

Elements of Usability

Visual Design

An educational presentation to the
EHR SIG

June 13, 2008



Visual Display Toolbox

Use dashboards

Problem List

- [Diabetes Mellitus Type 2](#) (250.60)
- Hyperlipidemia (272.2)
- [Hypertension](#) (401.1)
- Peripheral Neuropathy (356.9)

Allergies

- aspirin
- codeine
- egg containing compound
- penicillin

Home Medications

- albuterol: PRN
- aspirin: 81 mg Daily
- diltiazem: 240 mg Daily
- enalapril: 20 mg bid
- glyBURIDE: 20mg 2 Daily(0700)
- guaifenesin: PRN
- hydrochlorothiazide: 25 mg Daily
- insulin detemir: 30 units At Bedtime
- metformin: 850MG,2-AM,1-PM PO
- multivitamin: Daily
- pioglitazone: 30 mg Daily
- ranitidine: 150 mg Daily
- simvastatin: 10 mg Daily

Clinical Events

T: 36.0 DegC	(03/27/08)	36.6 DegC	(01/03/08)	
BP: 162/79 mmHg	(03/27/08)	134/78 mmHg	(12/27/07)	
HR: 76 bpm	(03/27/08)	52 bpm	(12/27/07)	
RR: 20 breaths/min	(03/27/08)	20 breaths/min	(01/03/08)	
Wt: 118.000 kg (260 lbs)	(03/27/08)	68.300 kg (150 lbs)	(12/27/07)	
BMI: 41 Est. BMI*	(03/27/08)	24 Est. BMI*	(12/27/07)	
Pain: 3	(03/27/08)	0	(01/03/08)	
Smoking Hx: not documented	()			

Labs & Diagnostics

Cr: 1.0 mg/dL	(12/20/07)	0.9 mg/dL	(06/27/07)	
Est. CCr*: 100.3 mL/min	(12/20/07)	111.4 mL/min	(06/27/07)	
Est. GFR*: 59 mL/min	(12/20/07)	> 60 mL/min	(06/27/07)	
ALT: 15 unit/L	(12/20/07)	16 unit/L	(06/27/07)	
Glu: H 179 mg/dL	(12/20/07)	H 175 mg/dL	(06/27/07)	
K+: 4.7 mmol/L	(12/20/07)	4.4 mmol/L	(06/27/07)	
Total Chol: L 125 mg/dL	(12/20/07)	150 mg/dL	(06/27/07)	
LDL: 62 mg/dL	(12/20/07)	83 mg/dL	(06/27/07)	
HDL: 49 mg/dL	(12/20/07)	50 mg/dL	(06/27/07)	
Trig: 69 mg/dL	(12/20/07)	85 mg/dL	(06/27/07)	
HbA1c: H 7.4 %	(03/21/08)	H 6.8 %	(12/20/07)	

Health Maintenance

DEXA	(09/27/06)
Mammography	(08/30/06, 08/30/06, 06/15/04, 05/05/03, 02/06/01, 01/16/01, 10/07/99)
Pap Smear	(09/01/00)
diphtheria-tetanus toxoids	(01/30/02)
pneumococcal 23-valent (Pneumovax)	(07/31/07, 01/03/01)

