مؤسسة قطر
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مؤتمر القمة العالمي للابتكار في الرعاية الصحية
World Innovation Summit for Health

GLOBAL DIFFUSION OF HEALTHCARE INNOVATION

USING BEHAVIORAL INSIGHTS TO ACCELERATE ADOPTION

Report of the Global Diffusion of Healthcare Innovation (GDHI) Working Group 2018

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Suggested reference for this report: Egan M, Brazier A, Mottershaw A, Ter Meer J, Hallsworth M, Fontana G, Parston G, Darzi A. Global diffusion of healthcare innovation: Using behavioral insights to accelerate adoption. Doha, Qatar: World Innovation Summit for Health, 2018

ISBN: 978-1-912865-10-9

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FOREWORD

What influences individual healthcare professionals to adopt innovations and to set aside old ways of working? This question has played an important part in influencing our research program on the Global Diffusion of Healthcare Innovation (GDHI) over the past five years. We have looked at system enablers and frontline behaviors that encourage adoption, but an individual's choice remains the essential step in ensuring that innovations in practice, products and policies are actually put into place.

This report focuses on the individual drivers of the diffusion of innovation. Specifically, we investigated whether cognitive biases, or thinking errors, among healthcare professionals make them less willing to adopt hypothetical new treatments, even when the treatments are superior to existing practice. Our research also tested whether relatively simple, inexpensive interventions can overcome these biases.

An important strength of clinical practice is doubt – questioning the veracity and validity of information that presents itself for clinical judgment. However, sometimes that strength may be undermined by mental shortcuts that can simplify decision-making. We certainly found that to be the case in our hypothetical experiments on the adoption of innovation. We also found, though, that there can be relatively simple ways to overcome these biases.

We hope that our findings will better inform health leaders about the role of cognitive bias in the adoption of innovation, encourage them to take steps to raise awareness among their colleagues, and provide them with the information and support to make the right judgments about the efficacy and adoption of healthcare innovations.

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EXECUTIVE SUMMARY

Building on the ongoing GDHI program, this report examines whether cognitive biases – mistakes in reasoning or judgment – affect the willingness of healthcare professionals to adopt healthcare innovations.

The report first presents two literature reviews which highlight an evidence gap on this topic. It then closes this gap with the results of two online experiments involving 1,824 healthcare professionals (41 percent doctors, 35 percent nurses, 24 percent non-clinical managers) from the US, UK, Germany, Spain and Qatar. These experiments show that:

1. Cognitive biases can make healthcare professionals less willing to adopt new healthcare innovations compared to continuing current practice.

2. Simple, low-cost graphical and behavioral interventions can reduce the effects of these biases and encourage the take-up of innovation.

Based on these findings, we make six practical recommendations to reduce the effects of these biases and thereby encourage the diffusion of innovation:

1. Raise awareness of cognitive bias in innovation take-up.

2. Build in 'breakpoints' in routine work processes to encourage reflection.

3. Strengthen metacognitive skills through training and feedback.

4. Structure communications in a way that: a) accepts that healthcare professionals will sometimes use heuristics (rules-of-thumb or problem-solving aids) to evaluate innovations; and b) works with (rather than against) these heuristics.

5. Use the types of graphical and behavioral interventions described in this report to reduce bias.

6. Test, learn and adapt these interventions to local conditions in order to optimize their effectiveness.

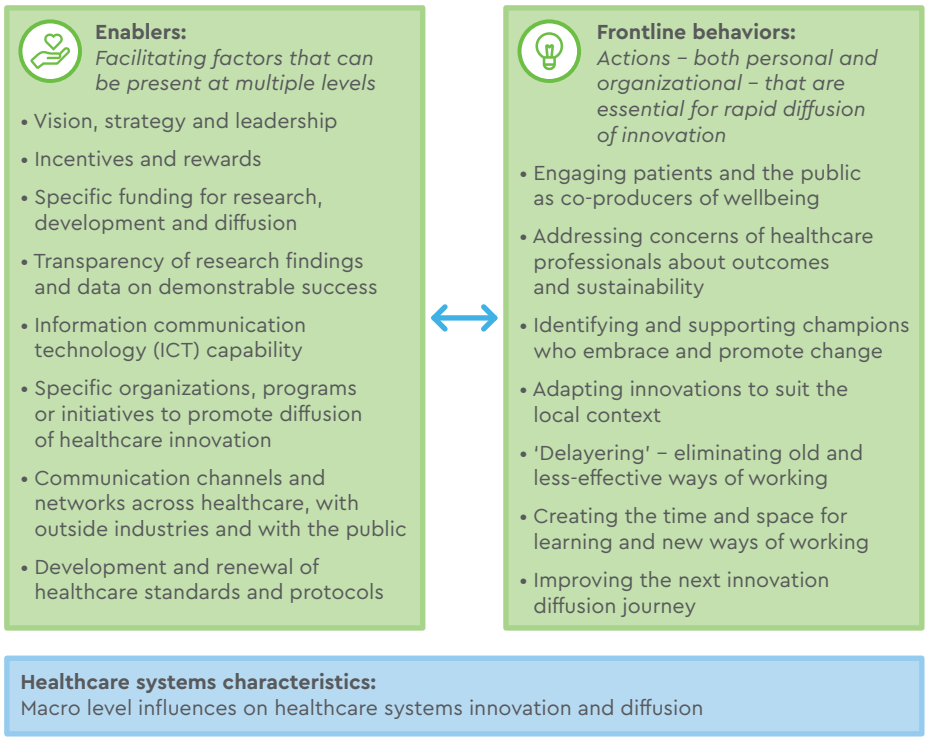
We encourage health leaders and innovation champions to review their existing communication materials and innovation diffusion channels in light of these findings, and to experiment with these intervention templates to address local challenges.

SECTION 1. BACKGROUND TO GLOBAL DIFFUSION OF HEALTHCARE INNOVATION

This research report focuses on overcoming behavioral biases in the adoption of healthcare innovation. It is part of an ongoing research program on the GDHI at the Institute of Global Health Innovation (IGHI), Imperial College London.

The GDHI program was initiated in 2013 with the development of a framework for the diffusion of healthcare innovation, which identified a number of system enablers and frontline behaviors that aid the adoption of innovation (see Figure 1).

