-trained technicians and/or equipment can do as well." The more such rote work could be displaced to paramedical personnel—or, better yet, be automated and displaced to the world of electronic data processing—the more time and space the clinician had for his more vital role of diagnosis. Here, too, the computer could help, as "in the decision-making role, computer processed data can help to minimize the gap between what is known and what is in use."[68]

Yet in spite of Collen's assurances, resistance from physicans to the perceived threats of

[67] Morris F. Collen to James A. Reynolds, May 5, 1967, MFCC, box 4.1, f 7, p. 2.
[68] Morris F. Collen, "Automation of Physical Examinations," manuscript appended to letter from Morris F. Collen to Frederick Silber, January 22, 1968. MFCC, box 4.1, f 7, p. 2.

automated multiphasic health testing did not simply dissolve as the utility of this new machinery became evident, nor did the promise of labor-saving machinery to rehumanize the doctor-patient encounter wing true with many practicing physicians. Richard Bates, a Lansing, Michigan based internist and contributing editor to *Medical Economics*, penned a critical essay in May of 1967 that rejected Williams and Fogarty's proposed "Preventicare" legislation as an unwanted era of "Machinicare.":

> There's another New Era coming down the pike, just beyond the next interchange: automated mass health screening, in which the computer replaces the doctor as a diagnostician. As yet, no one has given this New Era a snappy new name, so perhaps Machinicare will do.
>
> Machinicare will require a lot of expensive gadgets, and you can bet that the manufacturers will rush to sell them way before anybody has had a chance to report whether they're worth the cost.
>
> After all, Machinicare is bound to be popular, what with the American people's love of machines and the neurotic's compulsion to expose himself to any amount of poking, prodding, and peering in hopes of uncovering an illness teeming with secondary gains."[69]

Of course the federal health bureaucracies loved Machinicare, he continued: they spoke the same language. In time, "computer-manned centers in every large city, where millions of people will bare their chests, their veins, and their innermost psychic secrets" would crush American medicine, and American individuality, and fully replace the "complete, handmade, health-appraisal examination" conducted annually by American doctors. Doctors didn't fear loss of business per se, but a shift in the nature of the work. "Though we may spend less time diagnosing as a result of all of this testing," he continued, "there will be more ailments to care for and more neurotics to treat because of borderline tests."[70] But new forms of testing would take certain forms of test-based revenue away from individual doctors' offices (who billed per EKG), and to change the work of doctors in the

[69] "Better prepare for the Machinicare era!" Unpublished MSS, *Medical Economics*, 1967 MFCC, box 4.1, f 7, p. 2.
[70] The computers that will keep you healthy" Unpublished MSS, *Look Magazine*, MFCC, box 4.1, f 7, p. 5.

clinic itself: physicians should anticipate automated testing and become more aggressive in performing periodic examinations on their own terms.

Dr. Bates encouraged his readers to get ahead of the curve and encourage the use of multiphasic testing on the private physician's terms. If done well, they could generate more business. "If we can manage to survive Medicare and Medicaid," he concluded, "we can certainly survive Machinicare. Besides, I'm sure that multiphasic screening centers will never replace family physicians—at least not until someone invents a machine that empathizes with human apprehension."[71]

Patients and / as Data

Not all physicians were convinced that more tests equaled better medicine. By the late 1960s, critiques of the "worried well" had become a robust form of lay and professional sociology of medicine by the late 1960s. "For neurotics everywhere, there will be the additional boon of loads of borderline test results," a critical account in *Medical Economics* complained. "As the neurotic knows by instinct, no doctor can safely ignore a borderline test. It must be investigated, and the investigation holds the delicious possibility of turning up another borderline test or even (the jackpot) a real disease that is neither fatal nor painful but evokes universal sympathy and responds only to prolonged treatment. Even if subsequent investigation proves the test result groundless, there must always remain the wispy doubt that something is about to go catastrophically wrong. After all, doctors are merely human and mortal, while computers are shiny and expensive."[72]

These concerns regarding the increasing number of test results were soon underscored by

[71] The computers that will keep you healthy" Unpublished MSS, *Look Magazine*, MFCC, box 4.1, f 7, p. 11.
[72] The computers that will keep you healthy" Unpublished MSS, *Look Magazine*, MFCC, box 4.1, f 7, pp. 4-5.

other developments within medicine and public health. Larger studies of preventive medicine in the 1970s began to turn to the dangers of excessive testing: the accumulating dangers of false positives, false negatives, led many physicians to question shotgun mass screenings and focus instead on more An unease with trusting computer algorithms, even reflexive and learning ones, also provoked several backlashes by physicians who saw the computer as a possible competitor, or at best a dramatic constraint on the humanity of their medical practice.