Dashboards

Stephen Few

- Information Dashboard Design
- perceptualedge.com

INFORMATION DASHBOARD DESIGN

The Effective Visual Communication of Data

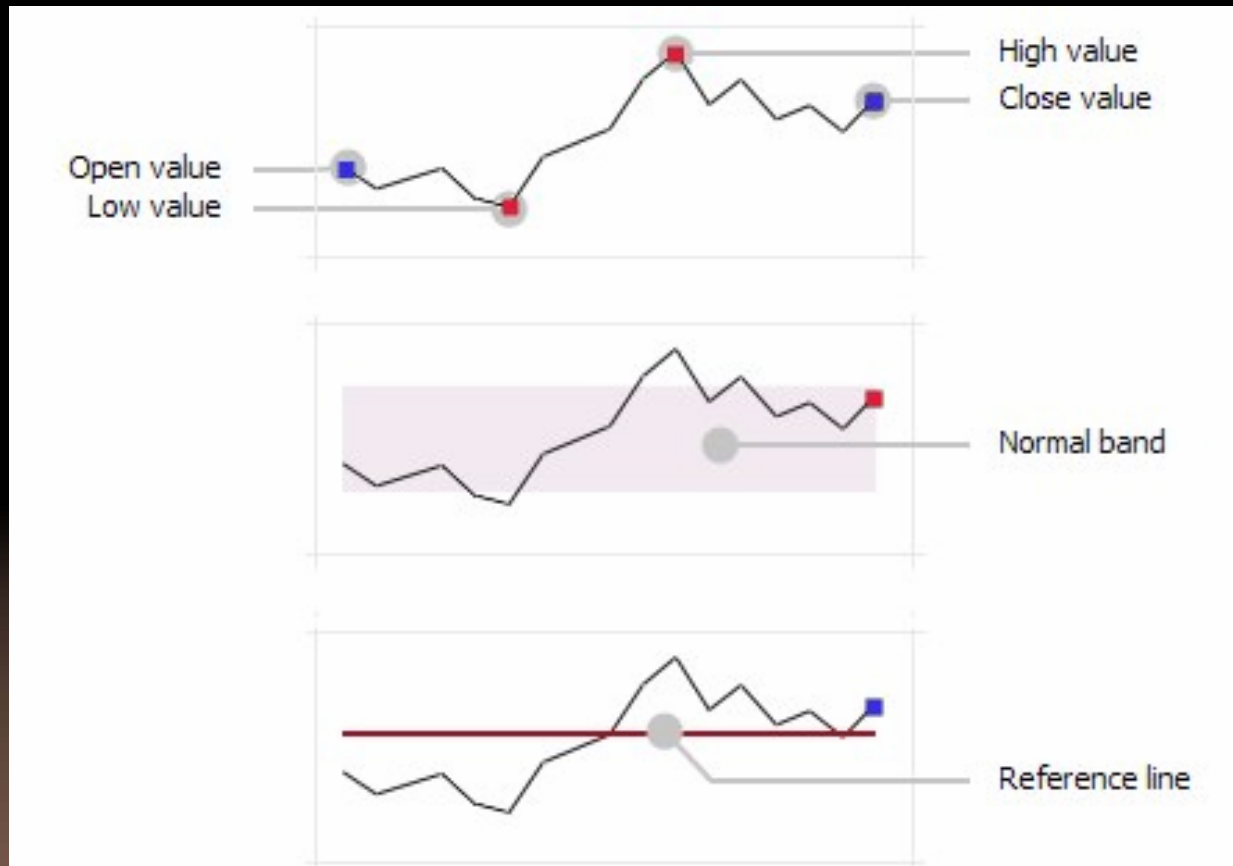


Stephen Few

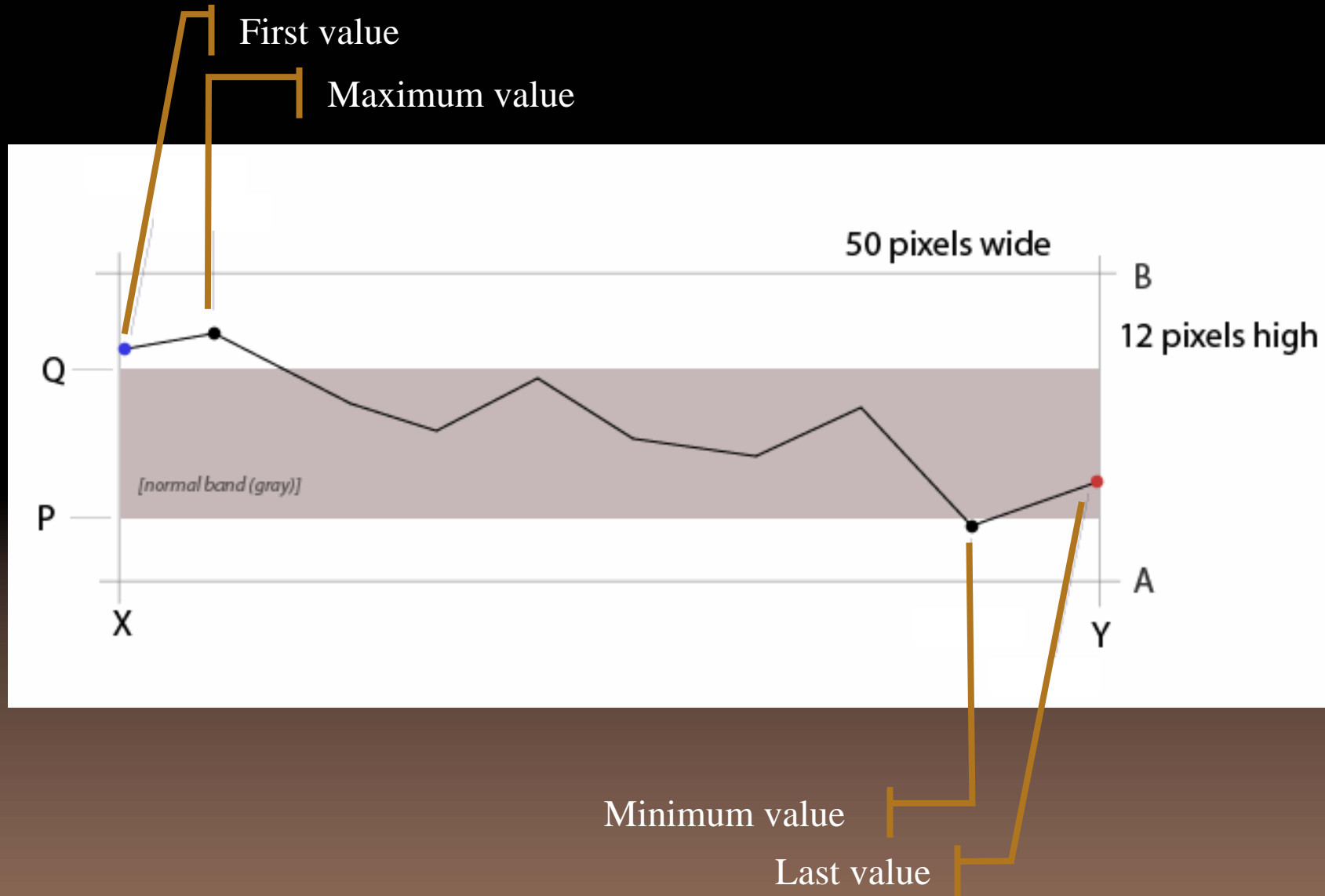
O'REILLY®

Sparklines

Data-intensive, word-size graphics



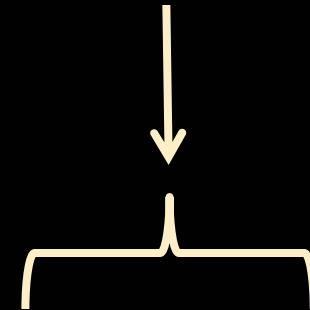
Sparkline Anatomy



Bullet Graphs

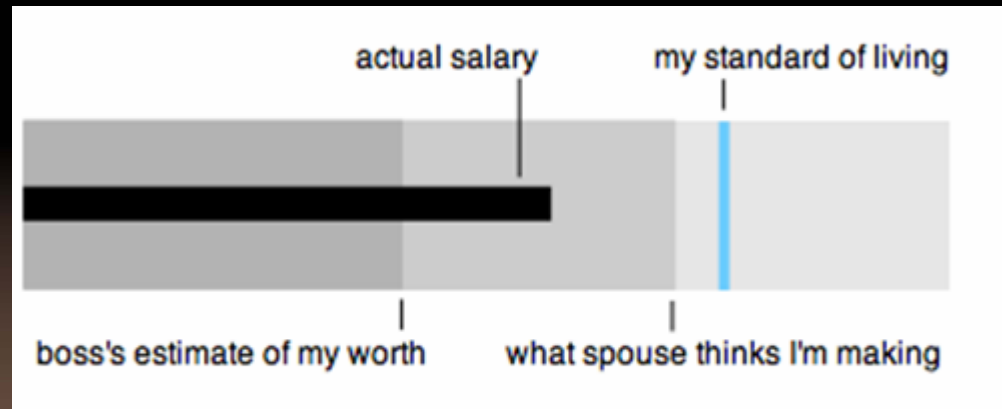
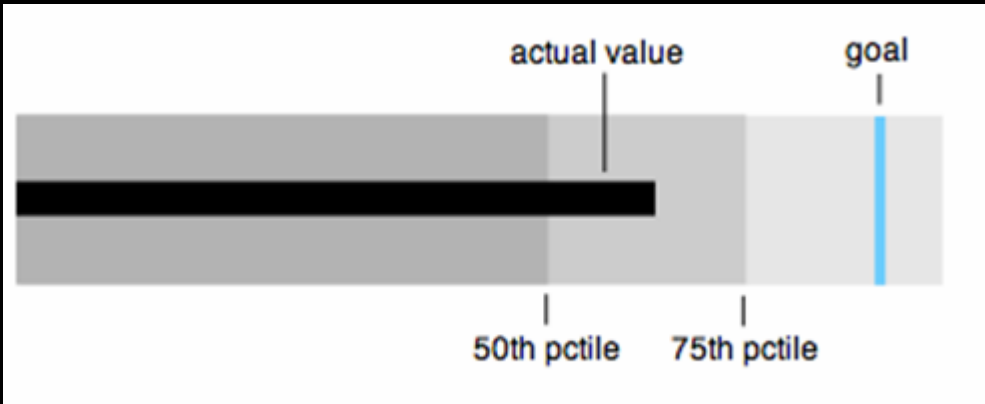
Show Key Quality Indicators for a cohort of patients

- Is A1C obtained annually? yes
- Is BP goal being met? no





Diabetes Mellitus NCQA Performance Targets		
This Patient	Target	My Performance
	1:Annual HbA1c	
	2:HbA1c <= 9.0%	
●	3:BP < 140/90	
	4:Annual LDL	
	5:LDL < 130	
	6:Annual MicroAlb	
●	7:Annual Eye Exam	
●	8:Annual Foot Exam	

How Bullet Graphs Work



Traffic Lights

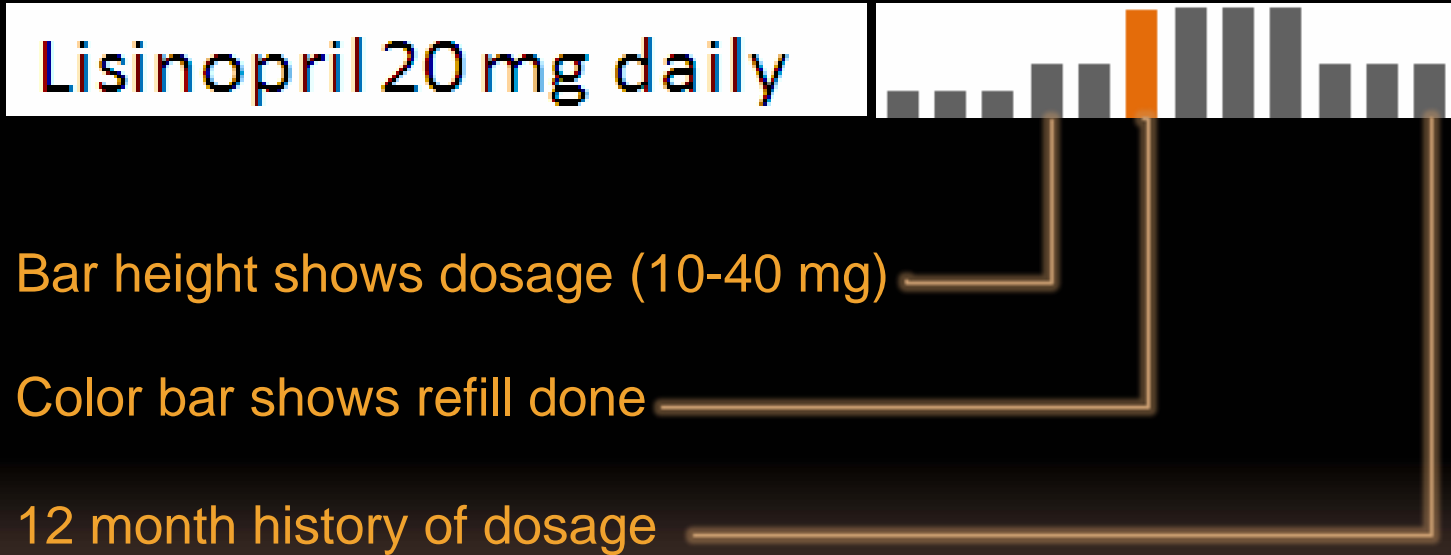
Bring attention to items requiring action

Health Maintenance	
DEXA	(09/27/06)
 Mammography	(08/30/06, 08/30/06, 06/15/04, 05/05/04)
 Pap Smear	(09/01/00)
diphtheria-tetanus toxoids	(01/30/02)
pneumococcal 23-valent (Pneumovax)	(07/31/07, 01/03/01)