Figure 1. Framework for diffusion of healthcare innovation



Source: Imperial College London

These enablers and behaviors were the focus of in-depth quantitative and qualitative studies, sponsored by Qatar Foundation and presented at the World Innovation Summit for Health (WISH) in 2013[1] and 2015.[2] A subsequent study, presented at WISH in 2016 focused on adoption of frugal innovation.[3]

The aim of the GDHI program is to deepen our understanding of the factors that can foster and facilitate the rapid adoption and diffusion of innovations. Ultimately, the goal is to produce better outcomes for patients and communities by helping health systems become more effective and efficient.

The individual IGHI studies have sought to identify practical ways health service leaders can encourage their fellow healthcare professionals to take up new and more efficacious healthcare practices, products and policies. We have found that the more effective system enablers include:

- having a clear vision of future practice
- developing a specific organization to manage change
- providing robust front-end funding for diffusion
- having effective communication channels in place across a wide range of stakeholders.

Similarly, frontline behaviors which encourage the successful adoption of innovation include:

- supporting local champions who embrace change
- harnessing the co-productive efforts of patients and the public
- directly addressing the concerns of healthcare professionals about outcomes and job sustainability.

With new technologies and genetic research, a proliferation of innovations have emerged, aimed at enhancing life expectancy, quality of life, preventative care, diagnostic and treatment options, as well as the efficiency and cost effectiveness of the healthcare system. Yet experience shows that it can take a very long time for many of these innovations to enter into practice, even when some facilitating enablers and behaviors are in place. Moreover, when evidence-based innovations are successfully adopted by individuals or by teams of clinicians in a hospital or clinical setting, they often fail to spread more widely across associated health systems. This hampered diffusion occurs partly because there are many other barriers to wider adoption.

Among these – as was found in the 2013 GDHI study – is the relative absence of three key frontline behaviors within the healthcare organizations that we have studied:

- creating time and space for learning
- adapting innovations to suit the local circumstances and setting
- eliminating old and less-effective ways of learning.

The last of these, in addition to delaying system transformation, can also lead in the interim to a piling up of multiple ways of providing treatment and care within the same system, or even organization. This multiplicity of practices, products and policies can be inefficient and less effective than new innovative ways of working. It can also become dangerous for patients. We have referred to this as a 'paleontological effect' – new practices piling on top of old – which is best addressed by what Oxford University's Sir John Bell has called 'delayering'. Delayering is an essential process in ensuring widespread adoption of innovation and ultimately system transformation.

We know from our research, however, that healthcare professionals can often be reluctant to switch from established practices to new ones. The reasons for this vary. In some cases, the innate strength of doubt, which underlies sound clinical diagnosis, can cause clinicians to hesitate. In other cases, the choice not to adopt a new way of working may involve 'rational' responses to local conditions related to local epidemiology, finance or peer pressure, among other factors.

However, there may also be other, less rational factors influencing these behaviors, such as psychological differences among healthcare professionals in terms of their general willingness to examine new practices, or risk adopting them. To date, there has been relatively little research examining the behavioral factors that discourage adoption of new ways of working and, as the counterpoint, prevent delayering.

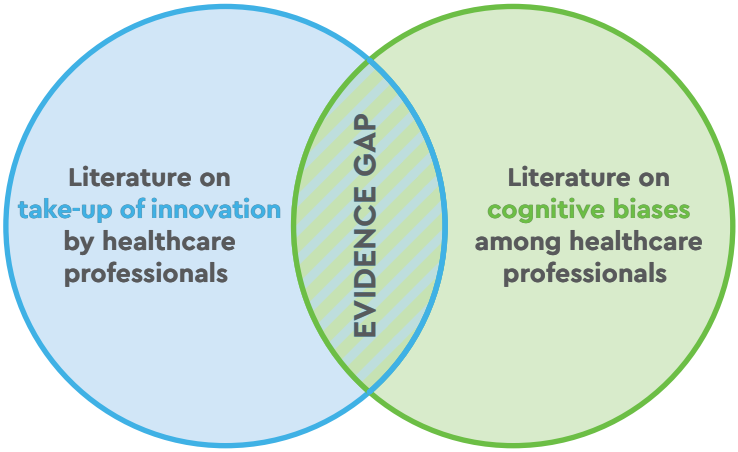
Working with The Behavioral Insights Team, a behavioral science research and consultancy organization, we sought to explore both the biases that hamper adoption and diffusion of healthcare innovations and to identify practical interventions – or 'nudges' – that health leaders can use to promote the adoption of new ways of working.

This report presents our initial study to uncover the cognitive biases that can affect the diffusion of innovation among healthcare professionals and to show how they can be reduced.

SECTION 2. INNOVATION AND THE JUDGMENTS OF HEALTHCARE PROFESSIONALS

Figure 2 describes the focus of this section. We conducted two separate literature reviews, looking at research results from the past decade – one on the context in which healthcare professionals adopt (or don't adopt) innovations, and another on how cognitive biases can affect their judgment. We then synthesize the two reviews to highlight an evidence gap on whether cognitive biases among healthcare professionals affect their willingness to adopt innovations.

Figure 2. The evidence gap highlighted by our literature reviews



When do healthcare professionals adopt innovations?

Our first review focused on the behaviors of healthcare professionals with regard to the adoption of innovation.

Frontline workers in healthcare systems, such as doctors, nurses, and non-clinical managers, play an essential role in implementing the 'final mile' of innovations by ensuring that they are actually put into practice. They can make or break an innovation's success by: addressing local concerns about the new practice; supporting champions who promote the change; adapting it to local contexts; and ensuring that, instead of being piled on top of existing practices, it is used to eliminate old, less-effective ways of working.[4]

Below we summarize the results, examining why some healthcare professionals are more likely than others to adopt healthcare innovations. The adoption of innovation in these studies is typically defined as implementing new evidence-based practices or proactively seeking out new research.

These studies find that:

- **Higher levels of education and positive attitudes to innovation are predictors of greater adoption.**[5,6] Healthcare professionals are more likely to adopt innovations when they have a positive attitude towards research and are more educated. Age and experience are not very important determinants of willingness to adopt innovation.

- **Proximity matters.**[7] A survey of 1,350 frontline healthcare workers found that they were, in descending order of likelihood, most likely to adopt interventions from colleagues, next from other organizations, and then from other countries.