What did patients themselves think of these computerized clinics? It is difficult for the historian to access any 'typical' or 'real' patient voice at this point. The liberatory aspects of these technologies tend to be imputed onto patients (by advocates like Collen and Oldfield) rather than expressed by patients themselves. Much of the popular press featuring the clinic—like the *Readers' Digest* article cited earlier, likewise emphasized its human side, its augmentation of the traditional doctor-patient relationship rather than any fear of eclipse. "Is this where medicine is taking us—to machines instead of doctors?" one account in *Look Magazine* in 1968 asked, "by no means. For the machines may be the biggest boon in bringing us back to the kindly, comforting presence of the doctor as we once knew him."[73]

Look nonetheless explored the fate of Eileen and David Plummer, a husband and wife patient team who found their experience in the Oakland clinic in 1968 to be a "pretty wild physical exam":

> Machines poked and measured them, audiometric headphones wailed a programmed diminuendo in their ears; oscilloscopes flashed their heartbeats into brilliant curves; and even the familiar blood pressure cuff, a reassuring relic of horse-and-buggy doctor days, murmured its systolic reading online into the IBM 360/40. But the nurses were human; smiling and gentle and eager to ease anxieties as they deftly moved Eileen and David down unfamiliar corridors into one testing section after another. And in some ways it was ***not unpleasantly impersonal*** to answer the medical history questions by popping cards into a box, or ticking off entries on a computer card. How simple to toss the card firmly into the "no" slot when it posed some absurd question like "Have you begun to feel that you have had strange and

[73] "The computers that will keep you healthy" Unpublished MSS, *Look Magazine*, MFCC, box 4.1, f 7, p. 3.

> peculiar experiences?" Yet during their 150-minute experience the Plummers became true pioneers in ***what has become medicine's most promising technological revolution since mass vaccination***.[74]

And yet it is also important to understand that none of the information that the Plummers had extracted from their bodies or minds over the course of their afternoon in the Oakland clinic was understood to be "their" data, at least not in any sense that they could be understood to have a right to access it. Precisely because the data collected indicated information of unclear significance—early detection of deviations rather than frank definition of disease—many accounts expressed the importance of buffering the patient themselves from undue anxiety which exposure to raw data or computer-mediated analyses might generate. The Plummers would never see their data:

> Thus, the computer's summary of findings and test results are never designed to be given to the patient himself. The print-out goes only to the patient's physician, who alone can make the skillful interpretation of their meaning. It is the doctor, freed by the multiphasic exams from routine and time-wasting procedures, who can diagnose more wisely and decide whether treatment or more tests or merely watchful waiting are needed. And how he has time for true counseling—time to meet his patients as human beings.[75]

Some popular press coverage on automated clinics expressed reservations about unreasonable findings by rational algorithms. A 1967 *Ladies' Home Journal* article on the Oakland clinic titled "Automated medicine is here! concluded that "the old-fashioned way of seeing the patient first and ordering particular tests has been superseded. Theoretically, with such a complete battery of tests, no clue would be missed…Several days later the patient has an appointment with the internist, who has reviewed the computerized summary and who then completes the medical history. The doctor examines the patient and then arrives at a diagnosis and proceeds with the treatment. Sounds pretty pat, but wait until that computer turns up a pregnant man!"[76]

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[74] Emphasis mine. "The computers that will keep you healthy" Unpublished MSS, *Look Magazine*, MFCC, box 4.1, f 7, p. 1-2.
[75] The computers that will keep you healthy" Unpublished MSS, *Look Magazine*, MFCC, box 4.1, f 7, p. 6
[76] "Automated medicine is here!" *Ladies' Home Journal,* 1967 84(2), p. 39.

