

# Bringing science to medicine: an interview with Larry Weed, inventor of the problem-oriented medical record

Adam Wright,<sup>1,2</sup> Dean F Sittig,<sup>3</sup> Julie McGowan,<sup>4</sup> Joan S Ash,<sup>5</sup> Lawrence L Weed<sup>6</sup>

<sup>1</sup>Department of Medicine, Brigham and Women's Hospital, Boston, Massachusetts, USA

<sup>2</sup>Harvard Medical School, Boston, Massachusetts, USA

<sup>3</sup>University of Texas School of Biomedical Informatics and UT-Memorial Hermann Center for Healthcare Quality and Safety, Houston, Texas, USA

<sup>4</sup>Department of Knowledge Informatics and Translation, Indiana University, Indianapolis, Indiana, USA

<sup>5</sup>Department of Medical Informatics and Clinical Epidemiology, Oregon Health & Science University, Portland, Oregon, USA

<sup>6</sup>Department of Medicine, University of Vermont, Burlington, Vermont, USA

## Correspondence to

Dr Adam Wright, Brigham and Women's Hospital, 1620 Tremont St., Boston, MA 02115, USA; awright5@partners.org

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## ABSTRACT

Larry Weed, MD is widely known as the father of the problem-oriented medical record and inventor of the now-ubiquitous SOAP (subjective/objective/assessment/plan) note, for developing an electronic health record system (Problem-Oriented Medical Information System, PROMIS), and for founding a company (since acquired), which developed problem-knowledge couplers. However, Dr Weed's vision for medicine goes far beyond software—over the course of his storied career, he has relentlessly sought to bring the scientific method to medical practice and, where necessary, to point out shortcomings in the system and advocate for change. In this oral history, Dr Weed describes, in his own words, the arcs of his long career and the work that remains to be done.

## INTRODUCTION

Larry Weed, MD is known as the father of the problem-oriented medical record, inventor of the now-ubiquitous SOAP (subjective/objective/assessment/plan) note, and developer of the Problem-Oriented Medical Information System (PROMIS).<sup>1</sup> His paper 'Medical Records that Guide and Teach'<sup>2</sup> is one of the most-cited informatics papers of all time, having been referenced nearly a thousand times. Over the course of his career, he has worked as a scientist, physician, entrepreneur, and, most recently, health system visionary, and has always been a fierce and tireless advocate for a safer, better organized, more efficient, and science-driven health system.<sup>3</sup>

On December 28, 2010, JMcG conducted an oral history interview with Dr Weed at his home in Underhill, Vermont using questions prepared by JSA and DFS. The interview was condensed, rearranged, and edited by AW, and is presented here in Dr Weed's own words, with the exception of (1) minor additions, clarifications, and references, indicated in brackets, (2) this introduction and the conclusion, and (3) an epilogue presenting a biography of Dr Weed.

## EARLY LIFE AND EDUCATION

I was born in Troy, New York and then I was brought up in Middletown, New York, and my interests were those of any teenager. I went on to college and then I went to medical school at Columbia [College of Physicians and Surgeons in New York City]. I did various residencies, did biochemistry at Penn [University of Pennsylvania, Philadelphia], had fellowships, and was in the military.

## THE DIFFERENCE BETWEEN SCIENCE AND MEDICINE

I had done research in biochemistry in nucleic acid chemistry in the late '40s and early '50s, and I accepted a double appointment at Yale in the Departments of Pharmacology and Medicine. A couple months a year they would come for me in Medicine and say, 'Would you make rounds on a ward with students and house officers?' I would then return to the basic science department and do research and teach.

It was in that process that I realized that a research scientist has one problem and can make time the variable and achievement the constant in his work, whereas a physician on a busy ward has multiple problems and limited time, making the behavior of a true scientist almost impossible. As a scientist, you have a very specific project. That's your research. You work on it and work on it, and you finally get it written up. You get it published in a journal. The scientist works under a disciplined system of review and publication of his work. A physician works in a chaotic system of keeping and organizing data and has no systematic review and correction of his daily work.

