

BLOOD SIMPLE

Lab reports are often beyond our comprehension. But they don't have to be. Better design and more context can clarify the results—and help us understand our options.

Glucose: 125 mg/dL

The blood test is,

when you think about it, a remarkable thing. With the prick of a needle, the molecules coursing through your veins can be extracted, centrifuged, and translated into a stream of digits, units, and acronyms. Blood becomes data, and in these numbers lies knowledge about your current health, your risks for disease, and your potential response to treatment.

Of course, you yourself would have a hard time deciphering any of this. The typical blood test report is an exercise in obfuscation, a document that needs to be translated by a lab technician or physician, and that's if you somehow manage to see a copy of your results. In many US states, it's illegal for a laboratory to send test results directly to a patient—a regulatory puzzle that leads some labs to simply deny direct results to any customer, anywhere. The blood may be yours—but the information it contains is not.

But lab reports don't have to be unintelligible. With some thought and design-minded thinking, tests can be as informative to patients as they are to physicians. With a little context and color, we can make sense of the numbers. And with a bit more understanding, patients can become participants in their own health.

On the next few pages, WIRED has given the lab report a makeover. We consulted with Lisa Schwartz and Steven Woloshin, physicians at the Dartmouth Medical School Institute for Health Policy and Clinical Practice and experts in communicating data to patients, to make sure the right information gets onto the forms and the irrelevant stuff stays off. And we tapped three exceptional designers to reimagine how this information can be presented—limiting them to one printed page per report. Consider these a proof of concept, a refutation of the argument that ordinary people can't handle their health (and inspiration, we hope, for the medical establishment).

It's your body. It's your information. Now it's yours to understand.

HDL: 46 mg/dL

LDL: 165 mg/dL

Triglycerides: 160 mg/dL

Vitamin D: 22 ng/dL

The Basic Workup

The standard blood workup takes more than 30 measurements and can go on for more than four pages. All sorts of things can turn up in the report; the challenge for physician and patient alike is to find the signal within the noise.

RESULTS REDESIGN BY MUCCA DESIGN

MAKE IT COLORFUL:

The ubiquity of color printers, email, and PDFs means there's no excuse not to use one of the most effective tools in information design. We adopt a familiar green-yellow-red palette to make it easier to identify what needs immediate attention.

MAKE IT CLEAR:

Doctors presumably know what high or low numbers might mean. But there's no reason not to augment the data with qualitative interpretations for all results above and below "normal." Are your numbers a little low or a lot low? We explain.

MAKE IT SIMPLE:

This printout is just the first of four dense pages. The original lists dozens of measurements, potentially too many for even a doctor to comprehend. We summarize the more esoteric tests, focus on the most relevant numbers, and add an overview at the top of the page.

MAKE IT RELEVANT:

Information is useless without explanation and a call to action. So we augment this patient's results with the relevant health risks and offer guidance about what the patient might do to improve her health.

MAKE IT EASY:

Listing various "reference ranges" on the right of the page, separate from the results, forces the eye to scan back and forth as you evaluate the numbers. We add charts that depict clearly and succinctly where you fit along the spectrum.