- **There is a major research gap concerning which individual psychological characteristics predict healthcare innovation take-up.**[8] Research has largely not examined whether characteristics such as risk aversion, openness to experience, need for cognition (the tendency to engage in and enjoy thinking), motivation, and tolerance of ambiguity influence healthcare innovation take-up – even though research in other settings has found that these characteristics are all important predictors of workplace innovation.[9]

Do cognitive biases affect take-up of healthcare innovations?

A key insight of behavioral science research is that human decision-making is often influenced by heuristics and biases – that is, mental shortcuts that simplify decision-making but which can lead to errors of judgment.[10] This means that people's decisions are not always the product of a purely calculated, reasoned process. Instead, they can be influenced by people's emotional or psychological state, by contextual factors surrounding the decision, or by the way information is presented.

A wealth of research has examined how such psychological factors and cognitive biases can affect the judgment of healthcare professionals.[11,12] Empirical examples of this type of heuristic-based decision-making include:

- US emergency department physicians were 20 percent more likely to diagnose ischemic heart disease for a patient who had just turned 40 years old compared to a patient who was just under 40.[13] This may be an example of the representativeness heuristic, in that the doctors see patients in their forties as more representative of what a heart attack patient typically looks like, compared to patients in their thirties.

- Evidence for loss aversion bias was found among medical professionals, who were more likely to recommend a hypothetical treatment when it was described in terms of avoiding losses (that is, reducing the risk of patient death) rather than achieving a gain (such as increasing the chances of patient survival), even though both descriptions were statistically identical.[14]

- An experiment involving 347 clinicians working in England found possible evidence of source bias, by showing that clinicians were 20 percent more likely to say the findings in a scientific article were relevant to them when the origin of the study was changed from a low- to high-income country (even though the content of the article remained identical).[15]

Table 1 describes how these biases could affect the willingness of healthcare professionals to adopt innovations. The type of heuristic-based decision-making described in these examples is not necessarily 'wrong' – the nature of these heuristics is that they are quick rules-of-thumb which work reasonably well most of the time.

Table 1. Potential impact of cognitive biases on the diffusion of healthcare innovation

Bias definition	Potential impact on take-up of innovation
Outcome bias: Evaluating the quality of a decision by its outcome rather the process used to reach that decision.	Healthcare professionals who have seen many patients successfully recover following a particular treatment may prefer to keep using it, even if other treatments have a better success rate.
Loss aversion: The tendency to weigh losses more strongly than equally sized gains.	Healthcare professionals assessing a new practice may put more weight on its downsides than its benefits (including the fact that their experience of using the old method will no longer be seen as valuable if they switch to the new one).
Status quo bias: The tendency to prefer the current state of things for their own sake, rather than because it is superior to alternatives.	Healthcare professionals may prefer to stick to old practices simply because they are already familiar with them.
Sunk cost bias: Evaluating something based on how much resource has been spent on it already, rather than whether it's a good idea on its own merits.	Healthcare professionals may be reluctant to adopt a healthcare innovation if a lot of time, money or effort has already been spent on the existing process.
Source bias: The source of information can influence whether it is readily accepted.	Healthcare professionals may prefer to adopt innovations that originate from more prestigious or well-known sources (eg high-income countries) compared to less familiar ones.
Relative risk bias: The tendency to be more accepting of options when their relative superiority to existing options is emphasized.	Healthcare professionals may grasp the benefits of an innovation more quickly when its superiority to current practice is described in relative (rather than absolute) terms.

Our second review of literature from the past decade focused on cognitive bias among healthcare professionals. These reviews found:

- **Cognitive biases are common among healthcare professionals.**[16,17] Dozens of studies have found evidence of clinical decision-making being affected by cognitive biases, including relative risk bias, loss aversion, and overconfidence.

- **These biases are associated with diagnostic and clinical management errors.**[18–20] One caveat is that these errors are typically measured using hypothetical scenarios, rather than by examining real-world performance.

- **Two proven strategies for reducing biases are: (i) improve the decision-making ability of individual healthcare professionals; and (ii) give healthcare professionals better decision-support tools.**[21] Individual decision-making can be improved through education (that is, explicitly teaching people about cognitive biases or giving them guided-reflection or metacognition training) and cognitive forcing techniques (that is, forcing a clinician to consider an alternative diagnosis). Examples of decision-support tools include checklists, graphical aids, and formatting changes in the way information is displayed.

The evidence gap

Together, the two literature reviews on innovation take-up and cognitive biases suggest that the psychological characteristics of healthcare professionals – including their personality traits and general propensity towards heuristic-based reasoning – may affect their willingness to adopt innovations.

We speculated that some of these psychological characteristics may offer protection against cognitive biases. For example, people who score highly on measures of cognitive reflection[22] (the tendency to override 'gut instincts') and need for cognition[23] (the desire to ponder a problem more deeply) also tend to be less affected by biases. This is possibly because their preference for thinking through problems thoroughly means they are less likely to default to quick judgments.

This suggests that, when different healthcare professionals are considering whether to adopt an innovation, their evaluations may be affected by their psychological characteristics. For example, a recent study of 152 senior healthcare professionals in Australia found that doctors, nurses and managers differed in their average need for cognition (managers scored highest on this measure) and faith in intuition (the tendency to 'go with what feels right' when making decisions; nurses scored highest on this).[24] Given that the need

for cognition has been identified as an important antecedent of individual innovation in the workplace,[25] these types of psychological differences may encourage certain groups of healthcare professionals to adopt innovations more readily than others.

Based on these reviews, we derived three hypotheses:

1. Cognitive biases make healthcare professionals less willing to adopt healthcare innovations.

2. Healthcare professionals with certain psychological characteristics (greater need for cognition, lower risk aversion, greater openness to experience) will be more willing to adopt healthcare innovations.

3. The effects of cognitive biases can be reduced by changing the way information about the innovation is presented.

In the next stage of our research, we tested these hypotheses in two online experiments with 1,824 healthcare professionals from five countries.

SECTION 3. TESTING THE EFFECTS OF COGNITIVE BIAS

For Experiment 1, we designed six vignettes related to adoption of a healthcare innovation or new way of working. Each vignette had a neutral (control) version and a bias-inducing (treatment) version. In all cases the treatment version of the vignette was designed to make participants less likely to favor the new innovation.

