

Designing  
for  
Uncertainty

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**“Uncertainty is in the head, but anxiety is in the pit of the stomach. (Kuhlthau, 1991, pp. 370)”**

P.1

Heisenberg's Uncertainty Relation

Assume two <sup>hermitian</sup> operators  $\underline{A}$  and  $\underline{B}$  do NOT commute:  
 $[\underline{A}, \underline{B}] \neq 0$

Assume

$$\langle \psi | \underline{A} \underline{B} | \psi \rangle = a + ib$$

Then

$$\langle \psi | [\underline{A}, \underline{B}] | \psi \rangle = \langle \psi | \underline{A} \underline{B} | \psi \rangle - \langle \psi | \underline{B} \underline{A} | \psi \rangle$$

$$\begin{aligned} \langle \psi | \underline{B} \underline{A} | \psi \rangle &= \langle \psi | (\underline{B} \underline{A})^\dagger | \psi \rangle^* = \langle \psi | \underline{A}^\dagger \underline{B}^\dagger | \psi \rangle \\ &= \langle \psi | \underline{A} \underline{B} | \psi \rangle^* \quad (\underline{A}, \underline{B} \text{ hermitian}) \end{aligned}$$

$$\Rightarrow \langle \psi | [\underline{A}, \underline{B}] | \psi \rangle = (a + ib) - (a + ib)^* = 2ib$$

Similarly  $\{\underline{A}, \underline{B}\} \equiv \underline{A} \underline{B} + \underline{B} \underline{A}$

$$\Rightarrow \langle \psi | \{\underline{A}, \underline{B}\} | \psi \rangle = (a + ib) + (a - ib) = 2a$$

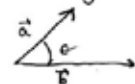
Thus

$$\begin{aligned} |\langle \psi | [\underline{A}, \underline{B}] | \psi \rangle|^2 + |\langle \psi | \{\underline{A}, \underline{B}\} | \psi \rangle|^2 &= 4(a^2 + b^2) \\ &= 4|\langle \psi | \underline{A} \underline{B} | \psi \rangle|^2 \end{aligned}$$

The 2nd term on the l.h.s. is positive definite

$$\therefore |\langle \psi | [\underline{A}, \underline{B}] | \psi \rangle|^2 \leq 4|\langle \psi | \underline{A} \underline{B} | \psi \rangle|^2$$

Schwartz inequality

$$|\vec{a} \cdot \vec{b}|^2 = |\vec{a}|^2 |\vec{b}|^2 \cos^2 \theta < |\vec{a}|^2 |\vec{b}|^2$$


"A unique, important, and wonderful book... You'll never look at your own doctor in the same way again."  
 — Steven D. Levitt and Stephen J. Dubner, authors of *Freakonomics*

# How Doctors Think



JEROME GROOPMAN, M.D.

**To explore the role that uncertainty plays in health care and search for opportunities for design to improve the current situation.**

What role does uncertainty play in doctor/patient communication/teamwork/decision making?

What scenarios in health care should we design for?

## **Literature review**

Build a base of knowledge

## **Interviews**

Generative research approach

Gather stories of coping with uncertainty in health care

Doctor, patient and student perspectives

**Nancy**

**50 years old**

**described two negative healthcare experiences**

**Age 23— misdiagnosed ectopic pregnancy**

**Age 47—misdiagnosed shoulder injury**

**Communication gaps:**

**doctor to therapist, patient to doctor**

**Lack of acknowledged uncertainty led to  
misdiagnosis and preventable hospitalization**

**Patients may feel they have no other option than  
to listen to medical professional**

## **Paul**

23 years old

1st year of residency at OHSU

patient health/social history is very important

puzzeling cases are anomalies

range of uncertainty is highly situational

## **Paul**

Time is key in determining the scope

General practitioners are the decision makers

Getting a patient's trust is essential



## **Patient faced with uncertainty**

In-person interview, artifact and written account.

## **Expert advisor, Anesthesiologist**

Telephone Interview.

for

Uncertainty

med also doesn't work...  
 wants to see a specialist - neurologist...  
 no way to see without referral...  
 L3 needs later a 3rd doctor finally refers to a neuroptomologist  
 (maybe you find usual.)  
 See pain in lower back weekend...  
 go to the ER. "sure said different use"  
 don't know - if work can't back + more symptoms - loss of feeling in hands and feet. or hold health  
 see another @ walk health surg cent, (exam) with  
 no other neurologist referral - slightly advice.  
 mid FEB - call of cancelled appointments symptoms have gotten better...  
 (POST OPERAL PAINING HEADACHE)  
 ZACIT'S DAD ... can be debilitating back to emergency room + perform a blood panel

blood clot to stop work (personal investigation)  
 friends + family network... know did too one feel you feel?  
 schedule surgery → onky help the headache...  
 no guarantee that problem would get fixed  
 + risks associated w/ spinal tap...  
 don't get it - better to wait it out.  
 hasn't been to school at all  
 go to see neurologist... good bad swings...  
 stress + tension along spinal tap...  
 go MRI + EEG  
 answers epileptic...  
 emotional jarring...  
 (1 week wait for results)  
 INTERIM MED  
 young increases its metabolic medication...  
 symptoms going away - but to not take risk of the side effects...  
 end of feb / beg of March -  
 END OF MARCH - INSET - FIRST W/ NEUROLOGIST

