

## The Right Stuff: Appropriate Mathematics for All Students

*Promoting the use of materials that engage students in meaningful activities that promote the effective use of technology to support mathematics, further equip students with stronger problem solving and critical thinking skills, and enhance numeracy.*



### Overview

In a real-life application, students will apply the concepts of

- Linear functions – Students will be able to write the equation of the line of best fit.
- Modeling – Students will be able to interpret a linear model within the context of the given scenario.

### Supplies and Materials

- Student Worksheet 7.1
- Excel file 7.3

### Pre-requisite Knowledge

Students must be able to

- Find a linear model
- Use a linear model to make predictions.

### Pedagogical Suggestions

1. Take time to discuss what the signal intensity ratio (SIR) is and why a lower value is bad.
2. Use the data to find a linear model. Discuss the relatively low value of r-squared.
3. Find the SIR value the point the physician might prescribe a biopsy and discuss why that might not be a hard-and-fast rule. Also discuss why solving the model for the independent variable using the value of 400  $\mu\text{mol/g}$  in the dependent variable does not produce a reasonable answer. Compare the graph with that answer.

### Assessment Ideas

1. Suppose new evidence (research) shows that if the SIR is less than 0.8, a biopsy should be ordered. What is the estimate for the iron content for an SIR of 0.8?

2. The following table gives SIR values for Pituitary Vasopressin Concentration (ng/sq mm).

SIR	1.19	1.22	1.18	1.21	1.4	1.35	1.3	1.29	1.45	1.4	1.5	1.6	1.55
PVC	580	550	900	1020	750	1100	1240	1200	1470	2050	2100	1770	2650

Construct a scatter plot.

Determine a linear model for PVC as a function of SIR.

3. Have a student do research on the causes of hemochromatosis.

### Module 7

This material is based upon work supported by the National Science Foundation under Grant No. DUE 0632883

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## Introduction

Magnetic resonance imaging (MRI) is a noninvasive medical test that helps physicians diagnose and treat medical conditions.

MRI imaging uses a powerful magnetic field, radio frequency pulses and a computer to produce detailed pictures of organs, soft tissues, bone and virtually all other internal body structures. The images can then be examined on a computer monitor, printed or copied to CD. MRI does not use ionizing radiation (x-rays).

During magnetic resonance imaging (MRI), a narrow tube moves the patient through a tunnel-like structure. Inside the structure, radio waves pass through a magnetic field around the patient, creating a 3-D image of the internal structures.



ADAM.

Figure 1

Source: [assets.aarp.org](https://assets.aarp.org)

Comparing the intensity of one part of an image to another part (of known density) provides an indication of the density of each the unknown portions of the image. In the Figure 2, the unknown density of the liver is compared to the density of the Para spinal muscle (the known value).

See further  
Hemochromatosis by James Barton and Corwin Edwards

See: 7.5 MRI of 4 Livers



Figure 2

Source: [oernst.f5lvg.free.fr](https://oernst.f5lvg.free.fr)

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A technician administers the test and sends the results to physicians who analyze the results.

According to Payscale.com, the hourly rate of pay for MRI technicians increases with experience.

- Find the ratio for the pay of MRI technicians with 20+ years of experience compared to those with 10-19 years of experience. Compare that with the ratio of 1-4 years to less than 1-year.