We ran two small online pilot studies (total N = 51) of the experimental materials using samples of healthcare professionals recruited through Imperial College London.

In Experiment 1 we used a sample of 827 healthcare professionals from the US, UK, Germany, Spain and Qatar (in total, 39 percent doctors, 34 percent nurses, 27 percent non-clinical managers). We examined whether cognitive biases affect how healthcare professionals interpret information about healthcare benefits of new treatments and if this influences their willingness to adopt new healthcare innovations.

Figure 3. Design of Experiment 1

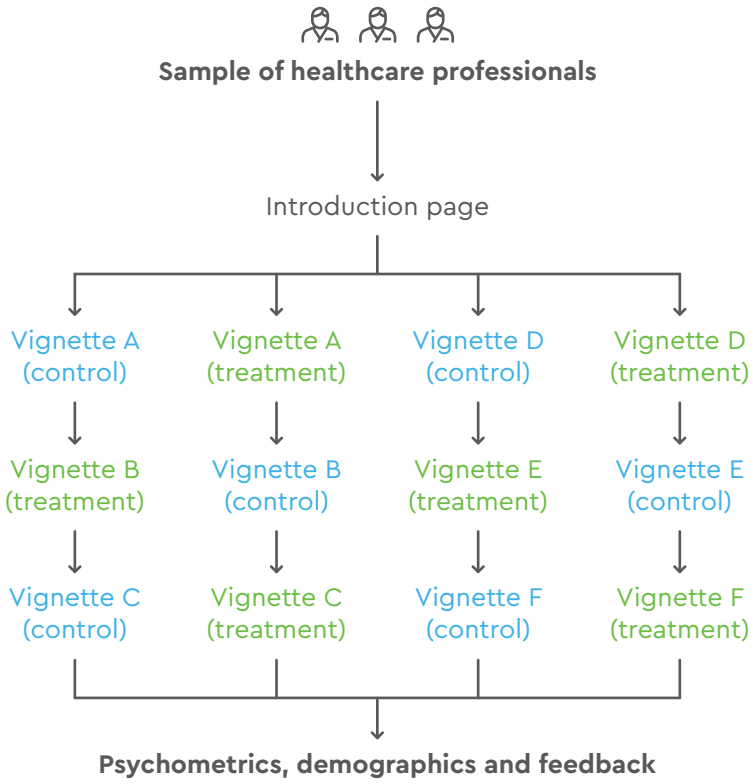


Figure 3 shows the experiment design. All participants saw an introduction page, and then were randomly assigned to see one of two tracks – control or treatment – each of which contained three vignettes. To isolate the effects of cognitive bias on people's decisions, we used a randomized controlled trial (RCT) design where participants were randomly assigned to see either a neutral (control) or bias-inducing (treatment) version of a vignette decision task.

All participants then completed psychometric questionnaires and provided demographic information and feedback about the survey.

For each vignette, participants saw a description of a healthcare situation and then had to choose between an existing healthcare treatment and a new one. We measured people's responses to these tasks and checked whether those who saw the bias-inducing (treatment) version of the vignettes were less likely to favor the new treatment. The six vignettes of Experiment 1, which were translated into German and Spanish for participants in those countries, are shown below.

Vignette A. Relative risk bias

Participants who saw the control (neutral) version saw the text in blue; participants exposed to the treatment (bias-inducing) version saw the text in green.

A new drug called 'Berotan' has just been developed to treat a dangerous viral disease. A group of university researchers has finished a study comparing the effectiveness of Berotan against Atarian, the drug currently used by most hospitals to treat the disease. The study involved 3,000 people infected with the virus. It examined whether people were more likely to survive over a six-month period, depending on whether they were given Atarian or Berotan. Here are the results of the study:

Control text	Treatment text
The proportion of patients who had died after six months was one-third lower among those who got Berotan compared to those who got Atarian.	Among patients who got Berotan, 96 percent were alive after six months. Among patients who got Atarian, 94 percent were alive after six months.

Compared to Atarian, would you say that Berotan is:

- Clearly worse
- Somewhat worse
- About the same
- Somewhat better
- Clearly better

Vignette B. Status quo bias

Participants who saw the control (neutral) version saw the text in blue; participants exposed to the treatment (bias-inducing) version saw the text in green.

Imagine you are a hospital service manager. You have been asked to allocate $2,200,000 in spending for the treatment of intestinal disease over the next three years. There are two treatment options, both of which are approved for use in your hospital:

- **Surgery.** This method is currently used in your hospital. It involves removing part of the patient's large intestine. All of the doctors working in the gastro-intestinal surgery department in the hospital are familiar with it.
- **Medication and monitoring.** This new method involves using medication in combination with camera monitoring. It is not currently used in your hospital, but staff could be trained to use it.

Here are data on the two methods:

Control				
	Number of hospitals in your country using this method	Years in practice at your hospital	Proportion of good patient outcomes nationally (%)	Proportion of bad patient outcomes nationally (%)
Surgery	345	11	74.0	26.0
Medication and monitoring	5	0	83.2	16.8
Treatment				
	Number of hospitals in your country using this method	Years in practice at your hospital	Number of good patient outcomes nationally	Number of bad patient outcomes nationally
Surgery	345	11	7,420	2,611
Medication and monitoring	5	0	134	27

Based on the above information, how would you allocate the $2,200,000 across the two treatments?

[Participants answer on a sliding scale ranging from "Spend 0% on surgery, 100% on medication" to "Spend 100% on surgery, 0% on medication"].

Vignette C. Outcome bias

Participants who saw the control (neutral) version saw the text in blue; participants exposed to the treatment (bias-inducing) version saw the text in green.

Imagine you are a heart surgeon with a 55-year-old patient named Sara. Sara has a serious heart condition that causes her chest pain. She has stopped working and finds it difficult to walk. She has now been referred for surgery. You have to choose which surgery to perform:

- **Still-heart surgery.** This involves temporarily stopping the patient's heart. Nationally, 15 percent of patients who have this operation do not survive. You have been using this method for 10 years. In that time you have done 154 operations using this method, and 132 of the patients survived.
- **Beating-heart surgery.** This is a new technique which allows the heart to continue beating during the operation. Nationally, 11 percent of patients who have this operation do not survive. You have been using this method for two months. In that time you have done seven operations using this method, and six of the patients survived.

You decide to do the beating-heart surgery.

