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The Unintended Consequence of Patient's Active Participation: A Theoretical and Experimental Study of Patient-Doctor Relationships

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October 16, 2023





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- Lack of trust is one of the main sources of patients' noncompliance (Li&Khan, 2022);
- The internet allows low-cost access to medical information and self-diagnosis;
- Empowered noncompliance: Patients are better able to make a decision on whether to follow a doctor's advice.

Being Your Own Advocate: Why Doing Medical Research Will Help Your Doctor Posted March 14, 2019 by Thuasne USA











• 59% of doctors attribute unnecessary treatments to patient requests (Lyu et al., 2017);



- 59% of doctors attribute unnecessary treatments to patient requests (Lyu et al., 2017);
- Doctors may not welcome patient's active participation.

When Docs Get Annoyed At Empowered Patients

Dr. Rankin on CNN article regarding doctors annoyed with patients

"They consider themselves an expert yet often their true medical knowledge is quite limited ..."; "Sometimes these patients are very overweight. They're out of shape..."



- 59% of doctors attribute unnecessary treatments to patient requests (Lyu et al., 2017);
- Doctors may not welcome patient's active participation.

When Docs Get Annoyed At Empowered Patients

Dr. Rankin on CNN article regarding doctors annoyed with patients

"They consider themselves an expert yet often their true medical knowledge is quite limited ..."; "Sometimes these patients are very overweight. They're out of shape..."

• There is still a lack of direct causal evidence on the impact of patients' active participation/potential noncompliance on doctors' investment in diagnosis and treatment selection.

Research Questions

- How does patients' active participation in diagnosis and treatment selection affect doctors' investment in diagnosis?
- Does giving an option for patients to go against doctors increase/decrease patients' welfare?
- Does communication or reputation (rating systems) increase patients' health outcomes?



- Existing studies on expert-client interaction:
  - The main source of client distrust is the heterogeneous expert diagnostic abilities (e.g. Balafoutas et al., 2020; Hilger, 2016; Liu et al., 2020);
  - Client's personal research or second opinion seeking may not lead to efficiency (e.g. Agarwal et al., 2018; Fong et al., 2014; Pesendorfer&Wolinsky, 2003).

# Introduction Theory Design & Prediction Results Interventions Conclusion Related Literature: Expert Services Services Services

- Existing studies on expert-client interaction:
  - The main source of client distrust is the heterogeneous expert diagnostic abilities (e.g. Balafoutas et al., 2020; Hilger, 2016; Liu et al., 2020);
  - Client's personal research or second opinion seeking may not lead to efficiency (e.g. Agarwal et al., 2018; Fong et al., 2014; Pesendorfer&Wolinsky, 2003).
- What I do: Expert-client interaction model
  - Focus on the impact of the client's **active participation** on the expert's investment in **diagnostic precision**;
  - Vary observability of diagnostic precision for the client;
  - Vary the option for the client to go against the expert.



- Existing studies of lab research in healthcare:
  - Advantage: theory testing and mechanism investigation without bringing extra risks;
  - Lab studies on information available for patients (e.g. Agarwal et al, 2018; Brosig-Koch et al., 2023);
  - Lab studies on doctors' altruism (e.g. Brosig-Koch et al., 2015; Brosig-Koch et al, 2017).



- - Existing studies of lab research in healthcare:
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    - Lab studies on doctors' altruism (e.g. Brosig-Koch et al., 2015; Brosig-Koch et al, 2017).
  - What I do: lab experiment
    - Induce incentive alignment between patients and doctors;
    - Create the **conflicting diagnostic results** between patients and doctors;
    - Impose exploratory conditions (Communication and Reputation) to improve patients' health.



- Theoretical framework: expert-client interactions;
- Laboratory experiment to verify theoretical predictions, with the following varying elements:
  - Options for clients to go against experts;
  - Observability of experts' diagnostic precision.



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- Laboratory experiment to verify theoretical predictions, with the following varying elements:
  - Options for clients to go against experts;
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- Two additional exploratory conditions (Communication and Reputation) in the lab;



- Theoretical framework: expert-client interactions;
- Laboratory experiment to verify theoretical predictions, with the following varying elements:
  - Options for clients to go against experts;
  - Observability of experts' diagnostic precision.
- Two additional exploratory conditions (Communication and Reputation) in the lab;
- Key findings:
  - Experts who prioritize clients' well-being are more likely to underperform if the client is not fully compliant;
  - Giving clients an option to go against experts decreases their well-being.