Conclusion: automating elsewhere

The early 1970s proved to be the high point for Collen's visions of a wave of automated clinics replacing the paper-based clinic with a digital one. H.R. Oldfield, Jr., who had served as president of both Mediqeup and Searle Medidata (the first company in the US to develop and market a fully deliverable AMHT system)[77], recalled that after the 1968 Andover conference the future of automated medicine seemed so bright that—as Harry Emlet from the competing firm Analytic Services, Inc, noted at the event itself, "one might well conclude from the point of view of both life and economics that the investment is too attractive for the nation to ignore."[78] Another would-be manufacturer of automated health systems, J.B. McCormick, recalled with Oldfield that:

> [We had] the altruistic thought that through our creativity we could improve the system of health delivery…We thought that the unique experience of being physicians operating medical testing laboratories and having knowledge of electronics and medical instrumentation would make us a natural contender to this market which was touted to be $900,000,000 by 1980."[79]

As Oldfield himself recalled, his investment in Medequip was based on "career commitments [which] were made as a result of influences brought to bear by the Department of Health, Education, and Welfare, the Department of Defense, and the Engineering Foundation—based heavily on the success of the Kaiser Foundation and supported by predictions of a "$900,000,000 market by 1980"—such prediction coming from one of the country's most prominent market research organizations… The research organization went on to state, "*MPS is coming like a big freight*

[77] This info from a panel paper found in MFCC box 1 f 3, including Alan Bailey (UK/BUPA), MFC, Fred Gilbert (Hawaii, experience with carrel systems), Paul Hall (Stockholm), Shigeaki Hinohara (President of Japan Society of AMHTS, Robert Hogan (K-P), Gideon Leshem (Tel Aviv), Lew Malter (Chicago)

[78] H.R. Oldfield, Jr. (President, Mediquip Coporation, Rockville Maryland) "Automated Multiphasic Hatleh Testing: A Diagnosis in Three Parts" *Journal of Clinical Engineering.* 1978; 3(2):1-5, p. 4.

[79] H.R. Oldfield, Jr. (President, Mediquip Coporation, Rockville Maryland) "Automated Multiphasic Hatleh Testing: A Diagnosis in Three Parts" *Journal of Clinical Engineering.* 1978; 3(2):1-5, p. 4.

train—and the medical community won't be able to block it even if they want to."[80]

Yet much changed after the election of 1968, and the Department of Health, Education and Welfare under Richard M. Nixon rapidly withdrew funds that had supported the development of computer clinics under the Johnson administration. "Whatever Happened to Automated Multiphasic Health Testing?" an undated, unpublished manuscript in Collen's archive asked. If enthusiasm for the computerized clinic had built swiftly between 1964 and 1968, "almost as suddenly, the party was over:"

> There was a pronounced shift in policy in the U.S. Government away from preventive medicine and towards research in technology and genetics. The USPHS withdrew its financial support from the four large experimental/demonstration centers, the Congress shelved its bill to provide reimbursement for AMHT procedures under Medicare, and funds were withdrawn from other supporting programs.[81]

It also turned out that the medical community had several means to slow down this "big freight train," and, as Odlfield later noted, "it is possible that the "train" may have been trying to travel too many tracks at the same time, or may sometimes have been loaded with the wrong grade of coal." [82]

While investor enthusiasm remained high in 1969—Medequip was one of several firms that three successful IPOs in 1969 to finance the development of next-generation technologies for building automated clinics, along with Medical International of Clearwater, Florida, automated Medical Laboratories of Palo Alto, CA.—the outlooks for the industry began to decline by the early 1970s. Looking back, Oldfield recalls "the pleasant hum of industry in action as these AMHT systems of the 1970 to 1973 era were manufactured, programmed, and marketed," but further

[80] H.R. Oldfield, Jr. (President, Mediquip Coporation, Rockville Maryland) "Automated Multiphasic Hatleh Testing: A Diagnosis in Three Parts" *Journal of Clinical Engineering.* 1978; 3(2):1-5, p. 4. Emphasis original
[81] "Whatever Happened to Automated Multiphasic Health Testing? (unpublished manuscript) MFCC box 5 f 1, p. 3.
[82] H.R. Oldfield, Jr. (President, Mediquip Coporation, Rockville Maryland) "Automated Multiphasic Hatleh Testing: A Diagnosis in Three Parts" *Journal of Clinical Engineering.* 1978; 3(2):1-5, p. 4.