You'd think that after all these years of being at Hopkins [Johns Hopkins University, Baltimore, Maryland] and Columbia and Bellevue [Hospital, New York] and Western Reserve [now Case Western Reserve University, Cleveland, Ohio], I would have sensed that there's something wrong. But when you're in an establishment, do as the Romans do. You just get along and do what you have to do to get on to the next job. What do you do to get a degree? And if they say, 'Go kill your grandmother,' you say, 'Well, where's my grandmother? And do you have a gun?' That's the way the academic business seemed to me.

Finally I asked myself: suppose you treated a medical student or resident like a graduate student working on a problem to get a PhD. You would say to the student, 'Well, what's your problem?' 'Well, Mrs Jones is one of my patients.' 'Well, what are her problems? Where's the list of her problems? We have to work up each problem. Well, don't you have a record?' The medical record of Mrs Jones must be a medical student's scientific notebook. With a scientist doing research you can see in his notebooks in the laboratory what he does each day. You can see his data, what came out of the spectrometer and so on, and you can examine it.

## THE BIRTH OF THE PROBLEM-ORIENTED MEDICAL RECORD

So I said to these interns and students, 'I need a problem list.' And they'd say, 'Well, do you



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mean the doctor's impression after he did the initial workup?'

But I'm not interested in somebody's impression. I want a clear definition of the problem, the data that support that definition and what you are doing to try to solve it. If I went to a graduate student saying 'What's your problem,' and they said, 'Well, I work in pyrimidine chemistry,' I would say, 'Specifically what pyrimidine? And tell me, what are you trying to do?'

I realized then—and it was very upsetting—that they weren't getting any of the discipline of scientific training on those wards. When I pick up a chart that is a bunch of scribbles, I say, 'That's not art. It certainly isn't science. Now, God knows what it is. The physician who is creating it will have to give it a name.' So that's what got me into the problem-oriented record... we started to rearrange the medical records. This was not easy. But after 4 years we got it going.

There are four sections to the problem-oriented medical record: the database, the problem list, titles, and numbered plans for each problem, and titled and numbered progress notes on each problem.<sup>4</sup> So I can pick up any record, and see for example: Problem No. 3: Hypertension. What were the plans? Let me read the progress notes. Now that's a very defined system.

As you go through such a record, there are four behaviors you should be looking for. Are practitioners thorough? Are they reliable? Are they analytically sound? And are they efficient? What I mean by thorough is are all the data in the required database there? If not you get an F in thoroughness. You then do the same things for the other three behaviors. Now, if you get a Pass in three of the behaviors, but it takes you 6 weeks to work up a single patient, you're not efficient. And you can't function in the real world. You won't make a living. Nobody or no clinic will hire you. An emergency room will be backed up.

### THE MOVE TO MAINE

Right at that time when I was coming to these realizations, I got a call from Bangor, Maine. The head of the board of trustees was on the other end of the line and he said, 'We need a Medical Director up here. Would you come up?'

In those days, in the late '40s and early '50s, Bangor, Maine was a 6-hour train ride through a bunch of pine trees from Boston. You didn't jump in a plane and appear there. And I had a wife and children and I said, 'Well, sir, I'm pretty much involved here.' I didn't say, 'I don't want to get off this academic track and go out in the boonies with a bunch of people in Maine that I've never seen before.' So we hung up. Two hours later the phone rings again. He said, 'My name is Henry Wheelwright. Does that name mean anything?' I said, 'The only Wheelwright I knew is Jeff Wheelwright who was a classmate of mine in medical school, and a good friend—he was just a great guy.' 'Well, I'm his father.' I said, 'Oh.' He said, 'I'm going to treat you like you're my son, like I treat Jeff, and I want to give you some advice right now. Never say 'no' to a job over the telephone. I'm paying your way up here, get your tail up here.' So I went home and told my wife about it—we had to get out a map in those days to see where Bangor was, how far from the academic world.