 Medium warning

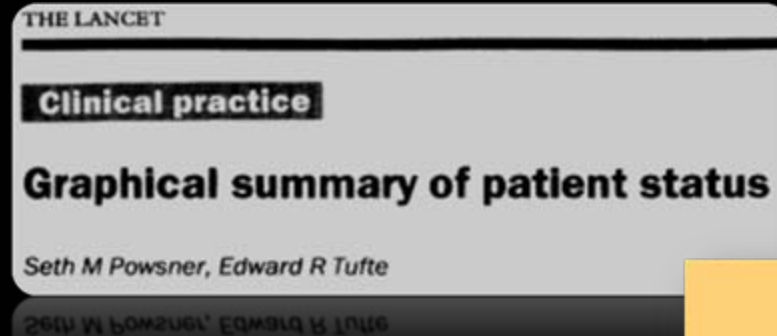
 Maximum warning

Medication History Shorthand

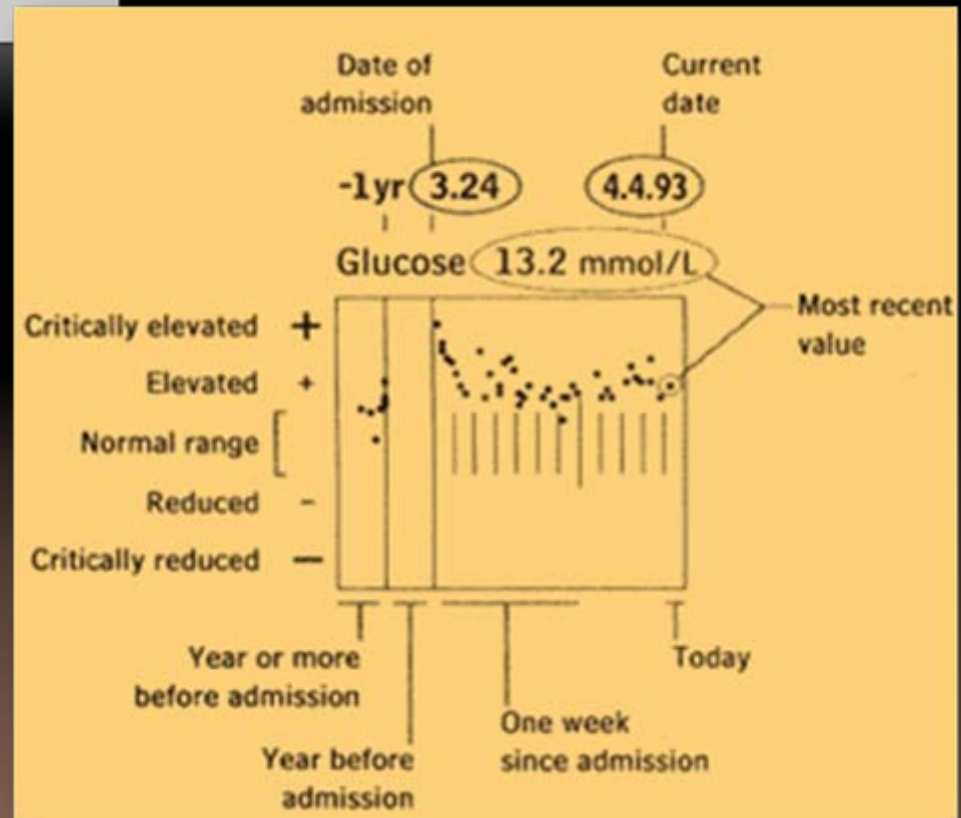


Some innovative examples

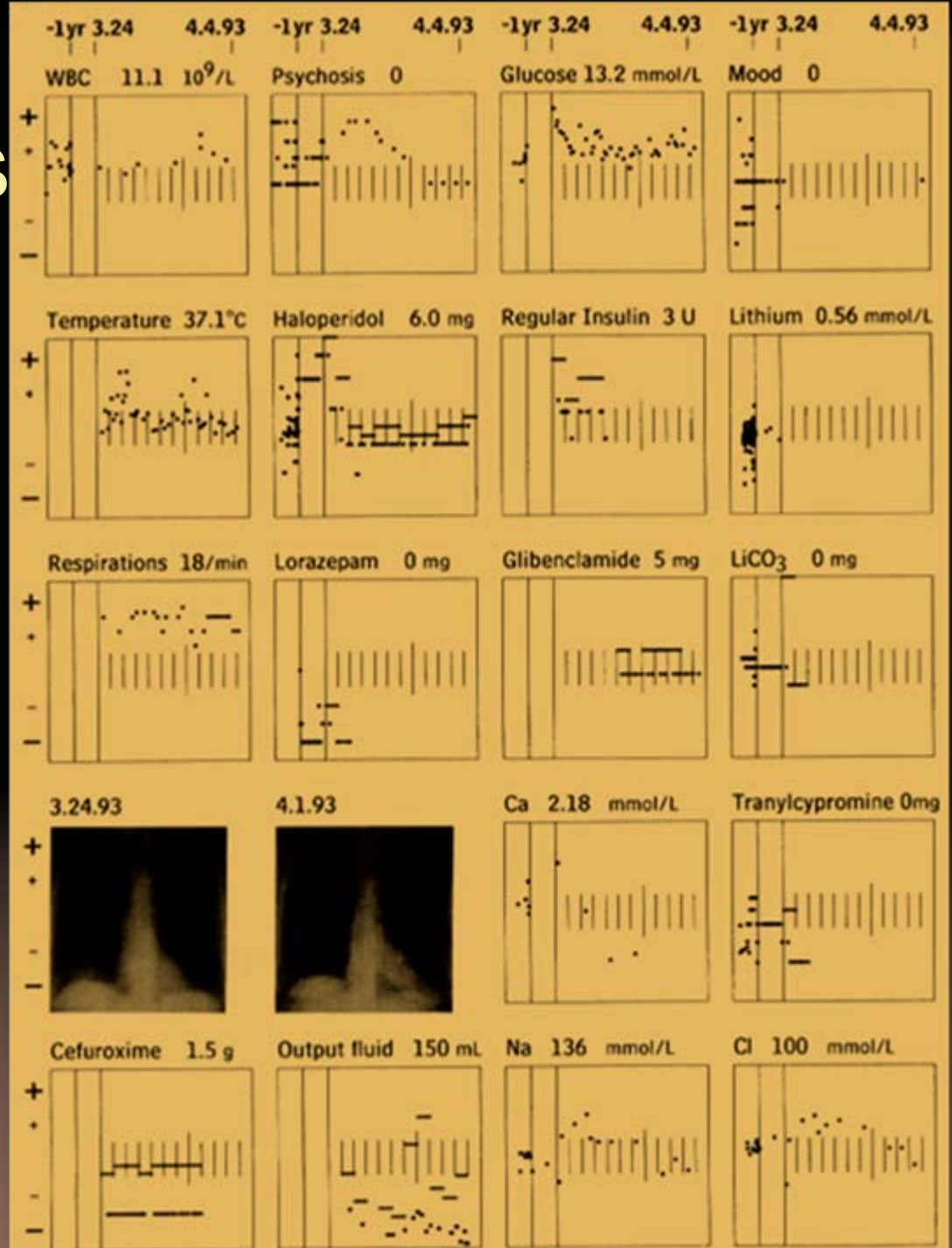
Inpatient Mini-Graphs



- Inpatient time-scale
- Deviation from normal range



Small Multiples

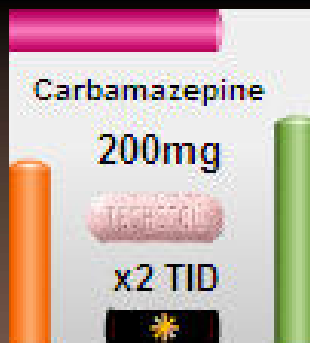


Medication Iconographs

Concept by Jason Cafer MD



Duration of use of this drug = 8 months



Compliance = 70%

Black bar means adverse effect

Medication Iconographs

Concept by Jason Cafer MD

Drug interaction
lowers
effective serum level

Relatively low dose



Visual Display Principles

Show WYNWYNIANM

What you need
When you need it

Details needed in the overall dashboard view

Medication

lisinopril 20 mg daily

metformin 500 mg BID

furosemide 20 mg 2 in AM

omeprazole 20 mg daily

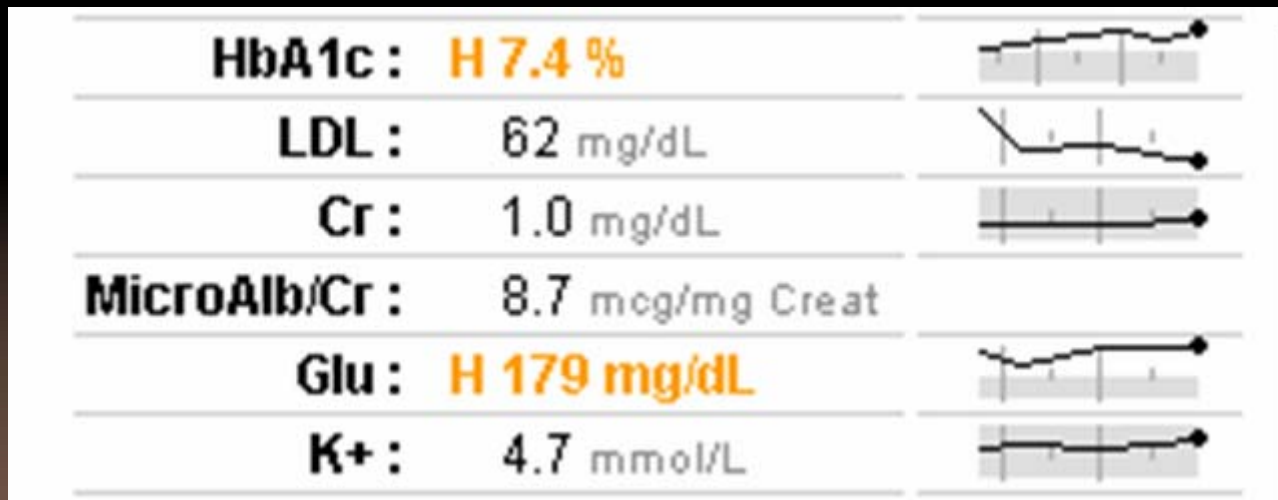
And nothing more

Details needed in managing new medications and refills

Medication	SIG	Qty	Refills	Start	End
lisinopril 20 mg	1 tablet daily	90 tablets	3 refills	10/19/07	11/20/07
metformin 500 mg	1 tablet twice daily	180 tablets	3 refills	4/29/07	-
furosemide 20 mg	2 tabs each AM	180 tablets	3 refills	9/2/2004	-
omeprazole 20 mg	1 tablet daily	90 tablets	3 refills	2/11/06	-