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# Theoretical Framework

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- Unknown problem  $z \in \{0,1\}$ , occurring with equal probability.
- Client receives private signal  $s^c \in \{0, 1\}$ .
  - Precision  $Pr(s^c = z) = q \in [0.5, 1]$
- Expert chooses diagnostic precision E ∈ [0.5, 1] to get a costly diagnostic result s<sup>x</sup> ∈ {0, 1}.
  - Precision:  $Pr(s^{x} = z) = E;$
  - Cost of effort:  $g(E) = k(E 0.5)^2$ ; k > 0;
  - Provides a treatment recommendation  $T \in \{0, 1\}$ , with  $T = s^{x}$ .

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Model:	Incent	ives			

- Client's utility *U<sup>c</sup>*:
  - Assume that the expenditure is fully covered by insurance.
  - If T = z:  $U^c = H$ ;
  - If  $T \neq z$ :  $U^c = L$ ;
  - Receiving desired treatment returns higher utility (H > L).

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- Client's utility *U<sup>c</sup>*:
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  - If T = z:  $U^c = H$ ;
  - If  $T \neq z$ :  $U^c = L$ ;
  - Receiving desired treatment returns higher utility (H > L).
- Expert's utility:

 $U^{x} = M + \gamma * I\{ProblemSolved\} * (H - L) - k(E - 0.5)^{2}$ 

- *M*: a lump-sum from providing service (i.e. capitation payment system);
- γ: <u>Alignment parameter</u>, which captures experts' concern about clients' utilities (altruism; reputation; fear of malpractice; ...)



- Passive client always follows the expert;
- <u>Active client</u> may go against the expert, i.e., choose the opposite treatment.



- Observable condition:
  - Client observes expert's diagnostic precision.
- <u>Concealed</u> condition
  - Client does NOT observe expert's diagnostic precision;
  - They have a belief  $\hat{E}$  about diagnostic precision.

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### Game Procedure



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# Design and Prediction

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#### • Client:

- Precision of private signal: q = 0.6
- Payoff (*U<sup>c</sup>*):
  - $U^c = 120$  (i.e. \$12) if treated correctly;
  - $U^c = 20$  (i.e. \$2) if treated incorrectly.

#### • Expert:

- Choice of precision levels:  $E \in \{0.5, 0.6, 0.7, 0.8, 0.9, 1\};$
- Alignment parameter manipulation:  $\gamma \in \{0, 0.2, 0.6, 1.0\};$
- Payoff:

 $U^{x} = 80 + \gamma \times 100 \times I\{\text{solved}\} - 100 \times (E - 0.5)^{2}.$ 



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Three Ca	ases for	Discussion			

	Observability of Precision	Client's Type
Benchmark	N.A.	Passive
Observable	Observable	Active
Concealed	Not Observable	Active



• Optimal diagnostic precision  $E^* = 0.5 + \frac{\gamma}{2}$  regardless of treatment conditions.

Expert's Precision Choices Conditional on Passive Client





• Optimal diagnostic precision  $E^* = 0.5 + \frac{\gamma}{2}$  regardless of treatment conditions.

Expert's Precision Choices Conditional on Passive Client





- If  $s^c = s^x$  (No Info Conflict): client always follows the expert's treatment recommendation.
  - This prediction holds under both Observable and Concealed conditions.
- Next few pages: discussions of equilibria are focusing on  $s^c \neq s^x$  (with Info Conflict).

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- With Info Conflict, client follows the expert if  $E \ge 0.6$  (expert's diagnosis is more precise than self-diagnosis).
- Equilibrium:
  - If  $\gamma <$ 0.4:

Expert chooses  $E^* = 0.5$ ; Client always overrules;

• If  $\gamma \ge 0.4$ : Expert chooses  $E^* = 0.5 + \frac{\gamma}{2}$ ; Client always follows.

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- With Info Conflict, client follows the expert if believes  $\hat{E} \ge 0.6$  (expert's diagnosis is more precise than self-diagnosis).
- Equilibria:
  - If  $\gamma < 0.4$ : Client believes  $\hat{E} < 0.6$  and always overrules; Expert chooses  $E^* = 0.5$ ;
  - If γ ≥ 0.4:
     (i) Client believes Ê ≥ 0.6 and always follows; Expert chooses E<sup>\*</sup> = 0.5 + <sup>γ</sup>/<sub>2</sub>;
    - (ii) Client believes  $\hat{E} < 0.6$  and always overrules; Expert chooses  $E^* = 0.5$ .