| Text Name | In Range | Out of Range | Reference Range | Lab |
|--|----------|--------------|----------------------------|-----|
| CBC (INCLUDES DIFF/PLT) | | | | |
| WHITE BLOOD CELL COUNT | 6.1 | | 3.8-10.8 Thousand/ μ L | SJ |
| RED BLOOD CELL COUNT | 3.98 | | 3.80-5.10 Million/ μ L | SJ |
| HEMOGLOBIN | 10.6 | | 11.7-15.5 g/dL | SJ |
| HEMATOCRIT | 37.3 | | 35.0-45.0 % | SJ |
| MCV | 94 | | 80.0-100.0 fL | SJ |
| MCH | 32.2 | | 27.0-33.0 pg | SJ |
| MCHC | 34.4 | | 32.0-36.0 g/dL | SJ |
| RDW | 14.0 | | 11.0-15.0 % | SJ |
| PLATELET COUNT | 292 | | 140-450 Thousand/ μ L | SJ |
| MPV | 7.9 | | 7.5-11.5 fL | SJ |
| ABSOLUTE NEUTROPHILS | 1945 | | 1500-7800 Cells/ μ L | SJ |
| ABSOLUTE LYMPHOCYTES | 1403 | | 850-3900 Cells/ μ L | SJ |
| ABSOLUTE MONOCYTES | 368 | | 100-950 Cells/ μ L | SJ |
| ABSOLUTE EOSINOPHILS | 304 | | 15-500 Cells/ μ L | SJ |
| ABSOLUTE BASOPHILS | 61 | | 0-200 Cells/ μ L | SJ |
| NEUTROPHILS | 65 | | % | SJ |
| LYMPHOCYTES | 23 | | % | SJ |
| MONOCYTES | 6 | | % | SJ |
| EOSINOPHILS | 5 | | % | SJ |
| BASOPHILS | 1 | | % | SJ |
| LIPIDS | | | | |
| LIPID PROFILE | | | | |
| CHOLESTEROL | 211 | | 125-200 mg/dL | SJ |
| TRIGLYCERIDES | 160 | | <150 mg/dL | SJ |
| LDL CHOLESTEROL (CALC) | 163 | | <130 mg/dL | SJ |
| RISK CATEGORY | | | | |
| VERY HIGH (E.G. DIABETES + CVD) | | | | |
| HIGH (DIABETICS, CHD RISK EQUIVALENTS) | | | | |
| MODERATELY HIGH | | | | |
| (MULTIPLE (2+) RISK FACTORS) | | | | |
| 0 TO 1 RISK FACTORS | | | | |
| LDL-CHOLESTEROL GOAL | | | | |
| <70 mg/dL | | | | |
| <100 mg/dL | | | | |
| <130 mg/dL | | | | |
| <160 mg/dL | | | | |

Page 1 Continued on Page 2

Your Test Results

PATIENT: Cora Peterson

GENDER: Female

AGE: 41

DOB: August 12, 1969

ORDERED BY: Dr. Pico Duval

COLLECTED: November 13, 2010, 8:40 a.m.

RECEIVED: November 13, 2010, 8:12 p.m.

RESULTS:

Comprehensive Metabolic Panel

Glucose (fasting): 125 mg/dL



Vitamin D

Total vitamin D: 22 ng/mL



Complete Blood Cell Count (CBC)

Normal for all 20 values, including white blood cell count (a high count can indicate infection).

Urinalysis

Normal for all 20 values, including color, appearance, and protein.

Endocrinology

Normal for TSH, which is an indicator of thyroid function, and for microalbumin and creatinine, measures of kidney function.

Chemistry

Normal for iron, transferrin saturation, and ferritin. (Abnormal levels could indicate anemia, hepatitis, or other problems.)

WHAT DO YOUR RESULTS MEAN?

- ELEVATED GLUCOSE:** The relatively high amount of sugar in your blood is typical of a patient with prediabetes, which can double your risk for heart disease, depending on other risk factors. See diabetes.org for more information.
- ELEVATED CHOLESTEROL:** Your relatively high cholesterol (a waxy substance produced in the liver) may also increase your risk of heart disease, depending on other risk factors. See heart.org for more information.
- LOWER LEVELS OF VITAMIN D:** Your results suggest insufficient vitamin D, which promotes bone density and immune-system function. Women who fit your profile can become deficient within five months if no action is taken. Vitamin D deficiency may increase your risk for osteoporosis, high blood pressure, and certain cancers.

Your results at a glance:

- YOUR GLUCOSE LEVELS ARE TOO HIGH, WHICH INDICATES PREDIABETES.
- YOUR VITAMIN D LEVEL IS TOO LOW.
- YOUR CHOLESTEROL LEVELS ARE BORDERLINE HIGH.
- YOUR KIDNEY, LIVER, AND THYROID FUNCTION ARE ALL NORMAL.

Questions?

Contact the physician who ordered this test for further interpretation of the results:

DR. PICO DUVAL
(212) 555-5253

Lipid Profile

Total cholesterol: 211 mg/dL



HDL ("good" cholesterol): 46 mg/dL



LDL ("bad" cholesterol): 165 mg/dL



Triglycerides: 160 mg/dL



WHAT CAN YOU DO?