Good visualizations are right-sized

Simplicity of display
hides complexity of data



Highlight Abnormal Values

Find the Flagged Abnormal Value

```
LAB RESULTS
*****ABNORMAL VALUES*****
TEST          VALUE      UNITS          RANGE
BUN/CR RATIO  6.4        N/A            0.9-5.6
HDL           39         mmol/liter     >40
LDL           108        mmol/liter    <100+
              *NORMAL LDL VALUES ARE BASED ON AGE AND SEX
PSA           14.0       mmol/liter    0.0-4.0
MCV           99.1       gm/unit        88.7-99.0
*****
```

From an actual malpractice case...

Oh...

LAB RESULTS

```
*****ABNORMAL VALUES*****  
TEST          VALUE      UNITS          RANGE  
BUN/CR RATIO  6.4        N/A            0.9-5.6  
HDL           39         mmol/liter     >40  
LDL           108        mmol/liter    <100*  
              *NORMAL LDL VALUES ARE BASED ON AGE AND SEX  
PSA           14.0       mmol/liter    0.0-4.0  
MCV           99.1       gm/unit        88.7-99.0  
*****
```

Here's a better alternative

LAB RESULTS

```
*****CRITICAL VALUE!! *****
*****
*****
*****          PSA 14.0          *****
*****
*****
*****CRITICAL VALUE!! *****
```

```
*****ABNORMAL VALUES*****
TEST          VALUE      UNITS          RANGE
BUN/CR RATIO    6.4      N/A           0.9-5.6
HDL             39       mmol/liter    >40
LDL            108      mmol/liter    <100*
               *NORMAL LDL VALUES ARE BASED ON AGE AND SEX
PSA            14.0     mmol/liter    0.0-4.0
MCV            99.1     gm/unit       88.7-99.0
*****
```

Or, make the highlight jump out

The “hanging outdent” ...


```
*****ABNORMAL VALUES*****
TEST          VALUE      UNITS      RANGE
BUN/CR RATIO  6.4          N/A        0.9-5.6
HDL           39           mmol/liter >40
LDL           108          mmol/liter <100*
              *NORMAL LDL VALUES ARE BASED ON AGE AND SEX
PSA           * CH 14.0    mmol/liter 0.0-4.0
MCV           99.1         gm/unit    88.7-99.0
*****
```

... juts out to the left of the other values,
grabbing the users attention

Or use color, bolding, ...

Labs & Diagnostics	
Cr:	1.0 mg/dL
Est. CCr*:	100.3 mL/min
Est. GFR*:	59 mL/min
ALT:	15 unit/L
Glu:	H 179 mg/dL
K+:	4.7 mmol/L
Total Chol:	L 125 mg/dL
LDL:	62 mg/dL

... or alert icons

Labs & Diagnostics	
Cr:	1.0 mg/dL
Est. CCr*:	100.3 mL/min
Est. GFR*:	59 mL/min
ALT:	15 unit/L
	Glu: H 179 mg/dL
	K+: 4.7 mmol/L
	Total Chol: L 125 mg/dL
	LDL: 62 mg/dL

Avoid cognitive overload

Wordy

Medication	SIG	Qty	Refills	Start	End
lisinopril 20 mg	1 tablet daily	90 tablets	3 refills	10/19/07	11/20/07
metformin 500 mg	1 tablet twice daily	180 tablets	3 refills	4/29/07	-

Terse

Medication	SIG	Qty	Refills	Start	End
lisinopril 20 mg	1 daily	90	3	10/19/07	11/20/07
metformin 500 mg	1 BID	180	3	4/29/07	-

Use different visual layers

Home Medications
albuterol: PRN
aspirin: 81 mg Daily
diltiazem: 240 mg Daily
enalapril: 20 mg bid
glyBURIDE: 20mg 2 Daily(0700)

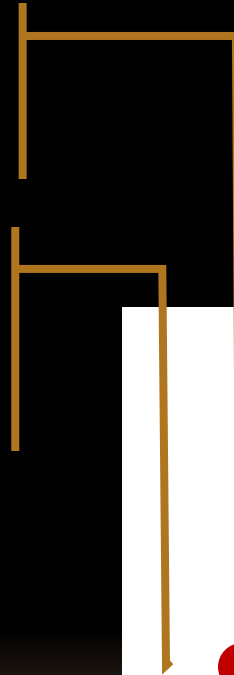
Black font
for name of drug

Gray font
for SIG, on a different
visual plane

Show Medication Adherence

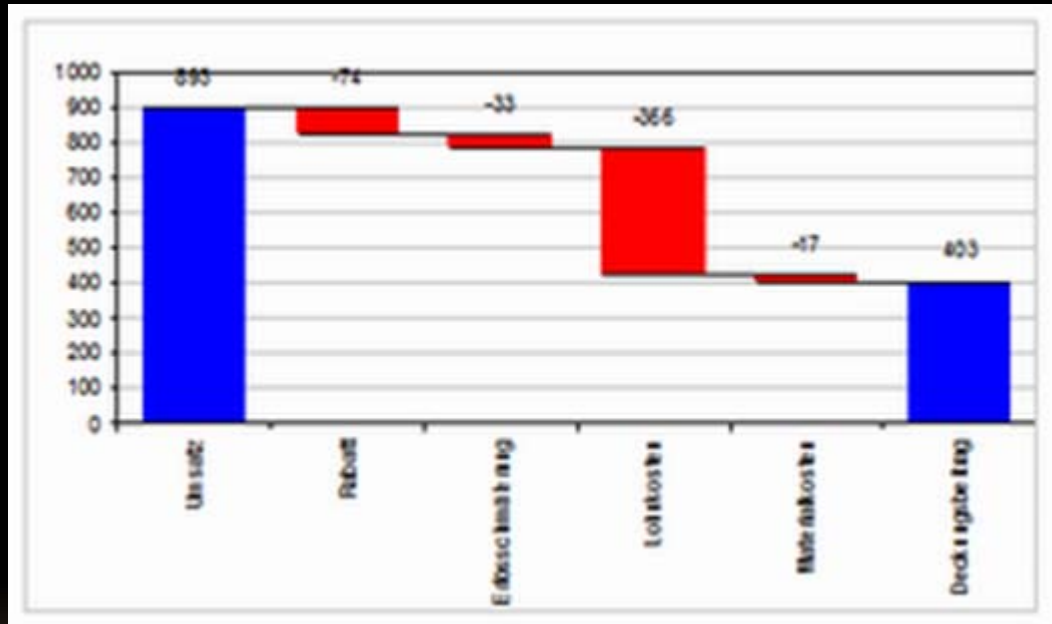
Red dot |
Not taking drug at all

Gray up-arrow |
Benefit noted
from this drug



- Allopurinol 300 mg Daily
- Hydrochlorothiazide 25 mg Daily
- Levothyroxine 125 mcg Daily
- Lisinopril 10 mg Daily
- Lovastatin 40 mg 2 at supper
- ▲ ▾ Metformin 500 mg BID