So I went up there and on the way, I made a list of all the requirements I would have for taking the job, knowing they couldn't meet them. To make a long story short, they met all the requirements. I went to Bangor, Maine to become the Medical Director of the hospital. They really called my bluff. They had five incoming interns and asked me if I would take over. That's when I said to the house officers and staff, 'This is

the way we're going to keep records on the patients. The patient's medical record will be the doctor's scientific notebook.' And since I had authority, I demanded it, or I wouldn't come.

I stayed in Maine for 4 years, and I got the record going.

### ONWARD TO OHIO

But I still had an interest in the biochemistry research that I'd been doing, and I continued my research and teaching at the medical school at Western Reserve. Charlie Burger was one of the students in the medical class there. I told him and other students about the problem-oriented record. I'd say to the students at Western Reserve, 'Do you have any idea what all this stuff you're learning in basic science has to do with taking care of patients when you get an internship? You are struggling in biochemistry, learning [the] Krebs cycle. Do you know how the details you are learning now would be used in the care of patients and are you sure you will remember them when the time comes to care for patients?' I reminded them of what Tolstoy wrote about 'the snare of preparation' ['The first and most common snare into which man falls is the personal snare, that of making preparations to live, instead of living'<sup>5</sup>] and that John Dewey said that learning and education in the real world means making connections.<sup>6</sup>

### COMPUTERIZATION OF THE MEDICAL RECORD AND LANDING IN VERMONT

At Western Reserve we got the problem-oriented record really rolling in the City Hospital [Cleveland Metropolitan General Hospital, Cleveland Ohio]. Cuyahoga County had put computers in the City Hospital and they asked me to come over and teach medicine. That's when I started to say, 'Well, we ought to get a computerized problem list.' So that's where the computers started.

Once we got the computer rolling, they came from Vermont and wanted me to come here to really get—and that was in '69 and the '70s—the problem-oriented record going and then a computerized ward at the hospital. [We started] the PROMIS lab in Cleveland and then brought the whole thing to Vermont.<sup>1 7</sup>

### THE LIMITATIONS OF HUMAN KNOWLEDGE

Real problems always cross specialty boundaries. If a patient has chest pain, it could be a cardiovascular problem. It could be a lung problem. It could be a spine problem. They could have a broken rib. There can be a hundred causes of chest pain. Well, when a patient goes to see a cardiologist, can she be sure that he *knows* the symptoms and findings of a thoracic disk [herniation], that doesn't have anything to do with her heart?

Speaking to [a group of physicians] I said, 'The problem with the field of medicine is you can't do what the patients think you're supposed to be doing. The patients think you know all 60 or 70 causes of an acute abdomen. But there's not a person in this room who could stand up and say, I *know* them.'

There were a bunch of surgeons in the room, and it was really quite a riot, this meeting. One of them said, 'Well, Dr Weed, are you trying to tell us—I've been doing surgery for 30 years—and don't you believe in intuition and experience? You know, you know an appendix when it comes in the door.' Yeah, but if it's not an appendix, what you think you sense might be wrong. The patient becomes a victim of your experience.

So I said to these physicians, 'You've got all this body of knowledge and you're trying to couple it to everyday action by putting it in people's [medical students'] heads. You're going to give them all these courses. And then they're going to learn to

take histories and physicals. They're going to learn all of these details about the patients, and then they're supposed to process it in their head and say, 'Therefore, Mrs Jones, you have appendicitis.' But the voltage drop across that transmission line is enormous. God knows what answer some of them end up with.' And they *knew* they were decompensating. Why am I saying they knew? They specialized. You take the surgery, I'll take medicine. Interns, then cardiologists, hematologists, endocrinologists, and red cell men. Then they formed their own journals.

So finally this one surgeon said, 'Well, it sort of makes sense but it's very upsetting. Anyway, I don't accept that experience and intuition aren't something.' I said, 'Well, I'm not saying you don't have intuitive feelings. What I'm suggesting is that they may be worthless.'

