of interest. Without any other information, we may consider both models equally likely to occur and assign equal prior probabilities to each model. That is,

\[
\begin{align*}
\text{Pr}(p = 0.17) &= 0.50 \\
\text{Pr}(p = 0.22) &= 0.50 \\
\end{align*}
\]

Assigning a prior distribution is often based on historical information, previous literature, expert opinion, or other appropriate sources. This assignment is subjective in nature, and there is no single 'correct' prior distribution. This is the most common criticism of Bayesian analysis. However, the prior distribution has less influence on analysis results as sample size increases.

Next, our previous knowledge (i.e., prior) is combined with our observed data to calculate posterior probabilities. The posterior probabilities represent the probability of each model given the observed data, and calculations are obtained using the following conditional probability relationship:

\[
\text{Pr}(\text{model} | \text{data}) = \frac{\text{Pr}(\text{model} \& \text{data})}{\text{Pr}(\text{data})}
\]

For instance, suppose that we observe one astronaut (A) who does not have a cataract (B). Combining this information with our prior probabilities we have

\[
\begin{align*}
\text{Pr}(p = 0.17 | B, A) &= (0.50 \times 0.17) = 0.085 \\
\text{Pr}(p = 0.22 | B, A) &= (0.50 \times 0.22) = 0.110
\end{align*}
\]

The probabilities are then updated with the next observation using the previous calculation as the prior probabilities. Suppose the second observation is an astronaut (A2) who has a cataract (B2), then the posterior probabilities are

\[
\begin{align*}
\text{Pr}(p = 0.17 | B, A, B_2) &= (0.085 \times 0.17) = 0.00145 \\
\text{Pr}(p = 0.22 | B, A, B_2) &= (0.110 \times 0.22) = 0.02420
\end{align*}
\]

According to Cucinotta et al., 48 out of 295 astronauts had developed cataracts as of 2000. In this case, the posterior probabilities are

\[
\begin{align*}
\text{Pr}(p = 0.17 | 295a, 48c) &= 0.95 \\
\text{Pr}(p = 0.22 | 295a, 48c) &= 0.05
\end{align*}
\]

Thus, Bayesian analysis strongly supports no difference between the prevalence of cataracts in astronauts versus the U.S. population over 40 years of age because there is 95% probability that the true prevalence of cataracts in astronauts is \( p = 17\% \). There is only a 5% probability that the true prevalence of cataracts in astronauts is \( p = 22\% \). Note, however, that this example is provided for explanatory purposes only and should not be interpreted as a thorough analysis of this dataset. Cucinotta et al. did not compare cataract incidence in astronauts to the incidence in an external population. They reported an increased risk of cataracts in astronauts with higher lens doses of space radiation compared to astronauts with lower lens doses. More sophisticated Bayesian analyses may consider many (i.e., infinite) alternative models, confounding variables, and time to cataract development.

References:

A Brief Introduction to Bayesian Statistics

BY CHARLES MINARD, PhD

Many researchers are surprised to learn that there are two branches of statistics that fundamentally differ in approach to statistical inference: Frequentist and Bayesian. Both methods may be used to answer statistically relevant questions; however, each method requires different assumptions and interpretation of analysis results. Historically, Frequentist statistics have dominated the literature, but Bayesian statistics have become increasingly popular alternative in recent years. The purpose of this article is to provide an introduction to Bayesian analysis.

One of the most common problems in epidemiologic research is to compare the occurrence of adverse events between two groups of people. Consider the prevalence of cataracts in astronauts compared with that of the U.S. population. The prevalence of cataracts among Americans at least 40 years of age is about 17%. Now suppose that we are interested in whether cataract prevalence in the astronauts is the same as or 5% greater than the U.S. population. We might consider two possible models for the prevalence of cataracts in astronauts: \( p = 17\% \) and \( p = 22\% \). Bayesian analysis asks “What is the probability of the model given the observed data?”,

\[
\text{Pr}(\text{model} | \text{data})
\]

This is opposed to the Frequentist methodology which asks “What is the probability of the observed data given the model?”,

\[
\text{Pr}(\text{data} | \text{model})
\]

The first step in Bayesian analysis is to establish a prior distribution for the parameter

continued from page 1

Ten Steps to Consider Before Taking Over-the-counter Medications

BY ADRIANA BAHIK-VAZQUEZ, MPH

The use of over-the-counter (OTC) medications has been steadily increasing through the years. Unfortunately, the precautions we take in the use of self-medication have not increased. Of particular concern is consumption of multiple OTC medications, sometimes in conjunction with prescribed medications for unrelated acute or chronic illnesses.