Reduce Visual Noise

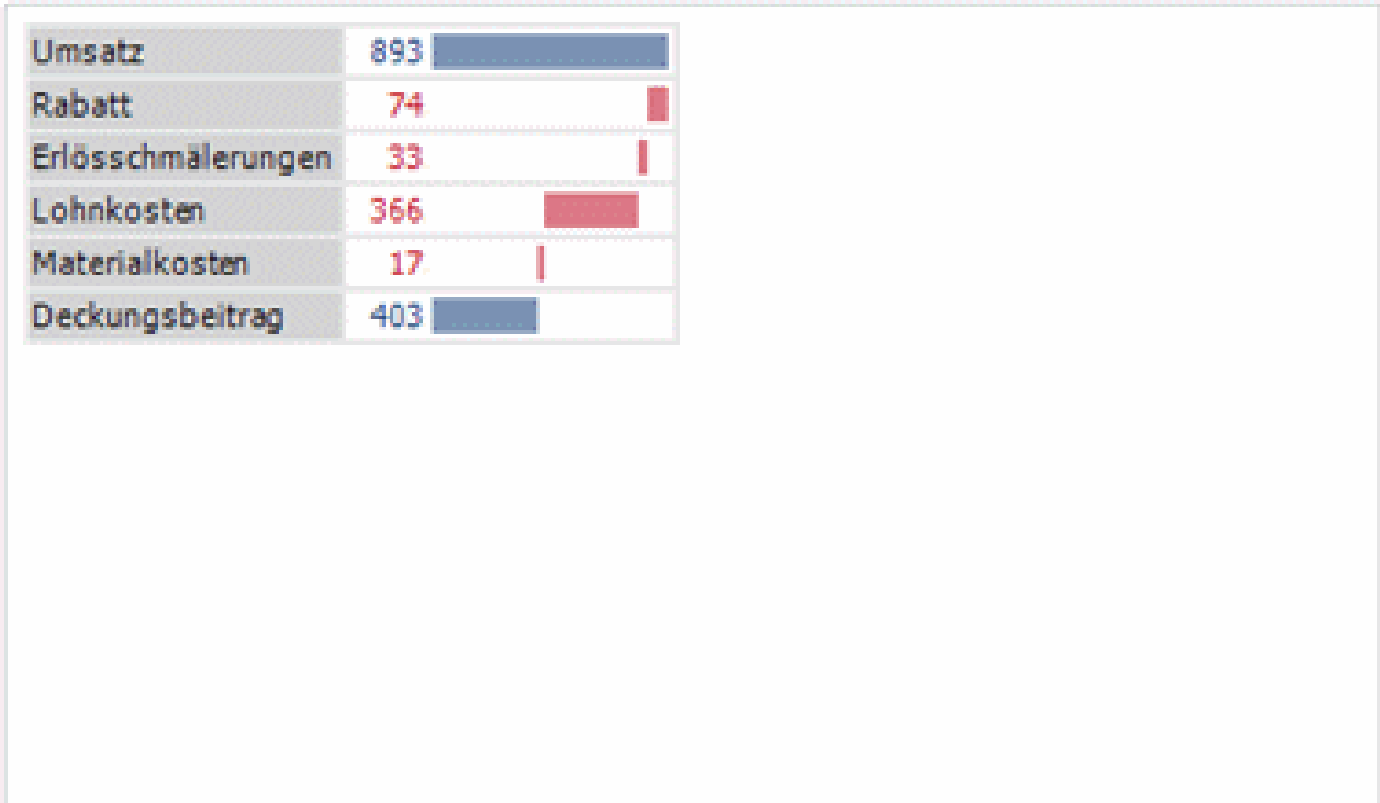


Noisy

Quiet

Umsatz	893	<div style="width: 100%; height: 10px; background-color: #4a86e8;"></div>
Rabatt	74	<div style="width: 8%; height: 10px; background-color: #e91e63;"></div>
Erlösschmälerungen	33	<div style="width: 4%; height: 10px; background-color: #e91e63;"></div>
Lohnkosten	366	<div style="width: 41%; height: 10px; background-color: #e91e63;"></div>
Materialkosten	17	<div style="width: 2%; height: 10px; background-color: #e91e63;"></div>
Deckungsbeitrag	403	<div style="width: 45%; height: 10px; background-color: #4a86e8;"></div>

Watch How It's Done



This much space is occupied by a business chart

Keep information on the same surface ...

The image displays a complex medical software interface with several overlapping windows. The primary window in the foreground is titled "Pathology" and features a "Flowsheet" dropdown set to "PATHOLOGY" and a "Level" dropdown also set to "PATHOLOGY". Below these are two panes: a "Navigator" on the left with a list of categories (all checked) and a main "PATHOLOGY" pane on the right showing a list of tests under "GENERAL CHEMISTRY".

Other overlapping windows include:

- Medication Profile:** Shows a "Name" field and a table titled "Medication(s) Being Given".
- Allergies:** Shows a table with columns for "Category" and "Reaction".
- Management Discipline View:** Shows a "Management Discipline View" header and a table with columns for "Active Problems".

The "Allergies" window contains the following data:

Category	Reaction
Drug	rash
Drug	NAU
Drug	hives
Drug	NAU

The "Medication Profile" window shows a table with the following visible text:

Medication(s) Being Given	
	al cream)
	et)
	et)
	et)
	blet)
	derall XR 10 mg oral caps

... by using Dashboards

Problem List		Clinical Events	
Diabetes Mellitus Type 2 (250.60)		T: 36.0 DegC (03/27/08)	36.6 DegC (01/03/08)
Hyperlipidemia (272.2)		BP: 162/79 mmHg (03/27/08)	134/78 mmHg (12/27/07)
Hypertension (401.1)		HR: 76 bpm (03/27/08)	52 bpm (12/27/07)
Peripheral Neuropathy (358.9)		RR: 20 breaths/min (03/27/08)	20 breaths/min (01/03/08)
Allergies		Wt: 118.000 kg (260 lbs) (03/27/08)	68.300 kg (150 lbs) (12/27/07)
aspirin		BMI: 41 Est. BMI* (03/27/08)	24 Est. BMI* (12/27/07)
codeine		Pain: 3 (03/27/08)	0 (01/03/08)
egg containing compound		Smoking Hx: not documented ()	
penicillin			
Home Medications		Labs & Diagnostics	
albuterol: PRN		Cr: 1.0 mg/dL (12/20/07)	0.9 mg/dL (06/27/07)
aspirin: 81 mg Daily		Est. Ccr*: 100.3 mL/min (12/20/07)	111.4 mL/min (06/27/07)
diltiazem: 240 mg Daily		Est. GFR*: 59 mL/min (12/20/07)	> 60 mL/min (06/27/07)
enalapril: 20 mg bid		ALT: 15 unit/L (12/20/07)	16 unit/L (06/27/07)
glyBURIDE: 20mg 2 Daily(0700)		Glu: H 179 mg/dL (12/20/07)	H 175 mg/dL (06/27/07)
guaifenesin: PRN		K+: 4.7 mmol/L (12/20/07)	4.4 mmol/L (06/27/07)
hydrochlorothiazide: 25 mg Daily		Total Chol: L 125 mg/dL (12/20/07)	150 mg/dL (06/27/07)
insulin detemir: 30 units At Bedtime		LDL: 62 mg/dL (12/20/07)	83 mg/dL (06/27/07)
metformin: 850MG.2-AM,1-PM PO		HDL: 49 mg/dL (12/20/07)	50 mg/dL (06/27/07)
multivitamin: Daily		Trig: 69 mg/dL (12/20/07)	85 mg/dL (06/27/07)
pioglitazone: 30 mg Daily		HbA1c: H 7.4 % (03/21/08)	H 6.8 % (12/20/07)
ranitidine: 150 mg Daily		Health Maintenance	
simvastatin: 10 mg Daily		DEXA (09/27/06)	
		Mammography (08/30/06, 08/30/06, 06/15/04, 05/05/03, 02/06/01, 01/16/01, 10/07/00)	

Pick colors that fit the job

ColorBrewer dg how to use updates
5-class diverging RYG about map **QG** credits
reset view

Step 1 number of classes: 5 learn more

Step 2 legend type: sequential, **diverging**, qualitative learn more

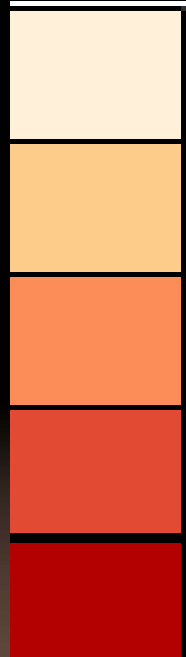
Step 3 mini legends: learn more

cmk rgb hex Lab AV3

0xd7191c
0xfdae61
0xffffbf
0xa6d96a
0x1a9641

map zoom map borders off city symbols off road network on
background color border color white black road network color
learn more

Pick colors that communicate data relationships

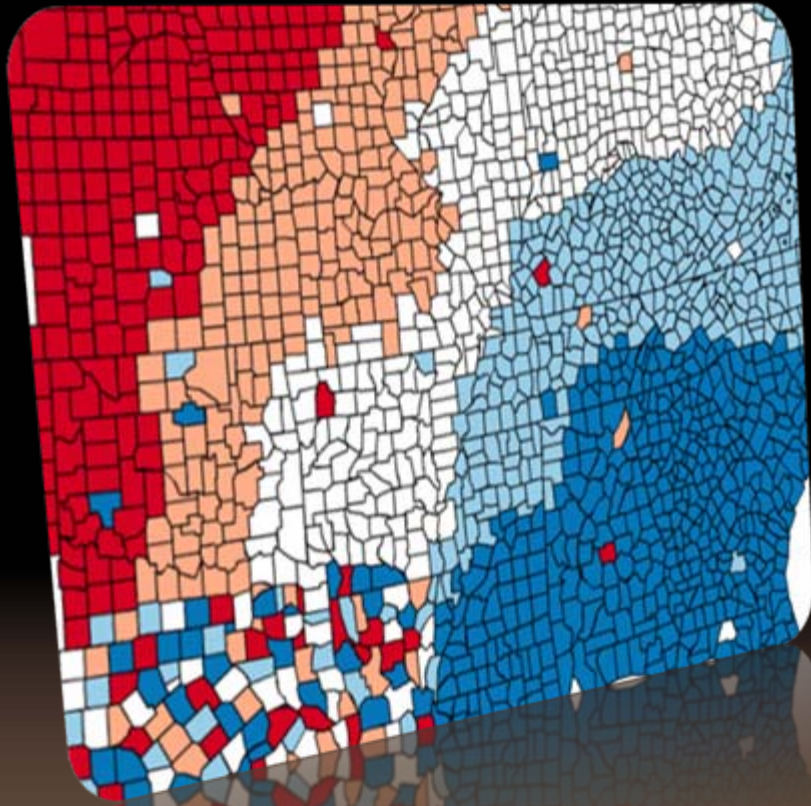


Sequential data







Diverging data



Beware Color Baggage







cm~~y~~k rgb hex Lab AV3

  0xca0020

  0xf4a582

  0xf7f7f7

  0x92c5de

  0x571b0

hexadecimal [print](#)

Red & Blue are now politically loaded colors in U.S.