So they asked if we could go to dinner together. I said, 'Look, if you don't catch onto this right away, it won't help to go to dinner.' It'd be like having an abortionist and an anti-abortionist have dinner together so they can settle their differences. They could *live* together for 10 years and they wouldn't settle their differences.

[By the late seventies, I saw that] we were drowning [the physicians with all the data we could compile in the computer. There was so much there that] they couldn't process it. This brought to mind the poem by Edna St. Vincent Millay<sup>8</sup>:

[Upon this age, that never speaks its mind,  
This furtive age, this age endowed with power  
To wake the moon with footsteps, fit an oar  
Into the rowlocks of the wind, and find  
What swims before his prow, what swirls behind –  
Upon this gifted age, in its dark hour,]  
Falls from the sky a meteoric shower  
Of facts [...they lie unquestioned, uncombined.]  
Wisdom enough to leech us of our ill  
Is daily spun; but there exists no loom  
To weave it into fabric

### Development of the problem-knowledge couplers

[I realized then that] we need[ed] a loom. I used the computer to implement combinatorial thinking and thereby create a fabric of care using data from the literature and data from the patient... the first coupler. Just ask yourself and answer all these questions, then hit COUPLE. There may be 300 questions. [We called it the problem-knowledge coupler.<sup>9-12</sup>]

Two years later, one of the guys in that meeting called me from New York and said, 'You know, I was one of the guys fighting with you. I run an emergency training program for emergency room residents. We have 28 residents, we have five rooms. It's a big New York City hospital, and we just missed a 10-year-old girl with an acute abdomen. Do you think this tool [the coupler] would have helped?'

I said, 'Well, I'll tell you what I'll do. I will send you—I'll print out the pages. And what you do is you go through these questions.'

What I did is I put them in. You just go through these questions with a problem, abdominal pain. Well what do you mean by the right lower quadrant? Well, put it at his fingertips. You click on it to show a picture of the abdomen. I said, 'That's the

way a coupler works. There's just a bunch of questions.' You can teach even high school kids how to use these tools. That's what training should be doing... if we're going to clean up the medical center, we should take the kids that have great hands, great interpersonal skills, and say, 'Alex, I don't care what else you do in this world, don't tell me you're a great skier, or you play the cello well, I couldn't care less. Can you do this coupler without making a mistake? Can you feel the spleen? We can use you.' He has no doubt that he's got a job and he can do something worthwhile.

If he said this is positive, the machine will know what it votes for. We just go through these questions. We're not going to try to put the knowledge in the doctor's mind. You can't do it. It's a whole different way of moving knowledge.

So at any rate, I said to this person in New York, 'I'm going to print the questions on sheets of paper so that you'll just get all the questions in the mail. You're going to sit down with the record of the patient whose acute abdomen you missed, and the resident and the intern and the attending, and you're going to mark on those sheets of paper the ones that were positive. Then I'll fly down and we'll put them into the computer. Then we'll hit COUPLE.'

So I sent the sheets of paper to him and I said, 'You've got to promise me, when you go through those sheets of paper with the residents, students, and the patient record, you have to mark every question you don't know the answer to because you didn't ask it. Or you don't even know what that test is, when you feel the abdomen. They're simple, inexpensive things that you didn't do. Mark those in red. And then we'll talk about it at the conference.'

So I get off the plane. We put the responses in the computer. When we were done I said, 'Now, you want me to hit COUPLE, all those findings with all those diseases, but I'm not going to do it.' [He replied] 'Well, you said you were going to show us.' I said, 'I'm not going to hit COUPLE. On these papers, half of these questions are red. You want me to hit COUPLE. Then we'll get the wrong answer and you'll say, see, the thing doesn't work. I know how you function. You all went to medical school. Your capacity for self-deception is beyond belief.'