#### Active Client & Concealed Condition



Active Client & Concealed Condition







Active Client & Concealed Condition



Active Client & Concealed Condition


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- Expert:
  - 1 Diagnostic precision **increases** with the incentive alignment parameter  $\gamma$ ;
  - 2 Diagnostic precision is **lower** under Concealed condition than Observable condition;
  - 3 Under the Concealed condition, experts with *higher* alignment parameter  $\gamma$  have **higher investment gap** between passive vs. active clients.
- Active clients:
  - Clients overrule experts only when information conflict occurs;
  - 2 Conditional on information conflict, clients follow experts if they observe/believe that experts' diagnostic precision is higher than 0.6.

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Experir	nental	Procedure			

- 20 rounds with random partner matching;
- Within each session:
  - Clients are randomly assigned to be <u>active</u> (70%) / <u>passive</u> (30%);

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- Experts are randomly assigned with alignment parameters  $\gamma \in \{0, 0.2, 0.6, 1\}$ ;
- Fixed role and type for each participant.

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Experime	ental P	rocedure			

- 20 rounds with random partner matching;
- Within each session:
  - Clients are randomly assigned to be <u>active</u> (70%) / passive (30%);
  - Experts are randomly assigned with alignment parameters γ ∈ {0, 0.2, 0.6, 1};
  - Fixed role and type for each participant.





- Observable condition: 49 pairs of clients and experts
- Concealed condition: 65 pairs of clients and experts

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• Pre-registered on aspredicted.org

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# Results

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• Active clients follow experts if there is no information conflict.



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• With info conflict, clients are more compliant if the observed/believed diagnostic precision is higher.





• Lack of direct effect of Concealed condition on reducing diagnostic precision.



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• Highly "altruistic" experts are more likely to be frustrated by active clients under the Concealed condition.



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#### Regression: Expert's Diagnostic Precision

• Diagnostic precision increases with incentive alignment, and decreases if the client is active.

	DV: Diagn	ostic Precision	
	(1)	(2)	
Alignment Parameter	0.247***	0.206***	
	(0.064)	(0.061)	
Concealed	0.010	0.037	
	(0.049)	(0.040)	
Concealed $ imes$ Alignment Parameter	0.054	0.054	
	(0.095)	(0.087)	
Active	-0.051*	-0.054**	
	(0.026)	(0.021)	
Active $ imes$ Alignment Parameter	0.045	0.053	
	(0.046)	(0.043)	
Concealed $\times$ Active	0.009	0.005	
	(0.040)	(0.033)	
Concealed $\times$ Active $\times$ Alignment Parameter	-0.155*	-0.140*	
	(0.084)	(0.074)	
Individual Controls	No	Yes	
Round	No	Yes	
Observations	2280	2280	
Number of Individuals	114	114	
	Image:	나 세르 에서 몸에	· 문(님 ~



• Active client reduces diagnostic precision for highly altruistic experts only under Concealed condition.





• Active client reduces diagnostic precision for highly altruistic experts only under Concealed condition.





 Concealed condition: giving the option for clients to go against experts reduces their probability of solving problems.



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Introduction	Theory	Design & Prediction	Results	Interventions	Conclusion
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#### • Experts:

 Concealed condition: Experts with a strong concern for clients' well-being choose lower diagnostic precision when dealing with <u>active</u> clients in contrast to <u>passive</u> clients.

Introduction	Theory	Design & Prediction	Results	Interventions	Conclusion
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Summa	ry				

#### • Experts:

- Concealed condition: Experts with a strong concern for clients' well-being choose lower diagnostic precision when dealing with <u>active</u> clients in contrast to <u>passive</u> clients.
- Olients:
  - Concealed condition: giving clients an option to actively participate in choosing treatments makes them worse off.

Introduction	Theory	Design & Prediction	Results	Interventions	Conclusion
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Summa	ry				

#### • Experts:

- Concealed condition: Experts with a strong concern for clients' well-being choose lower diagnostic precision when dealing with <u>active</u> clients in contrast to <u>passive</u> clients.
- Clients:
  - Concealed condition: giving clients an option to actively participate in choosing treatments makes them worse off.
- Next step: Exploratory conditions in the lab setting based on the Concealed condition.