Consider photocopy effect



Three color (hue) version



Monochrome version



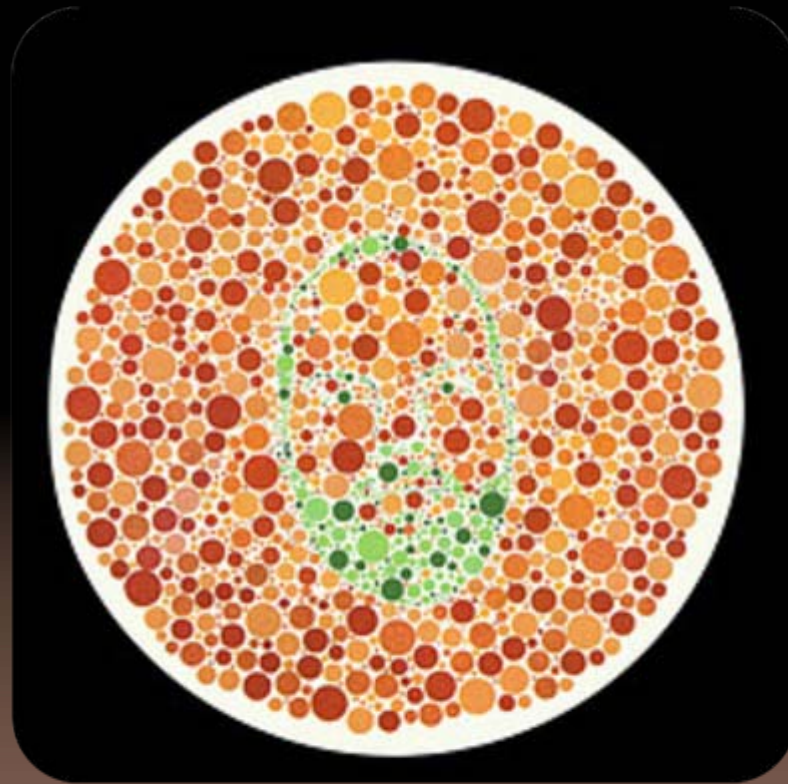
Single hue / different shades



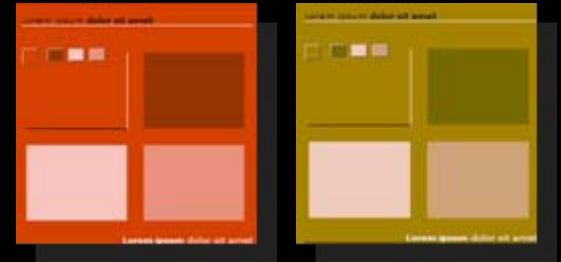
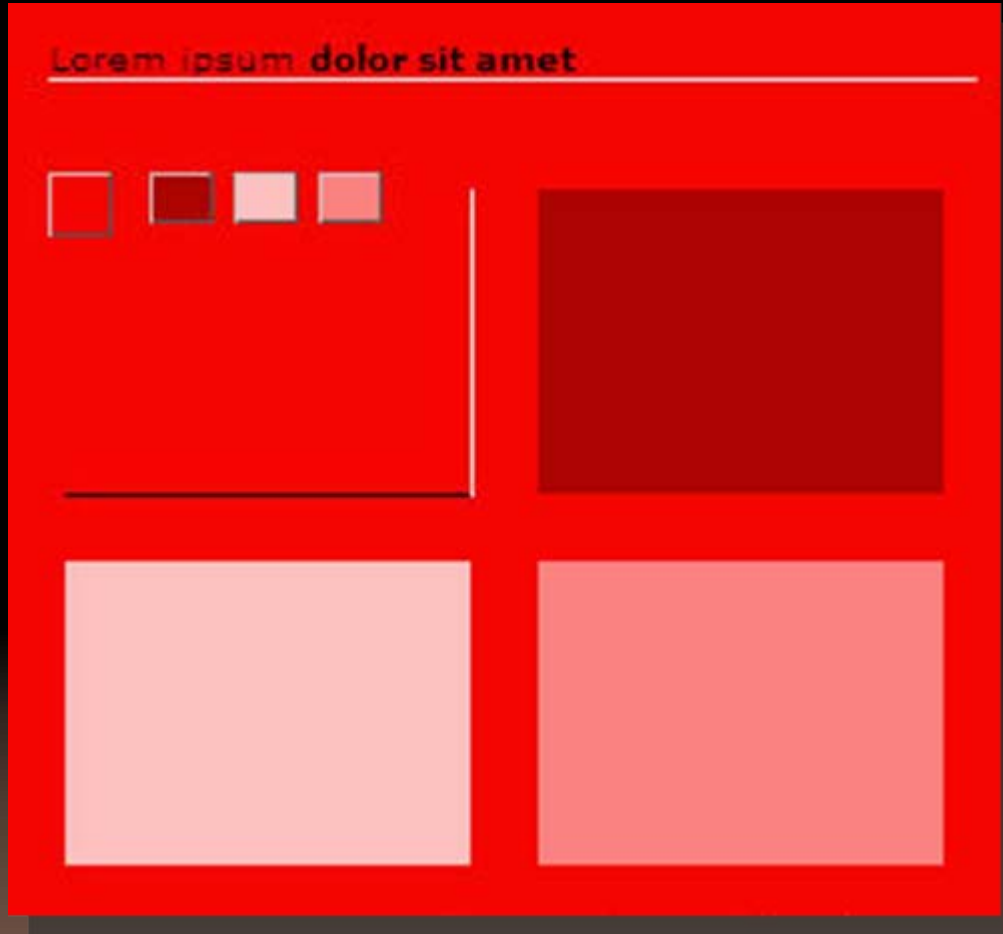
Monochrome version