- CONSIDER YOUR LIFESTYLE.** If you are inactive, overweight, and/or a smoker, your risk for diabetes and heart disease rises. Exercising regularly (30 minutes/day) and reducing your weight by 5 to 10 percent lowers your risk of diabetes by 58 percent.
- ADDRESS OTHER RISK FACTORS FOR DIABETES AND HEART DISEASE.** Dietary changes, like reducing alcohol consumption and increasing fruit and vegetable intake, can decrease your cholesterol and triglyceride levels.
- ASK YOUR DOCTOR ABOUT REDUCING YOUR HEART DISEASE RISK.** Medications like statins can lower cholesterol and delay the onset of heart disease. Calculate your risk at hp2010.nhlbi.nih.net/atpiii/calculator.asp.
- CONSIDER LIFESTYLE CHANGES TO CORRECT VITAMIN D INSUFFICIENCY.** These include diet, vitamin D supplements, and more exposure to sunlight.

The Heart Disease Test

Alongside cholesterol tests and high-blood-pressure monitoring, the c-reactive protein, or CRP, test is widely used to spot people at risk for heart disease, the leading cause of death in the US.

RESULTS REDESIGN BY DAVID MCCANDLESS

DESCRIBE THE TEST:

The CRP test was invented by Paul Ridker, a Harvard medical professor, to measure c-reactive protein in the blood. High levels indicate inflammation, which can be a sign of infection or cardiovascular disease. Though there's space galore on the page, this report makes no effort to explain the link between CRP and actual heart disease.

GIVE THE CONTEXT:

A doctor typically orders a CRP test based on the results of a lipid panel (which shows cholesterol levels)—then often orders the lipids again along with the CRP test. The two measures are used jointly to suss out a diagnosis or assess risk. So why not put them together on one sheet of paper? We do.

| | | | | | | |
|--|--|--------------|------------------------------|-----------------|------------------------------|---------------|
| SEND TO: CIRCLE DIAGNOSTICS 500 DOLores STREET SAN FRANCISCO, CA 94110 | | | | | Circle DiagnosTics | |
| PATIENT NAME MORROW, JEROME | BIRTH DATE 49 | SEX MALE | SAMPLED NO NOT GIVEN | OTHER ID NO | DATE COLLECTED 11/02/2010 | TIME 10:40 |
| ACCOUNT NO 36904447 | | | | | RECEIVED 11/02/2010 | 1:03 |
| REVISIONS SAMPLE REPORT. | NO SAMPLE SENT | | REFERRING PHYSICIAN LAMAR | | REPORTED 11/02/2010 | 1:03 |
| TEST | RESULT | OUT OF RANGE | UNITS | REFERENCE RANGE | | |
| Cardio CRP | | | 3.3 | mg/L | | |
| For Ages > 17 Years | | | | | | |
| CCRP mg/L | Risk According to AHA/CDC Guidelines | | | | | |
| <1.0 | Lower Relative Cardiovascular Risk | | | | | |
| 1.0-3.0 | Average Relative Cardiovascular Risk | | | | | |
| >3.0 | Higher Relative Cardiovascular Risk | | | | | |
| >10.0 | Consider retesting in 1 to 2 weeks to exclude a benign transient elevation in the baseline CRP value secondary to infection or inflammation. Persistent elevations upon retesting may be associated with infection and inflammation. | | | | | |
| 3.3 | | | | | | |
| TEST CODE | CLIA ID | DATE PRINTED | PATIENT NAME | | | |
| 20 | 1743 | 11/02/2010 | Jerome M. Morrow | | | |

PERSONALIZE THE RISK:

The phrase *relative cardiovascular risk* has little meaning without some context. An online calculator can combine the patient's CRP result and lipid profile to estimate their specific risk. And we give them the URL to let them use it themselves.

POINT TO THE NEXT STEPS:

The results are in. Now what? The original report buries advice on retesting in the fine print. We emphasize the point, explaining how a change in behavior (like eating better or quitting smoking) can reduce a patient's risk of heart disease.

Blood Work Cardiology Result

BACTA MEDICAL CENTRE

ORDERED BY: Dr. Francis Pulaski

Patient

NAME: **Jerome Morrow**

GENDER: M AGE: 49 DOB: 01/10/1961

Bacta Medical Centre
pulaski.f@bactamed.edu
(603) 555-9564 x1523

COLLECTED: 11/02/2010, 10:40 a.m.