**1.0767**

**20-yr vets are paid about 7 2/3 % higher than 10-19.**

**1.1071**

**1-4 yr vets are paid about 10 3/4 % higher than those with less than one year.**

**Discuss.**

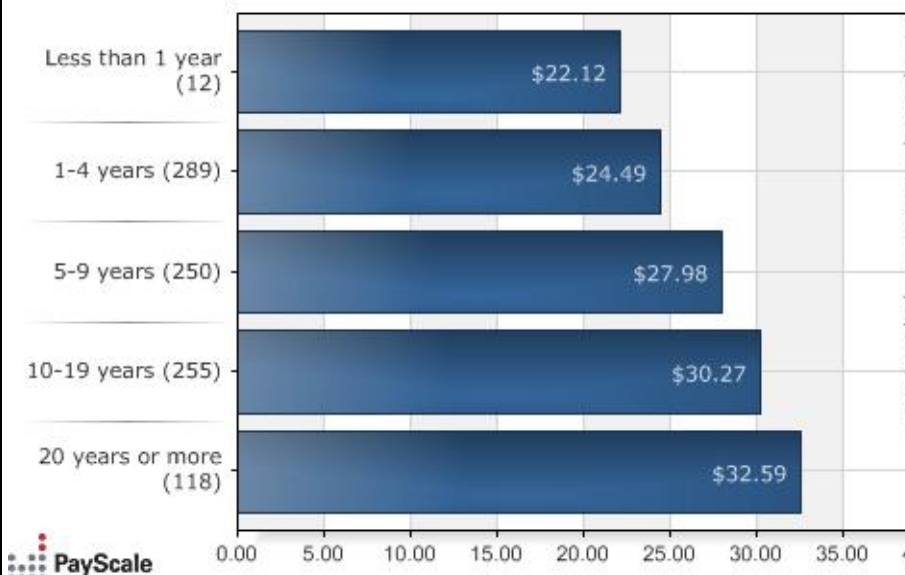


Figure 3

Source: www.payscale.com

Hemochromatosis is the most common form of iron overload disease. Physicians use the information from an MRI to decide whether to perform the invasive procedure of a liver biopsy. Iron content in the liver normally is around the 400 µmol/g.

- When the iron content is greater than 400 µmol/g, action may be required. Beyond what signal intensity ratio might physicians prescribe a biopsy?
- The signal intensity ratio of the liver (siL) and the signal intensity ratio of the paraspinal muscle (siM) on the same CAT-scan provide what is called the siL/siM ratio. The siL/siM ratio can be used to determine the amount of iron in the liver, measured in µmol/g. Iron overload in the liver decreases the signal intensity of the liver while muscle signal intensity remains unchanged.
- The data (right) came from biopsies and shows the signal intensity ratio and the iron content. Describe the general trend you see in the data.

For more information Hemochromatosis on see:

<http://digestive.niddk.nih.gov/ddiseases/pubs/hemochromatosis/index.htm>

Table 1

Signal Intensity Ratio (SIR)	Iron
0.42	960
0.58	800
0.6	570
0.77	420
0.82	360
0.83	680
0.92	280
1	510
1.02	315
1.16	390
1.3	250
1.51	230

**The general trend is that as the SIR increases the amount of iron decreases. This is due to the iron in the liver reducing the amount of light (signal) passing through the liver.**

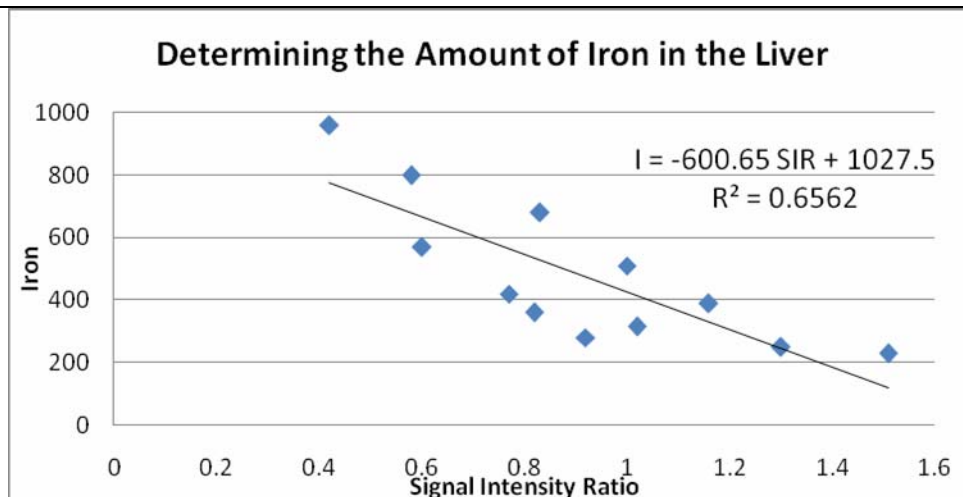
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The objective is to find a model that will predict the iron content in the liver. If the amount of iron found is greater than 400  $\mu\text{mol/g}$ , the physician may prescribe additional tests, including a biopsy.

5. Construct a scatter plot of the data in Table 1.



6. Find a linear model for iron as a function of the SIR.

**The line of best fit is**

**$\text{Iron} = -600.65 (\text{SIR}) + 1027.5$**

7. According to the model, below what SIR might the physician prescribe additional tests?

**If an iron level of 400  $\mu\text{mol/g}$  is the threshold, then**

<b>SIR</b>	<b>Model</b>
0.4	787.24
0.5	727.175
0.6	667.11
0.7	607.045
0.8	546.98
0.9	486.915
<b>1</b>	<b>426.85</b>
1.1	366.785
1.2	306.72
1.3	246.655
1.4	186.59

8. Discuss why other factors might enter into the decision.

**The model found with these 12 biopsies has a coefficient of determination of only 0.66 suggesting there is a great deal of variation in the data.**

**Further tests might be warranted if the physician had other data indicating problems and the SIR was not over the threshold.**

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