warning signs appeared, especially after the World Health Organization published a report that was critical of annual physical examinations in general, and especially critical of the prospect of overtesting and overdiagnosis that could entail by plugging the healthy population in to an expanding series of potentially unnecessary diagnostic tests.[83]

By 1969, Collen had come to regret the speculative economy of automated health testing, which he thought had developed prematurely—and exposed the core concept of multiphasic testing to undue critique, before it was fully ready to be rolled out as part of a national policy of preventive care. "The premature nationwide acceptance of automated multiphasic screening, with its politico-social implications," he wrote in a memo to the clinical directors at Kaiser-Permanente, "You well know that we did whatever we could to discourage publicity in the lay press. However, this is now a fact of life and I am prepared to accept it. As a Chief of Service and a responsible PMG Administrator, I suggest that you consider that this change in medical practice represents a growing and increasingly significant demand from the public—which is the market place. Whether medical practitioners like it or not, automated multitest laboratories are definitely a marketable process (witness the dozen medical-engineering-commercial enterprises being started to sell the system)[.]"[84]

Increasingly, by the mid-1970s, popular, professional, and policy accounts of Collen's Oakland clinic shifted from calling it avant-garde to calling it "non-representative", a fluke of the Bay Area and the self-selected nature of Kaiser-Permanente health plan subscribers, who were seen to be far more health-concerned than the average American citizen.[85] So, too, were the limitations in the

[83] J.M.G. Wilson and G. Junger, *Principles and Practice of Screening for Disease.* Geneva: World Health Organization, 1968. .R. Oldfield, Jr. (President, Mediquip Coporation, Rockville Maryland) "Automated Multiphasic Hatleh Testing: A Diagnosis in Three Parts" *Journal of Clinical Engineering.* 1978; 3(2):1-5, p. 7.
[84] Morris F. Collen to Leonard Rubin, C.C. Cutting, R. Feldman, and D. Crawford, August 29, 1969, [memo], "Complaints About Multiphasic Program" MFCC box 4.2 f2, p. 1-2.
[85] H.R. Oldfield, Jr. (President, Mediquip Coporation, Rockville Maryland) "Automated Multiphasic Hatleh Testing: A Diagnosis in Three Parts" *Journal of Clinical Engineering.* 1978; 3(2):1-5, p. 9.

structure and format of mainframe-based computer clinics once an early iteration of enthusiastic patients and physicians had worn off. Tellingly, the president of Medequip faulted some of the limitations of their own medical hisotry consoles in this process as well:

> Expensive and inflexible, these beautifully designed consoles proved highly acceptable to patients, but the difficulty of adapting the question-answer sequence to fit the specific needs of differing medical users produced a gradual disenchantment amongst even those physicians who were initially enthusiasts. It appears also that undue emphasis was placed upon the "space age" features of on-line, real-time input to the computer from the biomedical instruments. It is intriguing for a patient to step on a platform and have his weight and height automatically communicated to computer memory; however, it may not be worth very much in terms of cost and complexity to avoid the step of entering the three-digit number via keyboard."[86]

In the increased fiscal austerity of the Reagan administration, the 1980s witnessed further erosion of federal funds and total collapse of the dream of automated clinics in the United States. AMHT centers began to close their doors everywhere, Oldfield noted, with the exception of Japan.[87] By 1980, Oldfield addressed an international conference on Automated Multiphasic Health Testing Services in Tokyo, which celebrated the rising ranks of AMHTS units in Japan (more than 200,000 people screened in 1979), and the dwindling interest in the United States. "Many physicians in the United States have rejected Automated Multiphasic Health Testing" he complained, "…because the AMA lobby was successful in eliminating the U.S. Public Health Service program of the late '60s and early '70s to the point where the four large research AMHT centers—New Orleans, Brooklyn, Providence, and Milwaukee—were abandoned just at the point when their research was about to begin."[88]

86.R. Oldfield, Jr. (President, Mediquip Coporation, Rockville Maryland) "Automated Multiphasic Hatleh Testing: A Diagnosis in Three Parts" *Journal of Clinical Engineering.* 1978; 3(2):1-5, p. 12.

87 " [O]nly in Japan has there been a steady growth of AMHT centers as an accepted part of the country's health care delivery system, supported primarily by industry. " "Whatever Happened to Automated Multiphasic Health Testing?" (unpublished manuscript) box 5 f 1 p. 3.