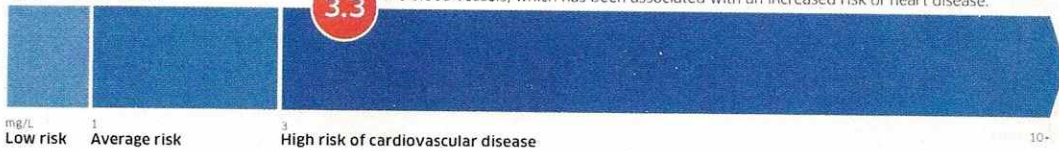
RECEIVED: 11/02/2010, 1:03 p.m.

1 About this test

This report evaluates your potential risk of heart disease, heart attack, and stroke.

2 Your results

CRP level test



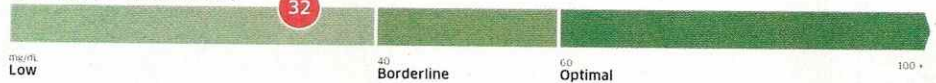
Total cholesterol level



LDL ("bad" cholesterol)



HDL ("good" cholesterol)



3 Your risk You show an elevated risk of cardiovascular disease.

If you're a smoker with blood pressure of 130 mm/Hg but a family history of heart attack before age 60 (in one or both parents), your risk over the next 10 years is:

15%

Your risk would be lowered to:

12% if your blood pressure were 120 mm/Hg.

10% if you quit smoking.

6% if you reduced your cholesterol to 160 mg/DL.

Use your CRP results and cholesterol level to calculate your 10-year risk of a cardiovascular event at www.reynoldsriskscore.org.

4 What now?



Diet and exercise can improve your cholesterol levels.



Avoid drinking alcohol, except in moderation: one to two drinks per day.



Ask your doctor about statins or other medications that can lower cholesterol.



Consider retesting in one to two weeks, in case your CRP level was caused by infection.

The Prostate Test

Short for prostate-specific antigen, the PSA test is one of the most common workups for men over 40—even though its reliability as a predictor of prostate cancer is controversial.

RESULTS REDESIGN BY JUNG + WENIG

UNDERSTAND THE LIMITATIONS:

As the original report states, "PSA levels, regardless of value, should not be interpreted as absolute evidence of the presence or absence of disease." (Even Richard Ablin, the doctor who discovered PSA in 1970, says the test is "hardly more effective than a coin toss.") That's why our revision includes helpful statistics (for example, 65 to 75 percent of men with a high reading do not have prostate cancer). We also list some of the many alternative reasons for an elevated PSA level.

KEEP IT IN PERSPECTIVE:

Even if he has a high PSA level, our patient's chance of prostate cancer is just 25 percent. And even if he has the disease, there's a 75 percent chance he'll live 15 or more years—and a near certainty he'll be alive in five years.

| ALIAS | READ TO | CIRCLE DIAGNOSTICS | 500 DOLores STREET | SAN FRANCISCO, CA 94110 | Circle | Diagnosics | |
|---------------|-------------------------------|--------------------|---------------------|-------------------------|------------|-----------------|---------|
| PATIENT NAME | GRANT, BOVD | PATIENT ID NO. | NOT GIVEN | DATE | 11/01/2010 | TIME | 11:40 |
| ACCESSION NO. | 36904467 | BIRTH DATE | NOT GIVEN | RECEIVED | 11/01/2010 | | 11:57 |
| SEX | NOT GIVEN | AGE | NOT GIVEN | REPORTED | 11/01/2010 | | 11:57 |
| REMARKS | SAMPLE REPORT: NO SAMPLE SENT | | REFERRING PHYSICIAN | MICHAELS | STATUS | FINAL | |
| TEST | PSA | RESULT | 5.1 | UNIT | ng/mL | REFERENCE RANGE | 0.0-4.0 |

This test was performed using the Siemens (Bayer) Chemiluminiscant method. Values obtained from different assay methods cannot be used interchangeably. PSA levels, regardless of value, should not be interpreted as absolute evidence of the presence or absence of disease.

GIVE SPECIFICS:

Since the prostate produces more PSA as a man ages, some researchers argue that reference numbers should vary by age to avoid unnecessary biopsies. So while the original report shows just one range (0.0 to 4.0), we tailor the risk to our patient's age group (50 to 59). Any lab could do the same.

KNOW THE CONTROVERSY:

Ablin called the overuse of the PSA test a "profit-driven public health disaster" in a recent *New York Times* op-ed. He says PSA screenings often lead to unwarranted, dangerous, and expensive biopsies. That won't stop the test from being used—but patients should know that the results are often ambiguous.