Control text	Treatment text
The operation goes well and Sara survives.	The operation does not go well and Sara dies.

For your next surgery with a new patient, which method would you use?

- Still-heart surgery
- Beating-heart surgery

Vignette D. Sunk cost bias

Participants who saw the control (neutral) version saw the text in blue; participants exposed to the treatment (bias-inducing) version saw the additional text in green.

Imagine you are a hospital service manager. You have been asked to recommend what type of blood cancer treatment the hospital should use over the next five years. There are two options:

- **Chemotherapy.** This is the procedure the hospital uses now. It will cost $3,350,000 over five years. Three years ago, the hospital spent $750,000 on chemotherapy equipment. This equipment can now only be sold for a small amount of money if the hospital stops doing chemotherapy.
- **Radiation therapy.** This is a new procedure which the hospital does not currently do. It will cost $2,660,000 over five years, and another payment of $465,000 to install new equipment and hire specialist staff.

Both treatments are expected to be equally effective and safe for patients. Based on purely financial grounds, what would you recommend?

- Continue using chemotherapy
- Change to radiation therapy

Vignette E. Loss aversion bias

Participants who saw the control (neutral) version saw the text in blue; participants exposed to the treatment (bias-inducing) version saw the text in green.

Ben has been diagnosed with cancer. He has two treatment options:

- **Existing surgery techniques.** The standard practice for hospitals in Ben's area is to use surgery to treat his type of cancer. This involves a three-hour operation. After the surgery, most patients spend two or three weeks in the hospital.
- **A new type of radiation therapy.** This therapy is common in other countries, but is rarely used in the hospitals in Ben's area. It uses radiation to kill the cancer, and requires the patient to come to the hospital three times a week for a month.

Here are statistics on how patients tend to do after the two types of treatment:

Control text	Treatment text
• For every 100 people who get surgery, 10 are dead after one month, 32 are dead after one year, and 66 are dead after five years. • For every 100 people who get the radiation therapy, 0 are dead after one month, 23 are dead after one year, and 78 are dead after five years.	• For every 100 people who get surgery, 90 are alive after one month, 68 are alive after one year, and 34 are alive after five years. • For every 100 people who get the radiation therapy, 100 are alive after one month, 77 are alive after one year, and 22 are alive after five years.

Which treatment would you recommend for Ben?

- Surgery
- Radiation therapy

Vignette F. Source bias

Participants who saw the control (neutral) version saw the text in blue; participants exposed to the treatment (bias-inducing) version saw the text in green.

Imagine you are a hospital service manager. Your hospital uses standard 'Bronn' surgical drills for orthopedic (bone) surgery. These cost $33,200 each and have been used for many years by the surgeons in your hospital.

Control text	Treatment text
You have read about a new type of surgical drill developed by researchers from America's Harvard Medical School.	You have read about a new type of surgical drill developed by researchers from Uganda's Makerere University School of Medicine.

The new 'Ladox' drill is a commercial drill (like the drills used in industry) which is covered in a specially designed sterile bag. They cost $27,500 each. The developers have published a peer-reviewed study showing that the Ladox drill is as safe and effective as other clinical drills on the market. The study also shows how the drill is used in many hospitals in **America**/**Uganda**.

The hospital procurement system is about to automatically order Bronn surgical drills. You can change this if you prefer. Both drills are approved for use in your hospital.

Based on the above information, what would you do?

- Do nothing and let the system order Bronn drills
- Change the order to Ladox drills

Cognitive biases reduce adoption of innovation

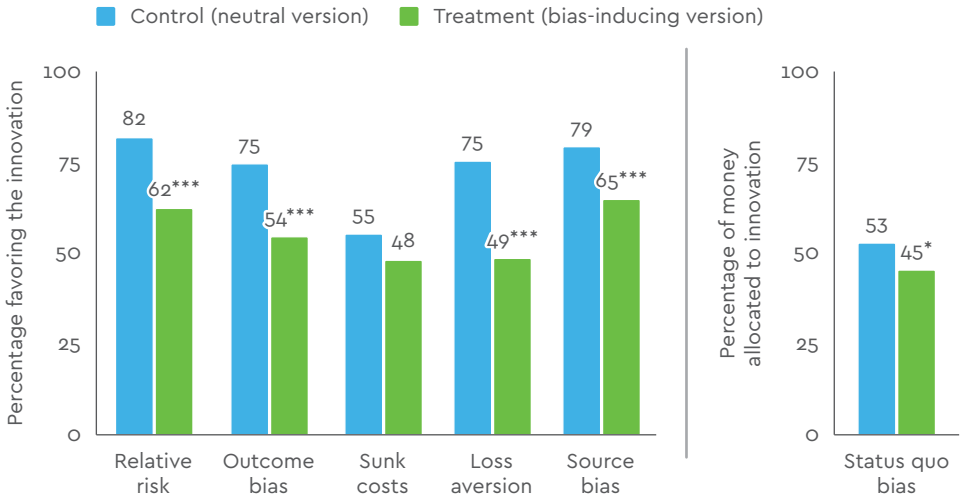
Figure 4 shows the (regression-adjusted) main results of Experiment 1. In all six vignettes, participants who saw the bias-inducing (treatment) version of the vignette were less likely to favor the new healthcare innovation.

Across all five countries, we found that the healthcare professionals surveyed were less likely to adopt the new practice when:

- the benefits of the new practice were described in absolute (96 percent versus 94 percent survival rate) versus relative (one-third lower mortality) terms (**relative risk bias**).

- using the innovation led to a salient poor outcome (death of a patient), even though it had a lower average national mortality rate than current practice (**outcome bias**).
- the money spent on current practice in the past was made salient, even though adopting the innovation would reduce future costs without harming quality (**sunk cost bias**).
- the benefits of the new practice were described in terms of the lives they would save ("22 are alive after five years") rather than the deaths they would prevent ("78 are dead after five years") (**loss aversion**).
- the innovation originated from a less well-known versus a well-known institution (**source bias**).
- the superiority of the innovation required cognitive effort to grasp (because the positive outcomes of the innovation were presented in raw numbers rather than in percentages) (**status quo bias**).

Figure 4. Results of Experiment 1



* $p<0.1$; ** $p<0.5$; *** $p<0.01$. *P*-values corrected for multiple comparisons.