Consider color-blind users

Up to 10% of males in US are red-green color blind



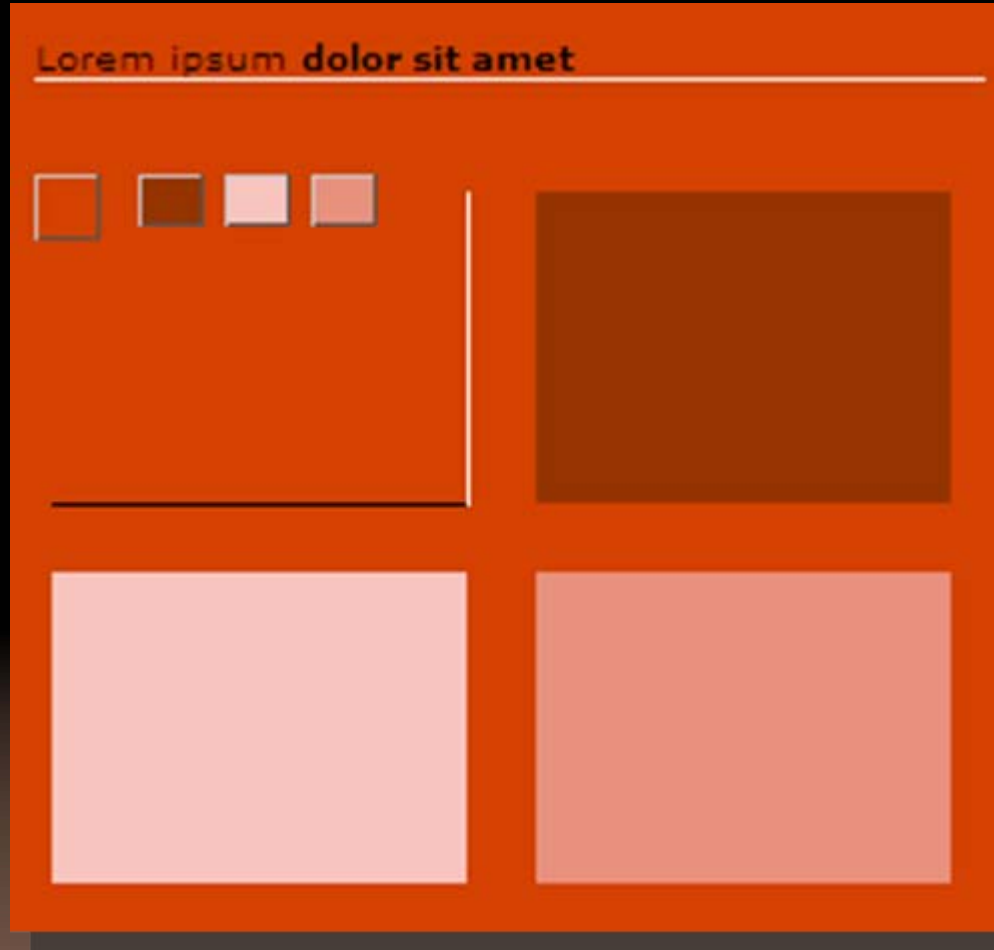
Color Blindness



Color Scheme Generator 2

Normal Color Vision

Color Blindness



Color
Scheme
Generator
2

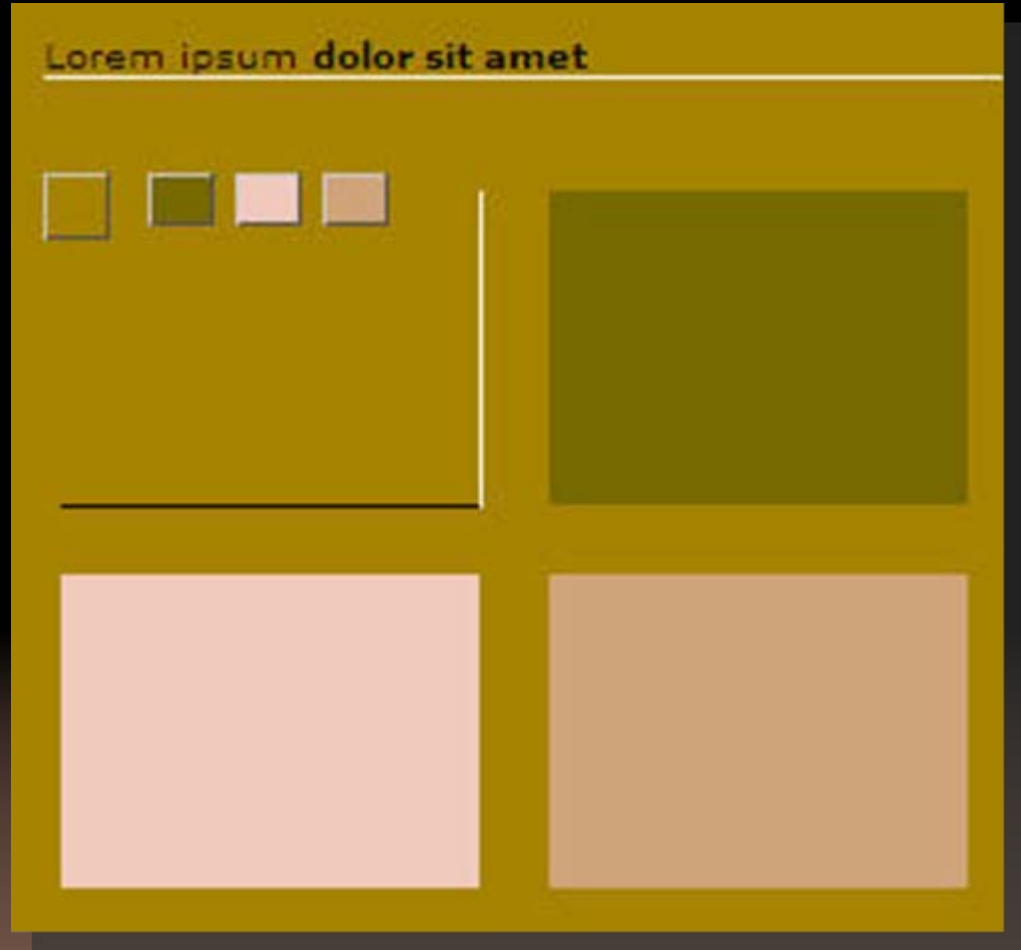
(5% men | 0.4% women)

Deuteranomaly

Color Blindness



Color Scheme Generator 2



(1% men)

Deuteranopy

Selective Data Display

Four-Layer EHR Concept

Show only what info is needed for this user now



Four-Layer EHR

The index of visits would display only this information



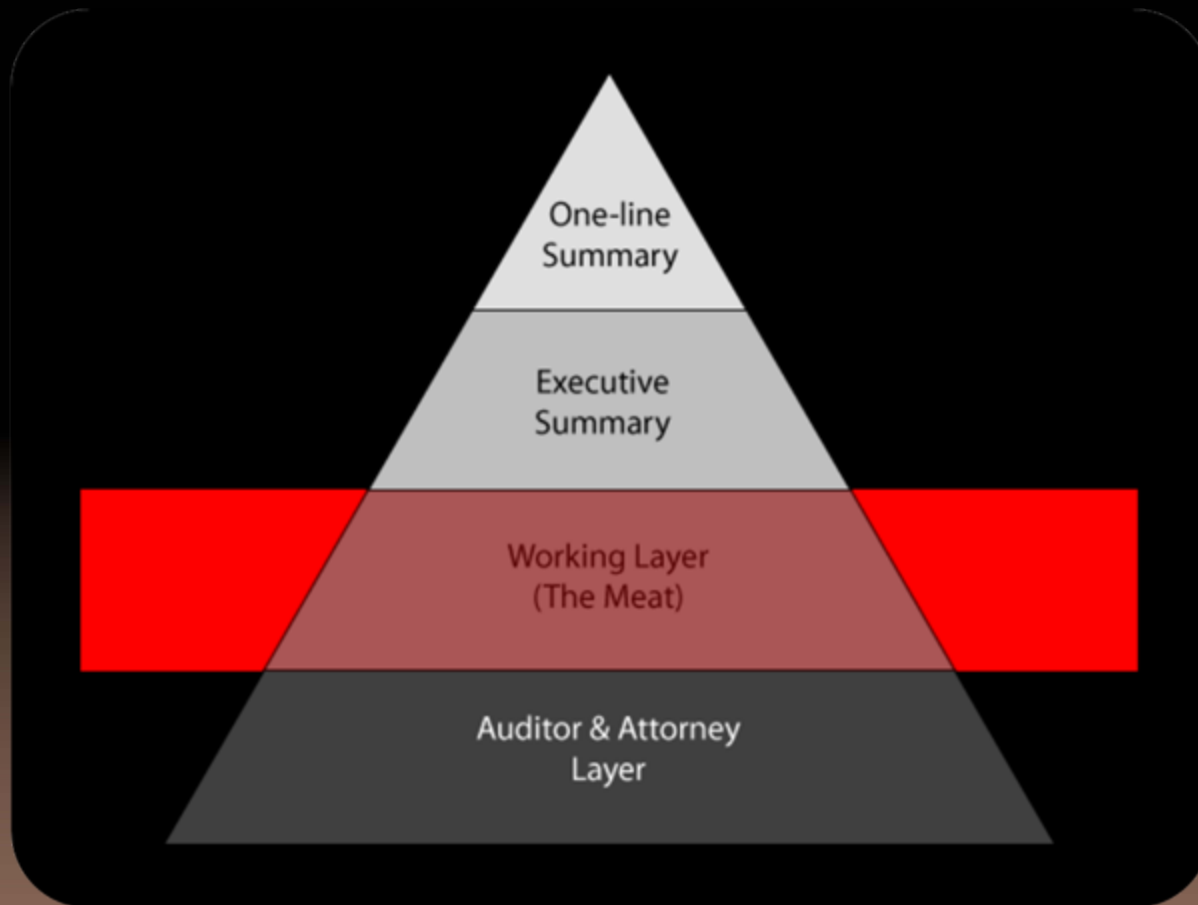
Four-Layer EHR

What the PCP would tell the specialty colleague



Four-Layer EHR

What most doctors need in the current visit.
Strip out pertinent negatives.



Find needle in haystack

Chest pain today

PAST MEDICAL/SURGICAL HISTORY

Reported History:

Reported prior tests: Patient has had PPD tests which were negative in the past. A Pap smear was performed -.

Reported medications: Taking OTC acne medication. No medication noncompliance.

Medical: No previous emergency room visit since last clinic appointment

. No kidney disease. Back trouble some back pain in past and mental illness. No previous fracture and no cancer. No infections. Recurrent URIs. No cardiac history, no endocrine history, no renal history, and no rheumatology history. Psychiatric history depression. Not psychologically abused. No dental history.

Pregnancy history: G 0, P 0, SAB 0, and TAB 0.

Diagnosis History:

Sinusitis

Allergic rhinitis.

No hypertension.