One of the residents said, 'Well, could we see the findings?' I said, 'Yes, I'll show you the findings that were positive. Here they are. Well, you can do automatic outcome studies. We don't have to have typists. They're all printed up. You can do population studies. You're all playing with half a deck. And no two of you play with the same part of the deck.'

This one resident that missed the case says, 'Dr Weed, I won't criticize you. Would you please hit COUPLE just to see what the machine would have found with half a deck. I'm promising not to be critical.'

So I hit COUPLE. [Pause for the coupling results] Well, it says there are four things—from a physiological point of view—that tell you a smooth muscle tube, like an intestine or a ureter, is obstructed. This patient has all four of them. When they're writhing and restless and vomiting and so forth, you want to think of that. Now, in more specific terms, there are eight things in the machine for small bowel obstruction. She's got six of them. The resident looked up and he said, 'That's what she had and that's what we missed.'

So I said, 'Even playing with a half a deck, the machine did better than you.'

The couplers are very sophisticated now. But in this case, this was the first thing that came up and the resident said, 'That's what she had and we missed it.' And some of these questions they'd never even asked. So then I said, 'You can page down

and *read*—you get comments about the leukocyte count being normal and there are points about the evidence.’ Well, how do we know we can believe all this? You click on this and it’ll give you [the] reference and the page number. See, you’re connecting that patient to the library without having that intermediate, limited human mind in the middle of it.

The coupler builder may not be perfect but he has all day to do nothing but build the acute abdomen coupler. He doesn’t have any more patients. You don’t know how long it took that person to build that beautiful Honda that you drive out there. All you know is you get in and move your foot and you go. That’s the way medicine has got to be. A new division of labor.

To get back to this business, you’d think after this—but one of the surgeons kept saying, ‘Well, this is impressive, Dr Weed, and on half a deck, you’re right. You did get it right. But it’s not going to work.’ And I said, ‘Why not?’ [and he replied] ‘Well, you can’t expect people with not a lot of experience to go mindlessly through all the questions. It takes too long.’

I said, ‘Well, first of all, I wouldn’t hire somebody who wants to make \$200 000 or a million dollars a year.’ We could train people to use these tools who are much less expensive. A good practitioner who has the right knowledge tools, hands-on skills, and interpersonal skills. You have to get over the idea that if he gets A’s in all his courses he has the best hands-on skills. You must have noticed on the campus that all the best football players are not valedictorians. They may not even get out of school. But for that hands-on thing, they got it. And that other kid, the patients all love her. She’s got interpersonal skills that you couldn’t graft onto some others if you tried. Of those three things, interpersonal skills, knowledge, and hands-on skills, I can move all the knowledge into tools. I’m going to select the kids who really care about people and have best hands-on skills. That’s a completely upside down approach compared to how it’s currently done. And then everybody’s got high morale because they are doing something useful.

Well, why did this take so long to get going? I wrote the first papers in 1982 in medical journals. That’s 30 years ago.

[End of interview]

## CONCLUSION: IMPLICATIONS AND THE ROAD AHEAD

It is hard to overstate the impact of Dr Weed’s work on medicine and medical informatics. His ideas led to a fundamental reorganization of the medical record and the introduction of the now-ubiquitous problem list and SOAP note, both of which are taught and used throughout the world. His later work focused on problem-knowledge couplers and the development of significant diagnostic and treatment knowledge bases. He founded a company (PKC) focused on couplers in 1982 and left in 2006. The company was, acquired by Sharecare, Inc. (Atlanta, Georgia) in 2012.<sup>13</sup>

Dr Weed’s most recent book, *Medicine in Denial*, an in-depth analysis of ‘a deep disorder [that] pervades medical practice... [and] exists because medical practice lacks a true system of care.’<sup>14</sup> *Medicine in Denial* proposes a new organization of care which has, at its core, four elements:

- ▶ A new ‘Center for Knowledge Building Tools’ which would develop and maintain problem knowledge couplers and other knowledge resources
- ▶ A training center which would ‘develop skilled personnel to complete those portions of the couplers that the patients cannot do for themselves, for example, listen to their own heart or lungs, etc.’