After application of a statistical technique, the Hochberg multiple comparisons corrections procedure, we found statistically significant results (at $p<0.01$) for the relative risk, outcome bias, loss aversion and source bias vignettes. The status quo bias effect ($p=0.049$) was deemed not significant at the 5 percent level after correcting for multiple comparisons. The sunk cost bias effect was not significant ($p=0.19$), although exploratory analysis found that this *p*-value dropped dramatically (to $p=0.02$) when excluding Qatar, where the treatment vignette did not induce bias.

Figure 5 shows the results by country.

Figure 5. Proportion of Experiment 1 participants favoring the new innovation, by country

With respect to demographic and psychometric characteristics of the individuals surveyed, our regression results, summarized in Table 2, show that:

1. **Gender, age and experience were (mostly) not predictive of bias.** The only exception was that participants with more years of healthcare experience were less affected by outcome bias.

2. **Doctors were less likely than nurses to adopt the innovations.** Nurses were less likely than doctors to be affected by sunk cost bias, loss aversion and source bias.

3. **Participants with higher need for cognition and lower risk aversion were more likely to adopt (some) healthcare innovations.** Participants with higher need for cognition were less affected by outcome bias and sunk costs bias, and those with lower risk aversion were less affected by loss aversion bias.

Table 2. Summary regression results from Experiment 1

	Outcome = Likelihood of favoring the healthcare innovation					
	Relative risk bias	Status quo bias	Outcome bias	Sunk cost bias	Loss aversion bias	Source bias
Treatment (vs control)	↓	↓	↓		↓	↓
Demographics						
Female (vs male)						
One year increase in age						
One year increase in experience			↑			
Job type						
Nurse (vs doctor)				↑	↑	↑
Non-clinical manager (vs doctor)						
Psychometrics						
Need for cognition (one SD increase)			↑	↑		
Risk-aversion (one point increase)					↓	
Openness (one SD increase)						

Key: Up arrow = higher statistically significant ($p<0.05$) probability of favoring the innovation; down arrow = lower statistically significant ($p<0.05$) probability; blank = no significant effect ($p>0.05$).

In summary, these results supported our first hypothesis that cognitive biases would make healthcare professionals less willing to adopt healthcare innovations, but only partially supported the second hypothesis that need for cognition, risk aversion, and openness to experience would predict greater willingness to adopt innovations.

SECTION 4. REDUCING THE EFFECTS OF COGNITIVE BIAS

Experiment 2 again used an RCT design to test our third hypothesis – that relatively simple interventions could reduce the effects of cognitive biases on healthcare professionals' evaluation of innovations and thereby make them more willing to adopt these innovations.

Experiment 2 carried over four of the vignettes used in Experiment 1: outcome bias, source bias, status quo bias, and sunk cost bias.* This time, the control version of the vignettes used the text that was used in Experiment 1 to induce the bias (that is, the treatment version of the vignette in Experiment 1). For each vignette, we tested the bias-inducing control version against two alternate versions that added a simple intervention to the control text:

- **Graphical interventions**, which used graphs to visually emphasize the superiority of the innovation to current practice.
- **Behavioral interventions**, which used messages, informed by behavioral science research, to help participants overcome the effects of cognitive bias and thereby be more likely to adopt the innovation.

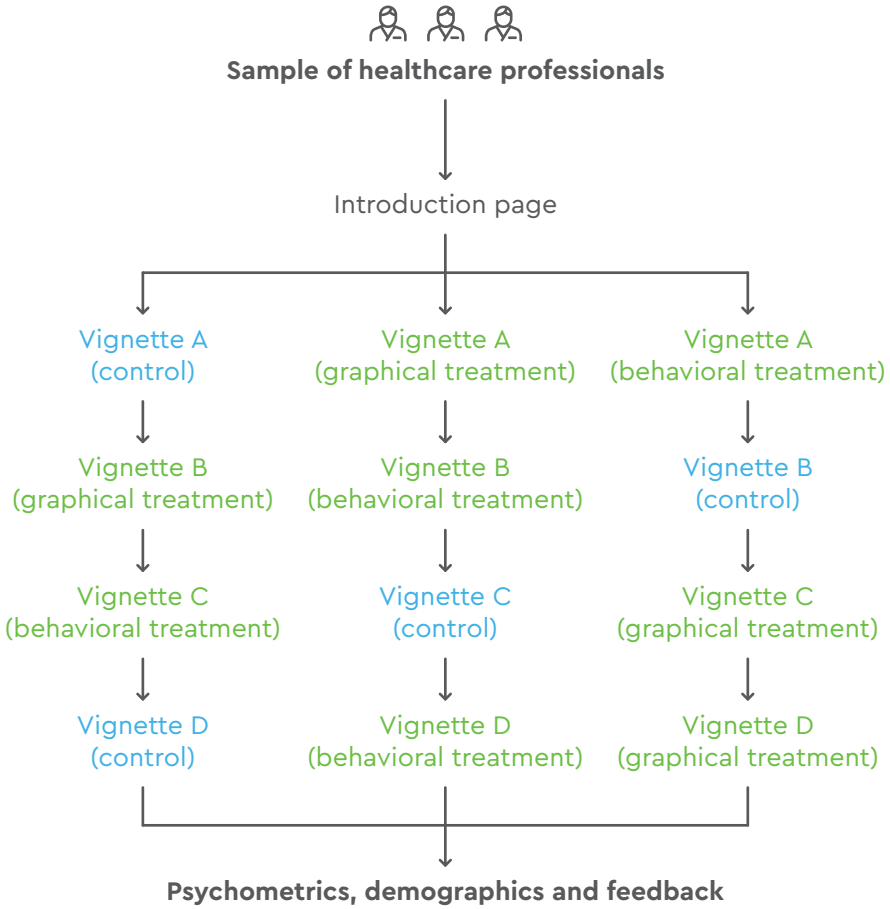
Before conducting the main experiment, we ran an online pilot involving 176 healthcare professionals. As in the previous experiment, all materials were translated into German and Spanish for participants in those countries.

Experiment 2 used a sample of 997 healthcare professionals from the US, UK, Germany, Spain and Qatar (in total, 43 percent doctors, 36 percent nurses, 21 percent non-clinical managers). None of the participants from the US, UK, Germany, or Spain took part in Experiment 1. We were not able to measure whether the participants based in Qatar in Experiment 2 also took part in Experiment 1.