Thrombophlebitis of deep vessels of the lower extremity.

No asthma.

No hepatic disorders

No liver, stomach, or bowel disease.

Urinary tract infection last episode was about two months ago.

No endometriosis.

No pelvic inflammatory disease.

No ectopic pregnancy.

No thyroid disorder

No diabetes mellitus.

No atopic eczematous dermatitis.

No seizure disorder.

No depression.

No tuberculosis

Try it now, with positives highlighted

Chest pain today

PAST MEDICAL/SURGICAL HISTORY

Reported History:

Reported prior tests: Patient has had PPD tests which were negative in the past. A Pap smear was performed -.

Reported medications: Taking OTC acne medication. No medication noncompliance.

Medical: No previous emergency room visit since last clinic appointment

No kidney disease. Back trouble some back pain in past and mental illness. No previous fracture and no cancer. No infections. Recurrent URIs. No cardiac history, no endocrine history, no renal history, and no rheumatology history. Psychiatric history depression. Not psychologically abused. No dental history.

Pregnancy history: G 0, P 0, SAB 0, and TAB 0.

Diagnosis History:

Sinusitis

Allergic rhinitis.

No hypertension.

Thrombophlebitis of deep vessels of the lower extremity.

No asthma.

No hepatic disorders

No liver, stomach, or bowel disease.

Urinary tract infection last episode was about two months ago.

No endometriosis.

No pelvic inflammatory disease.

No ectopic pregnancy.

No thyroid disorder

No diabetes mellitus.

No atopic eczematous dermatitis.

No seizure disorder.

No depression.

No tuberculosis

Were you looking for this?

Chest pain today

abused. No dental history.

Pregnancy history: G 0, P 0, SAB 0, and TAB 0.

Diagnosis History:

Sinusitis

Allergic rhinitis.

No hypertension.

Thrombophlebitis of deep vessels of the lower extremity.

No asthma.

No hepatic disorders

No liver, stomach, or bowel disease.

Urinary tract infection last episode was about two months ago.

No endometriosis.

No pelvic inflammatory disease.

No ectopic pregnancy.

No thyroid disorder

No diabetes mellitus.

No atopic eczematous dermatitis.

No seizure disorder.

No depression.

No tuberculosis

A better way to show that data

Chest pain today

And all the
negatives are
stripped away

PAST MEDICAL/SURGICAL HISTORY

Reported History:

Medical: Psychiatric history depression.

Diagnosis History:

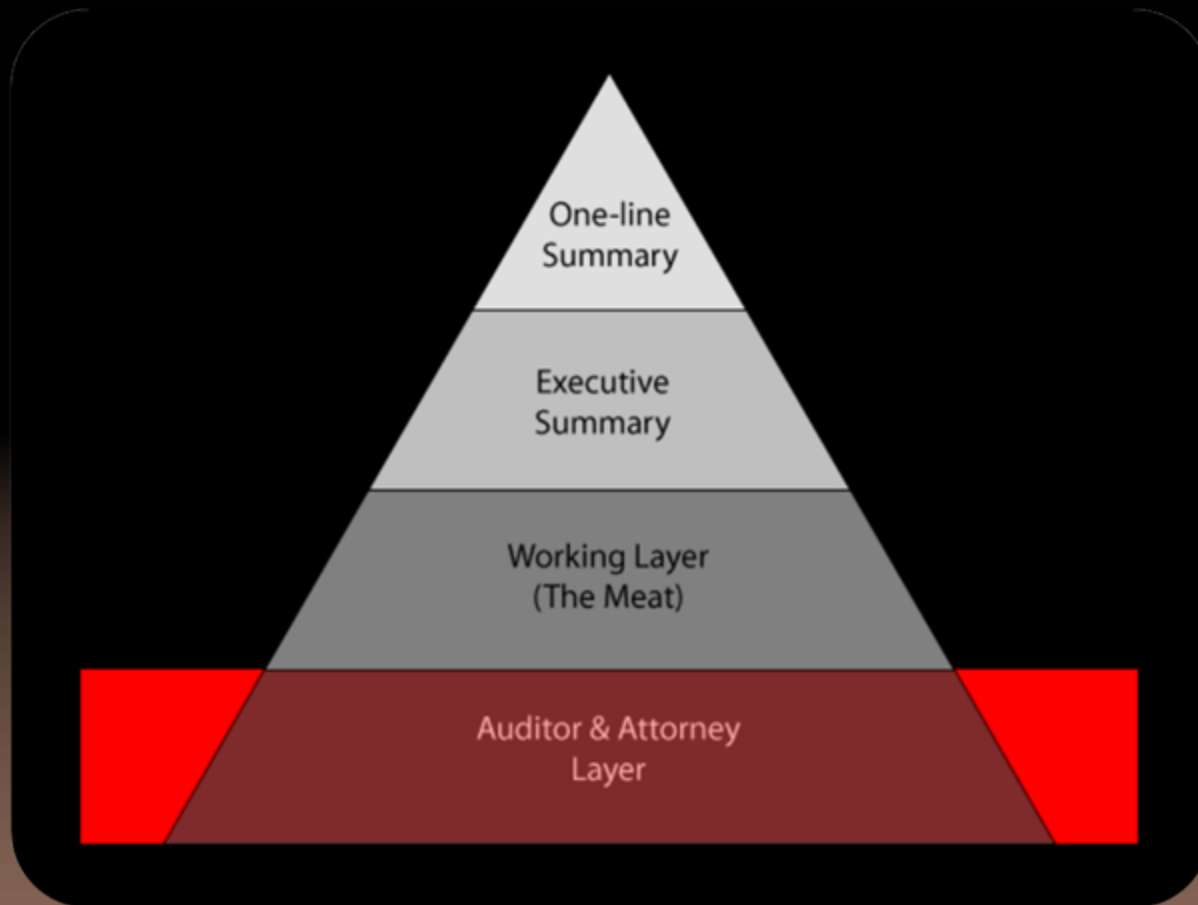
Thrombophlebitis of deep vessels of the lower extremity.

Primary hypercoagulable state

SOCIAL HISTORY

Four-Layer EHR

This layer contains the details that would defend you in court, or in event of an audit.



Web

Visual Display Resources

Web resources

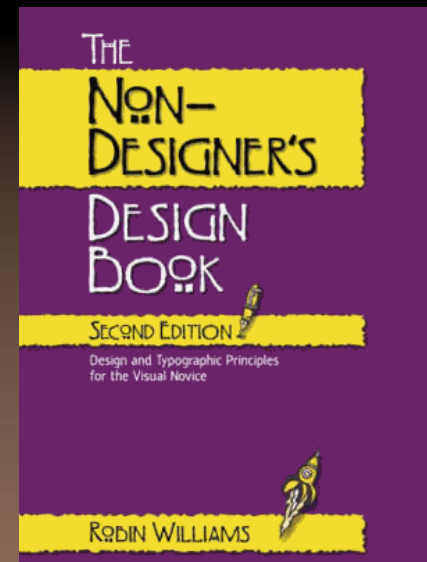
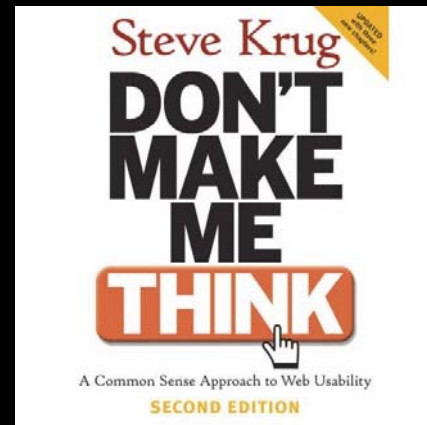
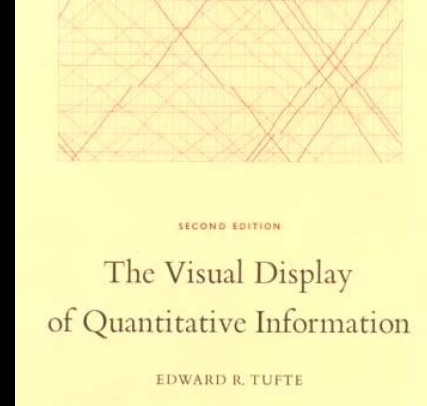
- PerceptualEdge.com
 - [On dashboard design](#)
- EdwardTufte.com
 - [Edward Tufte, creator of “sparklines” on visual display of quantitative information](#)
- Bella-Consults.com
 - [Blog on data visual display](#)
- [Color Brewer.org](http://ColorBrewer.org)
 - [Pick color schemes that fit the data](#)

Printed

Visual Display Resources

Print Resources

- The Visual Display of Quantitative Information
 - Edward Tufte
- Don't Make Me Think
 - Steven Krug
- The Non-Designer's Design Book
 - Robin Williams



More resources at

www.TooManyClicks.com

Thank you!

For more information,
please contact HIMSS Staff Liaison
JoAnn W. Klinedinst, CPHIMS, PMP, FHIMSS at
jklinedinst@himss.org