- ▶ A fully realized problem-oriented medical record (POMR) which would encompass a database for each patient, a problem list, plans for each problem, and progress notes
- ▶ A center for analysis which would review these POMRs and feed the results back to the Center for Knowledge Building Tools.

This bold proposal for care redesign goes much further than current health-policy approaches like accountable care organizations<sup>15</sup> and patient-centered medical homes.<sup>16</sup> As time goes by and the amount of knowledge instantly accessible via the internet continues to grow at an ever increasing rate,<sup>17</sup> such a vision for ubiquitous human interaction with a computerized, clinical knowledge base<sup>18–20</sup> seems less and less like science fiction and more and more like Weed’s vision that is already over 50 years old.

## EPILOGUE: A BIOGRAPHY OF DR LAWRENCE WEED

Lawrence ‘Larry’ Weed was born in Troy, New York in December 1923, and earned an MD degree from the Columbia University College of Physicians and Surgeons in 1947.

Dr Weed is best known as the father of the problem-oriented medical record—a construct he first published on in 1964 and brought to prominence in 1968 with his landmark paper ‘Medical Records that Guide and Teach’<sup>2</sup> in the *New England Journal of Medicine*. The POMR consists of four components<sup>21</sup>:

1. The database, a collection of all information known about the patient
2. A complete problem list
3. Initial plans for each problem, written in SOAP format
4. Daily progress notes, also organized by problem and written in the SOAP format.

The concepts of the POMR, particularly the problem list and the SOAP format for progress notes, are now ubiquitous. The POMR has been described, studied, or discussed in over 2000 academic articles as well as countless medical textbooks, is a cornerstone of medical and nursing education, and has had its positive effects documented.<sup>22 23</sup>

After developing the POMR concept in Bangor Maine, Dr Weed put it into action at Cleveland Metropolitan General Hospital and then as a faculty member at the University of Vermont (UVM), where he led development of the PROMIS.<sup>1 7</sup> PROMIS was the first clinical information system to use a touch screen terminal. PROMIS was driven by a large medical knowledge base that was initially developed by Dr Weed and his wife Laura Weed<sup>1</sup> and later by a team of clinicians, librarians, and systems analysts. PROMIS was organized entirely around the POMR concept, with the nurse beginning to populate the database, followed by the patient, who would complete a 275-question review-of-systems. Medical students and residents then added additional information, and documented a physical exam—all in structured form. Once the database was populated, the problem list was constructed, plans were developed, and progress notes developed. The knowledge base required to support all of these modules was vast, and eventually specialists were brought in to extend it. When UVM sought, in the 1990s, to implement a comprehensive new electronic health record, their biggest challenge was that no system available had the level of functionality and the richness of clinical knowledge contained in the PROMIS system.

Dr Weed left UVM in the 1980s to start PKC. PKC focused on the development of couplers, which link medical knowledge to problems using combinatorial logic.<sup>9–12</sup> In many ways, the couplers were a maturation of the knowledge base development Dr Weed did for the PROMIS system. Several years after

Dr Weed left PKC, it was acquired in 2012 by Sharecare, a consumer-focused site founded by Mehmet Oz (of the Dr Oz show) and Jeff Arnold, founder of WebMD.

In addition to his work developing the POMR concept, building PROMIS and leading PKC, Dr Weed has written five books: *Medical records, Medical Education, and Patient Care: The Problem-Oriented Record as a Basic Tool* in 1970, *Your Health Care and How to Manage it: Your Health, Your Problems, Your Plans, Your Progress* in 1975, *Knowledge Coupling: New Premises and New Tools for Medical Care and Education* in 1991, *Managing Medicine* in 1993 and *Medicine in Denial* in 2011. He has won numerous awards for his work, including the Institute of Medicine's Gustav O. Lienhard award in 1995, and is a founding fellow of the American College of Medical Informatics.

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