88 Homer R. Oldfield, Jr. "A new health management information system for industry" in Toshio Yasaka (ed.) *Progress in Health Monitoring (AMHTS): Proceedings of the International Conference on Automated Multiphasic Health Testing and Services, Tokyo, October 4-6, 1980.* Amsterdam: Excerpta Medica, 1981, p. 301—8, quotation p. 301.

In 1994, Collen—who had then moved on to a robust career in medical informatics—found himself back in Tokyo again, addressing the remnants of a Japanese audience still convinced of the value of automated medical health testing. "Although automated multiphasic health testing was first introduced in the United States," Collen lamented, "it was not widely used in this country because health checkups of well persons were not paid for by health insurers, because an AMHTS required a substantial capital investment, and because medical informatics was new and physicians generally opposed the non-traditional concept of programmed, computer-based health checkups." [89] In turn, those remaining advocates of AMHTS in the US, including Collen and Oldfield, "have had hard going in the U.S. and have had to proceed entirely without Government funding for either system development or epidemiological research," and because "most insurance carriers refuse to reimburse the patient for such procedures though they will cheerfully pay thousands of dollars for the subsequent surgical or therapeutic procedures." [90]

As Collen and Oldfield's automated clinics had withered in the United States, the use of automated health testing in Japan had blossomed in the 1980s and 1990s. Though the "human dry dock" (Ningen Dokku) approach to health checkups had started at roughly the same time as Collen and Breslow's initial longshoreman's projects in the early 1950s, and had become automated after contact with Collen in the early 1970s, by the early 1970s, however, the two paths diverged: the decline of automated medicine in the United States, however, was matched by a growth in interest in both computing and automated health screening in Japan, especially within Japanese companies. [91]

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[89] "Accordingly," he continued, "it only survived in the United States in some health maintenance organizations (HMOs) and in some industries." Morris F. Collen, "AMHTS—Past, Present, & Future" paper presented at the IHEA Tokyo Concerence, and the 22nd JMHTS Conference, Tokyo, May 1994. MFCC box 2.3, f 3, p.2.

[90] Morris F. Collen, "AMHTS—Past, Present, & Future" paper presented at the IHEA Tokyo Concerence, and the 22nd JMHTS Conference, Tokyo, May 1994. MFCC box 2.3, f 3, p.2.

[91] Morris F. Collen, "AMHTS—Past, Present, & Future" paper presented at the IHEA Tokyo Concerence, and the 22nd JMHTS Conference, Tokyo, May 1994. MFCC box 2.3, f 3, p.2; Miwa, Takuji. "Prehistory and Institution of Ningen Dokku in Japan." In *Progress in Health Monitoring*, edited by Miwa, 203–13. Amsterdam: Exerpta Medica, 1981. In the 1950s, the initial human dry docks

By 1979, as AMHTS facilities dwindled in the United States, 20 different multiphasic programs had opened in Japan, with others in Europe, Australia, New Zealand, South America, Canada, Mexico, and Asia. By 1993, more than 240 AMHTS facilities were functioning in Japan. As of 2016, the Japan Society of Ningen Dock included more than 5,500 physicians, and nearly 500 allied health personnel across 1,649 medical institutes throughout Japan.[92]

Collen viewed these developments as a mixed blessing. Preliminary results from Japan suggested than *ningen dokku* might be credited with extending the lifespan of the average Japanese worker over the second half of the 20th century (though admittedly it was very difficult to distinguish the role of this specific technical intervention compared to the general improvement in economic conditions over the same time).[93] By 1993, long term data from the original population of the Oakland clinic population (compared to a control group of Kaiser-Permanente patients who did not engage with the computer screening), suggested that participating in automated health screening was associated with a 30% decrease in death from colorectal cancer, and a 20% decrease in overall mortality for "potentially postponable conditions" over the 27 years of study, but it was harder to show differences in overall mortality.[94]

Even after decades of frustration, Collen remained optimistic that the future computerization of clinics in America might bring the U.S back on a par with Japan to realize the benefits of computers in preventive medicine. Just 2 years earlier, in 1991, the Institute of Medicine and the National Academy of Sciences had re-visited the role of computers in medicine, now that bulkier

took roughly 1 week, followed by a set of "fast human dry docks" which took two days. This was replaced, after 1970, by the Toshiba automated model

[92] Yukito Shinohara, "Message from the President" July 2016, *Japan Society of Ningen Dock* https://www.ningen-dock.jp/en/society/message

[93] Sasamori, Norio. "The Significance of Human Dry Dock Activities Relative to the Prolonged Average Life Span of the Japanese." *Japan Hospitals* 6, no. July (1987): 59–64.