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Case 3

Patient




**Cat scan... clean but only 97% correct... spinal tap to “clear the table”**

**Maybe a headache in a day or two but everything is fine. Went through the doomsday situations post spinal-tap, but did not bring up the most common side effect.**

**“To be fair”... the emergency room is concerned with life threatening situations - attention is diverted quickly.**

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 <b>UNIVERSITY OF WASHINGTON MEDICAL CENTER</b> Emergency Medicine Service (206) 598-4000 1959 NE Pacific St., Box 356123, Seattle, WA 98195-6123	<b>ED Discharge Instructions for:</b>
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Name: _____	Medical Rec #: _____
Address: _____	Phone: _____
_____	
Visit Date/Time: _____	

### Evaluation

Evaluation in the Emergency Department included triage, and a screening exam by the nurse. You were treated by the following Emergency Department staff:

### Diagnosis-1

Based on the evaluation and tests, the following diagnoses have been made. Remember that these are preliminary diagnoses and follow up with your referral physician may be necessary.

\* BACK PAIN AFTER LP

### Additional Instructions

\* TYPE IN INSTRUCTIONS: The pain should continue to improve over the next few days, and is from the lumbar puncture you had. If you develop fever, increasing pain, or nerve symptoms (shooting pains, etc) please return to the emergency room.

RETURN TO EMERGENCY: IF SYMPTOMS WORSEN.

\* RETURN TO EMERGENCY: FEVER, CHILLS

\* RETURN TO EMERGENCY: SIGNIFICANTLY INCREASING BACK PAIN

I have received the above instructions on January 6, 2007 at 21:20. The risks and benefits of being discharged home have been explained to me and I agree with the plans outlined above.

Signed: \_\_\_\_\_ Relation: \_\_\_\_\_

Witnessed: \_\_\_\_\_



# Designing for Uncertainty

## Case 3

## Artifacts

the test may relieve the headache.

You may feel tired and have a slight backache the day after the test. Some people have trouble sleeping for 1 to 2 days.

### Risks

A lumbar puncture is generally a safe procedure. Occasionally, a leak of cerebrospinal fluid (CSF) may develop after a lumbar puncture. Symptoms of this problem may include a persistent headache that does not go away after 1 to 2 days. A CSF leak can be treated with a blood "patch," in which the person's own blood is injected into the area where the leak is occurring in order to seal the leak.

Approximately 1 in 1,000 people who have this test suffers some minor nerve injury, which usually heals on its own with time. There is also a slight risk of infection of the CSF (meningitis), bleeding inside the spinal canal, or damage to the cartilage between the vertebrae. You should discuss your particular risks with your doctor.

People who have bleeding disorders and those who are taking a blood-thinning medication (such as warfarin or heparin) are at increased risk of continued internal bleeding after the procedure. Unless a life-threatening illness is suspected and needs to be diagnosed immediately, a lumbar puncture should not be done for these people until the bleeding disorder has been controlled or the drug effect has been corrected.

A lumbar puncture may be dangerous for the very small number of people who have increased pressure within the brain caused by a tumor, a pocket of infection in the brain (**abscess**), or major bleeding inside the brain. Your doctor will perform a detailed neurological examination to look for evidence of these conditions and signs of increased pressure before performing a lumbar puncture. In

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today on  
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A  
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c  
+ Brain C  
+ Multiple  
+ Walkin  
+ Driving  
video library

**Medical test information form**

You can complete this information form on this form online and then print the form for your reference. This form that is available on the form is printed. You will not print. Any test you enter on this form will be shown when you check the form you entered.

Print this form and fill in the information for blood, urine, X-ray, or any other test your health professional recommends. You may need to make copies if more than one test is recommended.

### General questions

What is the name of the test?

Why is this test needed?

What might happen if the test is delayed or not done?

How accurate is the test? Are there other tests that are more accurate?

### Questions to ask about the test

What should be done to prepare for the test?

Where will the test be done?

How long does the test take?

How will I feel during the test? Is it painful?

What are the risks?

What will the results show?

HealthWiser

**“It never came out of his mouth that it (post-dural puncture headache) was a possibility...”**

**“For me, the biggest problem has been navigating the system”**

**“...Emblematic of the problems with the health care system, over treatment that leads to a cascade of new problems.”**

**“...No road into the system”**

**“80/20% rule... more often than you think, and those are the cases you remember.”**

**“...When you’re a hammer everything looks like a nail (Doctor Krane).”**



**Patterns vs. Outliers - 80/20 rule.**

**Role of personal relationship with doctor**

**Continuity vs. discontinuity across providers**

**Dangers of over-under treatment**

**Doctor-patient communication gaps**

## **Making doctor's plans visible, post visit**

Provide patients with a representation of the diagnosis and a map, should things go wrong.

## **Medication maps**

What to do if you forget a dose? What happens if you stop taking the medication when symptoms subside?

## **Simulation in medical school:**

Representing decision-making in the face of uncertainty for reflection. Patterns in the outliers.

## **Patient coach or interpreter**

What to expect. How to communicate your ideas.  
Bypass time-pressure and anxious situations.

## **Encourage people to develop relationships with primary care providers.**

Gatekeepers who provide entry into the system.

## **Understanding subdomain perspectives at different medical touch-points.**

When you're a hammer everything looks like a nail.

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Next Steps

**Focus on one opportunity, clarify the audience  
and narrow our scope.**

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Conclusion

**Reactions, questions and thoughts?**