* We did not test debiasing strategies for relative risk bias and loss aversion. This is because we thought the results of Experiment 1 showed that these biases already have implicit solutions. Specifically, we suggest that communications about the benefits of healthcare innovations could take advantage of these biases relatively easily, by simply reframing information in a slightly different way. This makes them different from the other vignettes, where the bias is induced by facts that cannot be altered by merely changing the language used to describe those facts. For example, communications about the benefits of an innovation could emphasize the innovation's relative (rather than absolute) superiority over current practice (eg by saying it is "25 percent cheaper" or leads to "15 percent fewer bad patient outcomes"). This would effectively take advantage of relative risk bias. Similarly, describing the benefits of a new treatment in a way that capitalizes on loss aversion could involve describing the deaths it might prevent rather than the lives it might save. In both these cases, we think that simple reframing could be an effective strategy for changing behavior.

Figure 6 shows the experiment design. For each vignette, participants were randomly assigned to see one version only: the control version, the graphical intervention version or the behavioral intervention version.

Figure 6. Design of Experiment 2



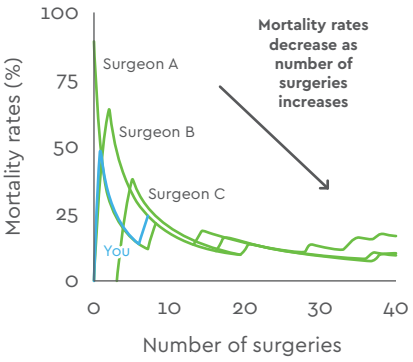
The graphical and behavioral interventions used in Experiment 2, which are summarized in Table 3, were designed to help people overcome the four biases and thereby be more likely to favor the innovations.

Figure 7. Summary of the graphical and behavioral interventions used in Experiment 2

Outcome bias

A named patient dies after receiving the new treatment.

Graphical intervention



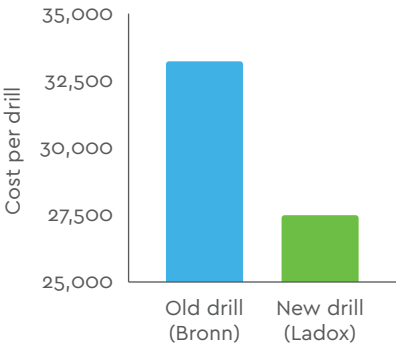
Behavioral intervention

"The Royal College of Surgeons has recommended the widespread adoption of beating-heart surgery because of its proven lower mortality rate. They recommend that heart surgeons begin using this method now and continue using it in the future."

Source bias

A new type of surgery drill is as safe and effective as the current drill and is significantly cheaper but originates from a less well-known institution.

Graphical intervention



Behavioral intervention

"A respected orthopedic unit in your country has released a video showing its surgical teams using the new Ladox drill. The surgeons in the video say the new drill performs as well as existing Bronn drills, and has no significant drawbacks. They recommend using the Ladox drill given its lower cost."

Status quo bias

A new type of treatment has better patient outcomes than the current practice, but some cognitive effort is required to grasp this.

Graphical intervention

Surgery

26 of every 100 patients have had bad outcomes

Medication

17 of every 100 patients have had bad outcomes

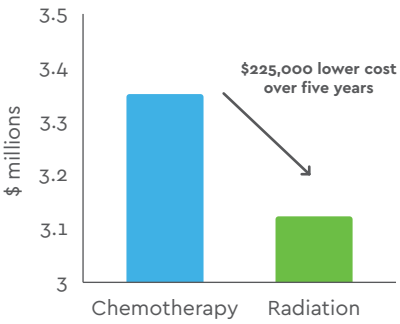
Behavioral intervention

"These statistics show that patients who receive medication and monitoring are 35% less likely to have bad outcomes compared with patients who have surgery."

Sunk cost bias

A new type of treatment is as safe and effective as current practice and is significantly cheaper, but resource has recently been spent on the current practice.

Graphical intervention



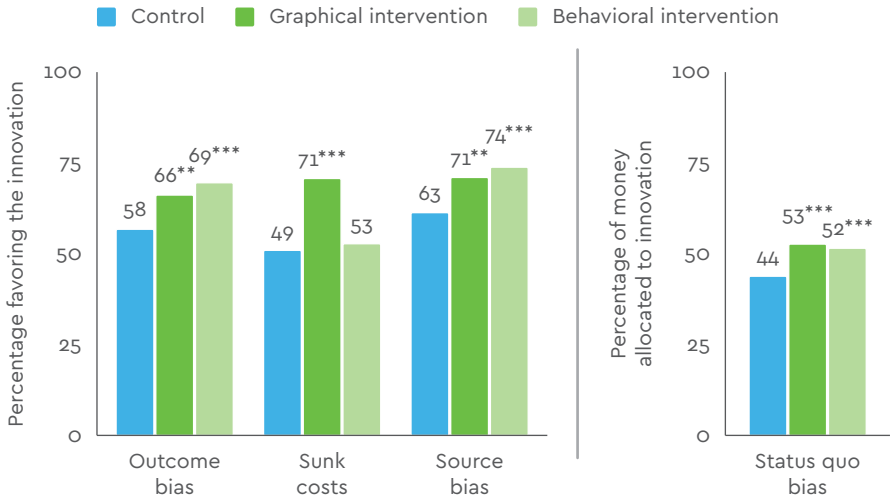
Behavioral intervention

"Remember that past costs cannot be changed, so please focus on how best to spend this money in future."

Results of Experiment 2

Figure 8 shows the (regression-adjusted) main results. Across all five countries, and after application of a Hochberg multiple comparisons corrections procedure, we found that healthcare professionals were significantly more likely to favor the innovation in seven of the eight treatment conditions.

Figure 8. Results of Experiment 2



* $p<0.1$; ** $p<0.05$; *** $p<0.01$. *P*-values corrected for multiple comparisons.

These results support our third hypothesis that the effects of cognitive biases can be reduced by using simple informational interventions – in this case, graphical or behavioral framings – to emphasize the benefits of the innovation. Specifically, we found that:

- **Outcome bias** was reduced by: (i) a graph showing that the average mortality rates for the patients of surgeons practicing the innovation tended to go down over time ($p<0.05$); and (ii) a behavioral message highlighting that the innovation was recommended by a respected authoritative body (such as the 'Royal College of Surgeons' for the UK participants) ($p<0.01$).