[94] Morris F. Collen, "AMHTS—Past, Present, & Future" paper presented at the IHEA Tokyo Concerence, and the 22nd JMHTS Conference, Tokyo, May 1994. MFCC box 2.3, f 3, p.6.

mainframes had been replace in both workplace and home with more flexible networks of personal computers. In this report, *The Computer-Based Medical Record: An Essential Technology for Health Care*, Collen saw possibility for another generation of automated clinics to transform American medicine where his earlier, punch-card based machines had failed. Collen's confidence in predicting the inevitable computerization of medicine had returned. While conceding that "it is unlikely that AMHTS, as we know it, will again become popular,"[95] Collen claimed that "in my opinion, by the end of the 1990s, all large medical centers will have comprehensive medical information systems with their network of computers, all using the same database containing integrated, continuing computer—based patient records. [96] If Collen's predictions were wrong in many of the particulars, and the exact timing, the general thrust of these predictions would ultimately come to pass.

Collen's contributions to medical informatics should not be summed up by the failure of the automated clinic to fully propagate within the United States. Along with Slack, Caceres, and other figures discussed in the next chapter, Collen played key roles in the spread of computer medicine and medial informatics, and in 1993 was the eponymous/inaugural recipient of the Morris Collen Award from the American Medical Informatics Association. His career spanned a number of different approaches to using computers to rationalize medicine in hospital, clinic, and elsewhere. By 1967, Collen had designed and installed a CliniCall Data Management system(with Sanders Associates) in the Kaiser Foundation Hospital in San Francisco, an early step towards a unified hospital electronic medical records system which "will permit doctors diagnoses and drug instructions to be flashed instantly on television-like displays throughout the hospital."[97] Like the

[95] Morris F. Collen, "AMHTS—Past, Present, & Future" paper presented at the IHEA Tokyo Concerence, and the 22nd JMHTS Conference, Tokyo, May 1994. MFCC box 2.3, f 3, p.9.
[96] Morris F. Collen, "AMHTS—Past, Present, & Future"
[97] Robert A. Hughes to James K. Joyce, August 15, 1967. MFCC, box 4.1, f 7.

automated clinic, Collen's colleagues hoped that "the automated system will enable doctors and nurses to spend considerably more time with patients, rather than doing routine paperwork."[98]

The rise and fall of the automated clinic allows us to examine one of the fundamental questions of this book: how do the media of medicine change: abruptly or gradually? And effectively answer: in the case of the computer, the answer must be "both." The younger Collen thought that rapid, total change in the informational architecture of medicine could be achieved nearly overnight, with the right technology . He saw in the digital computer a tool to rapidly transform the media of clinical communication from paper to electronic form, and also to transform the systems of health care itself, from idiosyncratic and individualized practices towards a more system-oriented program that generated big data, machine learning, algorithms and heuristics amidst an ever-expanding digital trace. Collen's original Oakland clinic is itself a symbol of that hope: a machine which, in three hours, could rapidly digitsalize a person, and recommend a path forward.

And yet the most obvious conclusion from the failure of these automated clinics to take root in American health care is that a promising, seemingly inevitable technology—which heads of health plans, physician organizations, federal bureaucracies, and medical device industries saw as inevitable—did not come to pass, at least not in the United States. The failures, as well as the successes of this vision of computer medicine offer an instructive window into the structures and contexts that support and hinder the role of new media in medicine. Recovering the history of automated clinics in the mid-20th century likewise offers a lesson for 21st century audiences: specifically, that like Senator Williams our ability in the present to see which new media will and which will not transform medical practice, is blurry at best.

[98] The irony of this prediction is not overlooked. Will bring this out in the conclusion. Robert A. Hughes to James K. Joyce, August 15, 1967. MFCC, box 4.1, f 7.