Introduction	Theory	Design & Prediction	Results	Interventions	Conclusion
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# Exploratory Interventions

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- Two interventions imposed on Concealed conditions:
- Communication
  - Patients and doctors lack sufficient communication (El-Jawahri et al., 2019; Karras et al., 2003; Strull et al, 1984);
  - Communication is vital for the quality of healthcare services (Alsan et al., 2019; Brekke et al., 2018; Cegala et al., 2000).
- Reputation
  - Online rating platforms are under-used for healthcare providers compared to movies, books, and restaurants (Hanauer et al., 2014);
  - Mixed evidence on the usefulness of rating system on credence good (Brosig-Koch et al., 2022; Kerschbamer et al., 2019; Ranard et al., 2016).

Introduction	Theory	Design & Prediction	Results	Interventions	Conclusion
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Design	of Inte	rventions			

- Communication condition: Procedure
  - Client and expert chat before expert's diagnosis;
  - Experts are allowed to revise diagnostic precision before conducting diagnosis.

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- Communication condition: Procedure
  - Client and expert chat before expert's diagnosis;
  - Experts are allowed to revise diagnostic precision before conducting diagnosis.
- Reputation condition: Procedure
  - Clients see average rating of matched experts before interaction;
  - Clients give ratings to experts after the interaction, which will be included to update the expert's average rating.



 Both interventions significantly improve active clients' outcomes.





• Clients' beliefs about precision are less noisy. They are able to make better choices.



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- Clients' ratings reflect experts' diagnostic precision level;
- Clients are more compliant with high-rating experts.





- Examine the interplay between patients' compliance and doctors' performance by using a general framework of expert-client interaction;
- Findings:
  - Doctors who prioritize patient well-being tend to invest less in diagnostic precision when patients are not fully compliant;
  - When the diagnostic precision is not observable, giving patients an option to go against doctors reduces the probability of solving a problem;
  - Implementing an online rating system, as a cost-effective intervention, enhances patient health outcomes by providing valuable insights into doctors' quality of care.

# Appendix

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Additional Analysis	Additional Design Info	Theory	Screenshots
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Clients' Payoffs			

• For active cliens: less likely to solve the problem under the Concealed condition compared to Observable condition.

Table: ME of Concealed	Condition from	Logit Regression
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	DV: Indicator of Disease Solved	
	(1)	(2)
Concealed (Patient=Passive)	0.095***	0.092***
	(0.036)	(0.034)
Concealed (Patient=Active)	-0.076**	-0.060*
	(0.030)	(0.032)
Individual Controls	No	Yes
Round	No	Yes
Observations	2280	2280
Number of Individuals	114	114

dditional	Analysis	
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# Clients' Compliance Conditional on Info Conflict

• Note: the figure below excludes the participant with label 3009. This participant played the role of patient, and he/she always chose  $\hat{E} = 1$  but always overruled the doctor.



## Over- and Under-Investment in Passive Clients

- Subjects' altruism was measured by a dictator game prior to lab sessions.
  - Pairwise corr with diagnostic precision:
    - 0.15 (p < 0.001) for all experts
    - 0.53 (p < 0.001) for  $\gamma = 0$
- Subjects' loss aversion was measured by a self-reported survey question.
  - Pairwise corr with diagnostic precision:
    - -0.12 (p < 0.001) for all experts
    - -0.06 (ho < 0.001) for  $\gamma = 1$

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# Clients' Belief vs. Actual Diagnostic Precision

• Clients' belief in diagnostic precision is noisy.



Experts' Diagnostic Precision

Additional Analysis	Additional Design Info	Theory	Screenshots
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Active Clients'	Payoffs		

• Concealed condition reduces active clients' health outcomes.

#### Table: Active Clients' Compliance and Outcomes

	Observable	Concealed	<i>p</i> -value
% Mistaken Compliance	24.71	29.99	.0549
% Mistaken Noncompliance	51.97	71.04	.0006
% Solved Problems (All)	69.11	61.48	<.0001
% Solved Problems (w/ Conflicts)	68.50	57.78	<.0001

## **Diagnostic Precision under Interventions**

• Both interventions are associated with higher diagnostic precision, but the difference is not statistically significant.





## Clients' Compliance under Interventions



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### Clients' Compliance under Interventions





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# Communication Condition: Word Cloud

 Main topics for discussion: experts' alignment parameters ("contract") and diagnostic precision ("accuracy").