It is this ‘mixing and matching’ in actual use that can prove dangerous to our health since most medications, OTC or prescription, have not been clinically tested in the myriad of combinations possible. Some OTC medications are actually combinations of several medications which treat different symptoms. One popular OTC cold and flu medication contains acetaminophen, chlorpheniramine maleate, dextromethorphan hydrobromide, and phenylephrine. This OTC medication advertises that it “relieves the headache, body aches, minor sore throat pain, and fever that accompany colds and flu.” It also unclogs stuffy nose and sinus, relieves cough due to minor throat and bronchial irritation, and combats runny nose, sneezing, itchy nose and throat, and itchy, watery eyes.” Therefore, often as we combine OTC drugs with each other or with prescription medications, we...
A pandemic is defined as a global disease outbreak. A flu pandemic occurs when a new influenza virus emerges for which people have little or no immunity, and for which there is no vaccine. The disease spreads easily person to person, can cause serious illness, and can sweep across the country and around the world in very short time. In the past 400 years, a total of 32 pandemics have been recorded with the first described in 1580; in the past century, three major influenza pandemics occurred in 1918, 1957, and 1968. The pandemic of 1918, 1919 was felt in three waves and was by far the most devastating, resulting in the death of 20 to 40 million disproportionately young people worldwide. One of the most important features about influenza viruses is that their structure allows them to adapt to changing conditions. Currently, there are three distinct influenza virus strains in general circulation in humans: seasonal influenza, avian flu, and potentially pandemic organisms such as HSN1 commonly called “bird flu.” Since 2003, a growing number of human HSN1 cases have been reported in Asia, Europe, and Africa. According to the World Health Organization, WHO, 61% of the people infected with the HSN1 virus died with most of these cases attributed to the ingestion of infected food. In addition, there has been documented human-to-human transmission in clusters extending three generations. For this reason, there is potential for this virus to travel around the world quickly and cause serious illness and deaths. The next pandemic, an event considered by many experts to be inevitable, could be toxic to the liver. Each individually may cause irreparable damage, but when taken together even more serious injury or death may occur.

If you are not a toxicologist, pharmacist or physician, how can you avoid these dire consequences? Consider the following ten steps recommended by the Food and Drug Administration before consuming OTC medications:

1. PRODUCT NAME: Take note of both the generic and brand names. The names focus on detecting circulating strains through virologic surveillance and evaluation of morbidity and mortality. The influenza vaccine and antivirals such as amantadine, rimantadine, zanamivir (Relenza®), and oseltamivir (Tamiflu®) form part of the control and prevention of influenza. Other measures, including severely limiting travel, may also be employed to slow the spread of the virus. All state and local governments are required to have an emergency management plan that addresses all hazards. The emergency management plans of hospitals, nursing homes, schools, and other congregate settings should incorporate a pandemic influenza plan in addition to their existing plans. In addition, it is also recommended that physician practices develop plans to manage the large numbers of patients seeking care. However, these plans are very difficult to construct and implement given the dynamics of our current system.

2. ACTIVE INGREDIENTS: It is very important to note all the main ingredients in the therapeutic product to avoid accidentally overdosing on the ingredient for the other medications you may be taking.

3. PURPOSE or USES: Know what this non-prescription medicine is treating and what the purpose of consumption is. The two are not necessarily the same; for example you may take a fever-reducer when you actually need a painkiller, or you may take a cough suppressant when you need an antihistamine or a decongestant, or you may actually need a combination of all of the above.

4. SIDE EFFECTS: Be aware of possible side effects or reactions that may occur when taking a particular OTC medication. Note what steps you need to take if these symptoms occur (e.g., “Call physician immediately”).

5. WARNINGS: Know what activities to avoid when taking medication (e.g., “don’t operate a moving vehicle while on medication”). Also, note if the medication is not suitable for people with certain diagnoses or chronic health problems (e.g., people with glaucoma, thyroid disease, diabetes, hypertension or on hypertensive medications).

6. DIRECTIONS: Ask yourself these questions: How much should you take a day, per dose (i.e., how many pills at a time)? When should you take it (e.g., time of day, before or after a meal)? How long should you take it or what period of time not to extend (e.g., “do not use longer than 5 days without seeing a physician?” How should you take it (e.g., with a full glass of water or with food or an empty stomach)?

7. SPECIAL INSTRUCTIONS: Note if there are special instructions and follow them (e.g., “Patients should avoid sun exposure when taking this medication”).

8. INACTIVE INGREDIENTS: These are substances such as flavoring or color added or binding. Sometimes these ingredients can cause allergic or unexpected reactions, especially in chemically sensitive people.

9. EXPIRATION DATE: Discard promptly after reaching expiration date. Expired therapeutic products may not work as effectively and in some cases can be harmful if ingested.

10. STORAGE INFORMATION: Be aware if the OTC medication needs to be kept refrigerated or in a cool area. Not all packaging-indicates this clearly; some packaging may simply list a temperature range for storage. Do not leave medications on the window sill, in a car, in your luggage, or in a warm house. All these conditions can leave medications exposed to heat or cold. Also, note if the medication needs to be protected from light. This is especially important when removing pills from an original container and placing them in another container that may not have special taping for light protection.

Keeping these ten items in mind may save a lot of aggravation and heartache. Remember, there is nothing on the therapeutic product label that is placed there lightly or as a general statement. If you need additional information or clarification about both OTC medications and their specific interactions with prescription medications, consult with your pharmacist and/or with your physician. It is imperative to your health that your physician know all of the medications you are taking, either with or without a prescription. Help your doctor and pharmacist to help you to stay safe—keep them informed of the OTC and prescription medications you are taking.

References: