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*Machine Learning for Detecting Iron Deficiency through Comprehensive Blood Analysis.*

Clin Chem 2025; 71(9): 949–61. <https://doi.org/10.1093/clinchem/hvaf074>

**Guest:** Dr. Yu Hsin Chang is an attending physician in the Emergency Department at China Medical University Hospital in Taiwan.

Bob Barrett:

This is a podcast from *Clinical Chemistry*, a production of the Association for Diagnostics & Laboratory Medicine. I'm Bob Barrett. Iron deficiency is a health concern affecting millions of individuals throughout the world. If detected early, it is relatively easy to correct, but if left untreated, it can progress to anemia, with affected individuals experiencing severe weakness and shortness of breath. Unfortunately, like several other health conditions, iron deficiency is difficult to diagnose in the early stages, as presenting symptoms and initial laboratory results are subtle or nonspecific. Targeted testing can help establish a diagnosis, but this requires providers to have identified iron deficiency as a clinical concern.

Clearly, identification of iron deficiency using routine labs ordered as part of a general annual health screening would have immense value, facilitating the identification of patients in the early stages who otherwise would have gone undiagnosed. The trick, then, is to alert providers to subtle changes in basic lab parameters that indicate iron deficiency that are currently flying under the radar. A new research article, appearing in the September 2025 issue of *Clinical Chemistry*, describes a machine learning tool designed to do exactly that. Using complete blood count results, this new model helps identify iron deficiency in a general population consisting of patients with and without anemia.

In this podcast, we are joined by the article's lead author. Dr. Yu-Hsin Chang is an attending physician in the Emergency Department at China Medical University Hospital in Taiwan. He is also affiliated with the hospital's Artificial Intelligence Center, where he is actively involved in advancing the integration of AI into clinical practice to improve patient care. So, Dr. Chang, what prompted you to focus on identifying iron deficiency even in non-anemic individuals who don't often trigger any diagnostic alerts?

Yu-Hsin Chang:

All right, I think that's a great question. Anemia occurs only after iron deficiency has progressed to a more advanced stage. By that point, hemoglobin levels have already

dropped. The condition is more severe and recovery takes longer. In its early stage, iron deficiency often causes no clear symptoms, perhaps just mild fatigue or reduced concentration. But detecting that at that point gives us the chance to treat it before it gets worse. We are applying machine learning to routine blood test data with the goal of not only identifying patients who already have iron deficiency anemia, but also detecting early-stage iron deficiency even before anemia develops, so we can begin treatment sooner and avoid further impact on quality of life.

Bob Barrett: Are there any other reasons why early detection of iron deficiency is clinically important?

Yu-Hsin Chang: All right. Actually, this enables clinical doctors to intervene earlier before the condition gets worse. Iron deficiency, even if you don't have anemia, can still affect your life. People may feel tired, run out of energy more quickly, or find it harder to focus. For athletes, especially endurance athletes, research shows that iron deficiency can cut performance by a few percent, and getting iron can boost results by anywhere from a couple percent up to 20%. That's why regular checks and early treatment really help to keep performance and recovery on track. In pregnancy, iron deficiency raises the risk of preterm birth and low birth weight, and for people getting ready for elective surgery, having low iron, even without anemia, can make you more likely to need a blood transfusion and can slow down your recovery. In fact, studies show that patients with a low iron before surgery often have more transfusions, longer hospital stays, and lower recovery quality. The bottom line is, if we can spot and treat iron deficiency earlier, before it turns into anemia, we can step in sooner and help improve quality of life.

Bob Barrett: It's been noticed in your results that the model didn't perform as well in non-anemic individuals. Why do you think the model struggled more with that group?

Yu-Hsin Chang: Yeah, you're right. The model didn't perform equally well across all subgroups. In our analysis, we found that performance was slightly lower in non-anemic population. One reason is that in early stage iron deficiency, there are fewer noticeable changes in blood cell morphology, which makes it harder for the model to learn clear differences during training. Of course, no model is perfect, but our goal is to provide an additional layer of support for clinical doctors, especially in flagging cases that might otherwise go unnoticed.

Even if the model isn't 100% accuracy, being able to identify a subset of at-risk patients earlier can be a valuable trigger for further evaluation or monitoring.

Bob Barrett: Dr. Chang, could you walk us through what the real-world workflow looks like now that this model's been deployed in your hospital system?

Yu-Hsin Chang: All right. Developing tools that can be applied directly in clinical practice has always been a priority for our team. The model has now been deployed in our hospital system and is connected to our laboratory information system. Every time a complete blood count is processed, the data, such as hemoglobin, red blood cell count, and hematocrit, are sent through the model automatically in the background. The model output is simplified into a binary classification displaying either high risk or low risk of iron deficiency. The prediction is shown directly below the corresponding lab report, allowing clinical doctors to see the AI's report by reviewing the original blood analysis.

Without needing to click extra buttons or open another screen, we designed that so it doesn't interrupt the doctor's workflow or override their judgment. It's simply an additional piece of information they can use. In practice, this means a doctor who might not have initially considered iron deficiency, especially in a non-anemic patient, gets a subtle prompt to take a closer look, order complementary tests, or monitor the patient over time. The goal is to make the model's insight available at the right time and place, without adding steps or slowing the original workflow down.

Bob Barrett: So, if the model detects that a patient is at high risk for iron deficiency, is there any alerting mechanism in place to make sure that clinicians actually take note of it?

Yu-Hsin Chang: Right now, the high risk of iron deficiency label appears directly under the patient's blood analysis result in the electronic label report. So, it's visible in the same place clinical doctor is already looking. For patients flagged as high risk, we also display a recommendation to confirm iron status or refer the patient to a hematologist for further checkup. And for hematologists, if the patient is flagged as high risk, the system automatically checks whether any iron-related tests have been performed in the past 30 days. If none have been done, a small window will pop up and ask whether they would like to order the tests. If the doctor agrees, the system takes them straight to the order page and fills in the necessary tests automatically, making the whole process faster and easier.

Bob Barrett: Well, Dr. Chang, let's look ahead. What's next for your team? Do you have any plans for the next phase of developmental research?

Yu-Hsin Chang: Now that the model is running in routine care, we are continuing to adjust it to further improve its performance. In

addition, we want to confirm its real-world clinical value, specifically whether it can influence doctors' decision-making and increase the detection rate of iron deficiency. Our goal is for it to be more than just a research model, but a practical tool that makes a real impact on clinical care.

Bob Barrett:

That was Dr. Yu-Hsin Chang from China Medical University Hospital in Taiwan. He wrote a new research article in the September 2025 issue of *Clinical Chemistry* about a machine learning model to identify iron deficiency, and he's been our guest in this podcast on that topic. I'm Bob Barrett. Thanks for listening.