- **Source bias** was reduced by: (i) a graphical intervention which emphasized that the innovation was as safe and effective as the old one, and was significantly cheaper ($p<0.05$); and (ii) a behavioral intervention saying that "a respected orthopedic unit in your country" recommended the innovation ($p<0.01$).

- **Status quo bias** was reduced by: (i) a graphical intervention which emphasized that the new treatment led to better patient outcomes ($p<0.01$); and (ii) a behavioral intervention stating that the patients who got the new treatment were 35 percent less likely to have bad outcomes ($p<0.01$).

- **Sunk cost bias** was reduced by a graphical intervention showing the lower future costs of the innovation ($p<0.01$). The behavioral message, which encouraged people to focus on future costs when evaluating the innovation, was not effective ($p=0.59$).

Figure 9 shows the results by country.

Figure 9. Proportion of Experiment 2 participants favoring the new innovation, by country

Our regression results, summarized in Table 3, replicate several of the findings from Experiment 1. Once again, gender, age and experience were (for the most part) not predictive of bias; doctors were (sometimes) more biased than nurses; and participants with higher need for cognition (those identified with a strong tendency to engage in and enjoy thinking) were more likely to adopt innovations.

Table 3. Summary regression results from Experiment 2

	Outcome = Likelihood of favoring the healthcare innovation			
	Outcome bias	Source bias	Status quo bias	Sunk cost bias
Graphical treatment (vs control)	↑	↑	↑	↑
Behavioral treatment (vs control)	↑	↑	↑	
Demographics				
Female (vs male)				
One year increase in age	↑			
One year increase in experience				
Job type				
Nurse (vs doctor)		↑		
Non-clinical manager (vs doctor)				↑
Psychometrics				
Need for cognition (one SD increase)	↑	↑		↑

Key: Up arrow = higher statistically significant ($p<0.05$) probability of favoring the innovation; blank = no significant effect ($p>0.05$).

SECTION 5. RECOMMENDATIONS

This research, as far as we are aware, is the first to systematically examine how cognitive biases might affect the willingness of healthcare professionals to adopt healthcare innovations. Our experiments found that healthcare professionals in the US, UK, Germany, Spain and Qatar were affected by a range of cognitive biases which made them less willing to adopt (hypothetical) healthcare innovations that delivered superior outcomes. We also found that these biases could be reduced by relatively simple graphical or behavioral interventions.

A limitation of these results is that they are hypothetical and presented in a simulated online environment, whereas healthcare professionals in the real world would have access to much more information than is presented in our vignettes. That said, healthcare professionals in the real world do not have an infinite amount of time to evaluate innovations, and will sometimes need to use heuristics to evaluate them. This means that there will likely continue to be space for cognitive biases to affect how innovations are viewed and eventually adopted.

Based on the findings from the literature and our experiments, we identify two sets of actions and six practical steps that healthcare professionals and leaders can take to reduce the effects of cognitive bias on innovation take-up. We end with one final recommendation for future research in this field.

Action set 1. Strengthen the reasoning skills of healthcare professionals

One way to reduce cognitive biases is by encouraging people to 'think harder', by educating them about biases and discouraging them from relying too much on heuristic-based evaluations for important decisions.[26] Health leaders could facilitate this by implementing three practical steps:

1. **Raise awareness** of cognitive bias in innovation take-up among healthcare professionals. Frontline health workers may be aware of potential biases in diagnostic judgments, while biases in the adoption of innovation are less acknowledged. Health leaders should communicate the existence of such biases as a first step to address the issue.

2. **Build breakpoints** in routine workflows. Making time and space for learning has been a frequent finding of GDHI research and is the case again here. Informing healthcare professionals about the existence of biases will not always be enough, since overcoming the biases also requires cognitive

capacity and motivation to change existing workflows.[27] Health leaders could enable frontline workers to 'stop and think' by having regular break-point sessions where health workers are asked to actively reflect on their adoption of new products, practices and policies.

3. **Strengthen metacognitive skills** of healthcare professionals. Health leaders could incorporate metacognitive training into existing modules on diagnostic judgments, where health workers are asked to reflect on the way they process information about innovations.

Action set 2. Make it easier to grasp the superiority of innovations

The problem of cognitive biases in healthcare cannot be solved only by encouraging healthcare professionals to 'think harder' – the ability to deploy mental heuristics at great speed, low cost, and with generally high accuracy means that these cognitive shortcuts will remain a valuable tool for people operating in busy healthcare environments.[28]

Health leaders should therefore also aim to 'make it easy' for healthcare professionals to identify the benefits of innovations. We recommend three steps to help achieve this:

1. **Structure communications in a way which accepts that healthcare professionals will sometimes use heuristics to evaluate innovations, and which works with (rather than against) these heuristics.** Healthcare professionals working in resource-constrained environments will continue to rely at times on quick mental rules-of-thumb for evaluating innovations. Health leaders should design their innovation communications in a way that makes it easier for a person using heuristic-based judgment to easily grasp the comparative benefit of the innovation. An example of this is our behavioral message to reduce status quo bias ("*patients who receive [the new treatment] are 35 percent less likely to have bad outcomes compared with patients who have [the old treatment]*").

2. **Use the types of graphical and behavioral interventions described in this report to guide heuristic-based decision-making**. Appropriately designed graphs and behavioral messages, such as those used in Experiment 2, can emphasize the benefits of innovations in a way that makes their superiority to existing practice easier to grasp. These types of interventions could be used in institutional communications about innovations, and by local innovation champions in smaller units within organizations.

3. **Test and adapt** the types of interventions described in this report.[29] Although we found robust results for some graphical and behavioral interventions across five countries, there is no 'one size fits all' solution to reduce cognitive bias in all healthcare settings. Health leaders should use the interventions presented here as a starting point and test different variations to find out what works best in their own local context.

Cognitive biases can affect clinical choices about the take-up of innovation. As a final recommendation for future researchers, we suggest that research should move beyond the environment of online hypothetical experiments to the real world. This means investigating in practice the extent that these biases affect the willingness of frontline healthcare professionals to adopt innovations.

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WISH gratefully acknowledges the support of the Ministry of Public Health

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ISBN 978-1-912865-10-9

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