# Communication Condition: Sentiment Analysis

• Chat messages are mostly neutral or positive in sentiments.



**Clients' Sentiment Distribution** 



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## Game Procedure: Communication



52 pairs participated. Go Back
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# Game Procedure: Reputation



52 pairs participated. Go Back

Additional Analysis

Theory •00000000

# Three Cases for Discussion

	Observability of Precision	Patient's Type
Benchmark	N.A.	Passive
Observable	Observable	Active
Concealed	Not Observable	Active

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### Benchmark: Passive Patients

### Proposition 1

When the patient is passive, i.e. she always accepts the doctor's recommendation, the doctor's optimal precision level will be:  $E^{passive} = 0.5 + \frac{\gamma(H-L)}{2k}$ .

• Doctor's optimal diagnostic precision is increasing with altruism parameter  $\gamma$ .

• 
$$gamma = 0 \rightarrow \mathsf{E}^{passive} = 0.5.$$

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## Prediction: Passive Clients

• Relationship among  $\gamma$ , H - L, and the optimal precision  $E^*$  (set k = 100):

**Optimal Precision with Passive Patients** 



# Observable vs. Concealed Conditions

### Lemma 1 (No Info Conflict)

When  $s^d = s^p$ , the patient always follows the doctor's treatment recommendation.

### Lemma 2 (Info Conflict)

When  $s^d \neq s^p$ , the patient follows the doctor's treatment recommendation only when  $E \geq q$  for Observable Condition or  $\hat{E} \geq q$  for Concealed Condition; otherwise, the patient will choose the treatment  $T = s^p$ .

• With information conflict, the patient listens to the doctor only if the doctor is (believed to be) more accurate than the patient's self-diagnosis,

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### Equilibrium Characterization: Observable Condition

### Proposition 2 (Observable Condition)

(1) For  $\gamma < 4k(q-0.5)/(H-L)$ , the doctor's equilibrium strategy is E = 0.5, and the patient will only follow her private signal. (2) For  $\gamma \ge 4k(q-0.5)/(H-L)$ , the doctor's equilibrium

strategy is  $E^{act\&obs} = 0.5 + \gamma (H - L)/2k$ , and the patient will follow the doctor.

# Prediction: Observable Condition

### • Visualization of equilibrium (set k = 100):



Equilibrium under Observable Condition



# Equilibrium Characterization: Concealed Condition

### Proposition 3 (Concealed Condition)

(1) For  $\gamma < 4k(q - 0.5)/(H - L)$ , the doctor's equilibrium strategy is E = 0.5, and the patient will only follow her private signal.

(2) For  $\gamma \ge 4k(q-0.5)/(H-L)$ , there will be two equilibria: (i) the patient believes that  $\hat{E} < q$ , and the doctor chooses E = 0.5;

(ii) the patient believes that  $\hat{E} \ge q$ , and the doctor chooses  $E^{act\&conceal} = 0.5 + \gamma (H - L)/2k$ .

• Under the Concealed condition, there is one more equilibrium among high-alignment doctors, where low precision and noncompliance occur.

# Prediction: Concealed Condition

• Visualization of equilibrium (set k = 100):



Equilibrium under Concealed Condition

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### Prediction: Observable & Concealed



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# Doctor's Decision Screen

### Round 1

In this round, you are matched with a ACTIVE client. This means that he/she may NOT always follow your recommended solution.

Please choose one of the six accuracy levels below to conduct the diagnosis.

The client will be able to observe your accuracy level.

Diagnostic Accuracy	○ 50%	0 60%	○ 70%	○ 80%	○ 90%	○ 100%
Cost of Diagnosis in Tokens	0	1	4	9	16	25

Note: In today's game, your assigned contract is 60-Contract. This means that if your matched client's problem is solved, you will gain extra 60 tokens.

#### Next

### Patient's Decision Screen: Concealed

### **Choose Treatment**

Your Own Information				
Your signal	Problem A			
Accuracy of Your Signal	60%			

Expert's Information				
Diagnostic Result	Problem B			
Solution Recommendation	Solution B*			
Please guess the expert's diagnostic accuracy	~			

Note: Solution A* solves Problem A. Solution B* solves Problem B. If you receive the correct solution, you will receive 120 tokens. If you receive the incorrect solution, you will receive 20 tokens.			
Which solution would you choose for solving your problem?			
○ Solution A*	○ Solution B*		

Next