USE THE WHITE SPACE:

The original printout leaves most of the page blank. We put this fallow ground to use, adding more information and context.

Lab Test Result: PSA

WIRED DIAGNOSTICS
520 Third Street, Suite 305
San Francisco, CA 94107
phone: 415-555-5000

| PATIENT NAME | BIRTH DATE | PATIENT ID NO | COLLECTED |
|--------------|------------|---------------|-----------------------|
| Grant, Boyd | 1956 | 9131-10-1 | 11 01 2010 11:40 AM |
| | | | RECEIVED |
| | | | 11 01 2010 11:57 AM |
| | | | ORDERED BY |
| | | | Dr. Beverly Michaels |

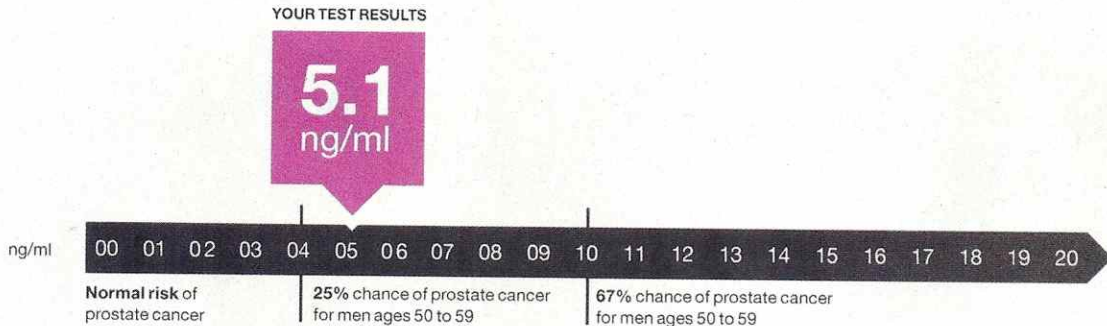
1 About the PSA test

This test measures the amount of a substance called prostate-specific antigen, or PSA, in the blood. The prostate gland releases more of this antigen as you age, but PSA levels can also rise due to an inflammation of the prostate or prostate cancer. While the PSA test is used to screen for cancer, there is debate over whether PSA testing actually reduces your chance of dying from prostate cancer.

2 What do your results mean?

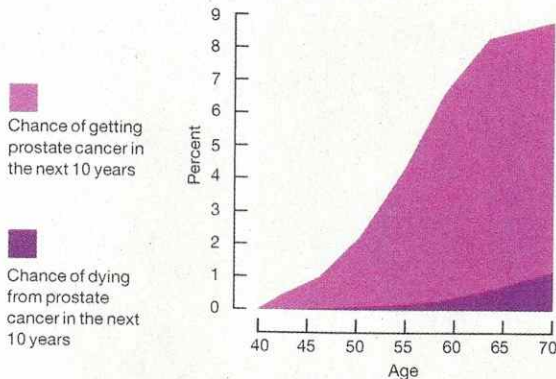
The higher your PSA level, the greater the chance you have prostate cancer. However, it's possible to have cancer and a low PSA level. It's also possible to have a high PSA level but no cancer.

So this test is not definitive. The most common problem with the test is false alarms — where the PSA level is high but there's no cancer. Between 65 and 75 percent of men with an elevated PSA level who have a biopsy turn out NOT to have prostate cancer.



3 Additional perspective

In the general population, the risk of prostate cancer at your age is about 4 percent and the risk of dying from it is less than 1 percent.



4 What now?

If this was your first PSA screening: Talk to your physician about alternative causes for your elevated PSA level, including benign prostate enlargement, inflammation, infection, age, and race.

If you've been tested previously: Compare your PSA results and talk to your physician about possible conditions other than cancer. Many doctors say a rise of 0.75 ng/ml per year is not worrisome.

Talk to your physician about additional tests, including a digital rectal exam or biopsy.

Groupon and
the Rise of
Retail Hacking

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How to Build
Alien Life Here
on Earth

p.208

Wish List 2010
100 Best Gifts
for Geeks

WIRED

TRON

IT'S NOT JUST A MOVIE.

LIGHT CYCLES, HOLLYWOOD,
AND THE EVOLUTION
OF CYBERSPACE.

BY ADAM ROGERS

Flash back | dec. 2010

